DOCTOR OF PHILOSOPHY

Naming and generalisation of behaviour in infants

Hughes, J. Carl

Award date:
2000

Awarding institution:
University of Wales, Bangor

UNIVERSITY OF WALES

NAMING AND GENERALISATION OF BEHAVIOUR IN INFANTS

J. CARL HUGHES

Thesis submitted for Doctor of Philosophy

School of Psychology

University of Wales, Bangor

September 2000

ACKNOWLEDGEMENTS

Although there is only one name on this thesis, it would not have been possible without the help I received from many people. If any thesis deserves an "et al.", this is it.

I owe a great debt of gratitude to both my supervisors for their hard work and guidance. I would like to thank Professor Fergus Lowe for giving me the *testing* opportunities over the past years, and, in his subtle and encouraging manner, guiding me when I erred. I would like to thank Dr. Pauline Horne for gentle support and timely positive reinforcement just when it was needed most.

I would like to thank to Mr. Edward Ingram for being my industrious, hardworking, ardent, and enthusiastic teacher; for teaching me to hate superfluous, useless, irrelevant, and meaningless adjectives, and, also, for teaching me to additionally hate all tautologous, repetitive statements too; and for his shaping of my writing behaviour.

I would also like to thank the staff at Tir Na N'Og for all their help and support, and the lovely children who participated in this research for making the data collection fun.

Thanks are also due to Praveena, for all her help and hard (frustrating) work; to the teckies, Dave, Steve, Gaz, Sion, for their technical support and computer assistance; and to the support staff in the School of Psychology, for their help over the years. Thanks too to Mike, for his humour and expert APA proof reading; to Jaci, for her chats; and to my fellow PhD students, Faye, Val, and Mags, who blazed the trail for me to follow. I owe all a debt of gratitude.

I also thank my family, who often shared the stress, but seldom the praise. I thank them for their support.

I'd like to thank the lovely Joanna, my WIFE (there I said it!). I thank her for being there through it all. Here's to the next nine years — and hoping they'll be as good as the last.

I'd like to thank my friends Dean, Kyle, P.O., Huw Lloyd, Paul Bradley (my first academic mentor), and all the lads — I thank them for the good times, and I thank Jim for his support and help.

Finally, a message to my mother and father:

Mum, I think the fortune teller was right, and Dad, I wish you could have seen it.

Diolch pawb. JC

This thesis is dedicated to my mother and father.

ABSTRACT

Horne and Lowe (1996) define *naming* as a higher order bidirectional relation that incorporates listener and speaker functions such that objects given the same name enter into a class and become functionally related. Behaviour trained to a subset of this class may generalise to other members without direct training. A key prediction of the naming account is that naming is necessary for the categorisation of formally unrelated objects and events. A series of studies was conducted to tests this prediction by attempting to demonstrate categorisation in the absence of naming behaviours. The behavioural measure of categorisation adopted was *categorisation by generalisation*; this tested whether behaviour trained to a subset of a potential stimulus class generalised to untrained members of the potential class.

Study 1a investigated whether children between 2.5 and 4 years showed categorisation of formally unrelated stimuli following only common listener training; four out of four children succeeded on a naming test (tact test) and demonstrated categorisation. Study 1b tested for the extension of classes from three to six-member classes; all three participants demonstrated naming and extension of classes. Study 2 investigated whether children of a similar age group showed categorisation following only common speaker training; all four children succeeded on a naming test (listener behaviour test) and demonstrated categorisation. Study 3 further examined these issues using a modification of the design used in Study 1a and 2.

Study 4 (common listener training) replicated Study 1a with six children under 2.5 years old; two failed a naming test and failed to categorise. Study 5 (common speaker training) likewise replicated Study 2 with three children under 2.5 years old; all three children passed a naming test and categorised.

Studies 1a through 5 incorporated a naming test *prior* to testing for categorisation. Studies 6 and 7 investigated whether the temporal position of the naming tests affected the incidence of naming behaviour. Study 6 (common listener training) replicated Study 1a with four children, except that the naming test occurred *after* the categorisation tests; two children failed to categorise and both failed to name. Similarly, Study 7 (common speaker training) replicated Study 2 with three children except that the naming test occurred *after* the categorisation tests; all three categorised and named.

Studies 8a, 8b, 9a, and 9b examined the generalisation of vocal behaviours following either baseline common listener training (8a & 8b) or common speaker training (9a & 9b) through the gestural modality; all four children demonstrated categorisation and named.

Chapter 7 summarises all the studies' findings and discusses their implications for behaviour analytic accounts of categorisation. Taken together, the findings suggest that children who name formally unrelated objects can categorise them, and children who do not name formally unrelated objects cannot categorise them. These results provide **correlational** support Horne and Lowe's (1996) account of naming, and they extend the data on stimulus class formation in infants.

CONTENTS

CHAPTER 1

> Every time we see something as a *kind* of thing, for example, a tree, we are categorising (Lakoff, 1987, p. 5; emphasis original).

This quotation raises important questions concerning the nature of categorisation and language, such as: how do organisms categorise? how do children learn language? is language related to certain kinds of categorisation, and if so, how? The aim of this thesis is to help address these questions.

*   *   *

Thesis overview

Chomsky (1980) maintained that grammar is a necessary characteristic of language and all human languages have a finite system of rules, or grammar, that conform to a biologically determined universal grammar. People's knowledge of language and its rules is therefore implicitly gained as a result of their innate ability to "tune in" to the language to which they are exposed. Chomsky's analysis concerns the study of sentences and rules of syntax. However, although linguists have accumulated much descriptive knowledge of language forms, this tells us little about the functional aspects of language; this is because a formal analysis accounts neither for the circumstances in which language is produced nor for the consequences to the listener of such productions (Catania, 1998a). Thus for "innate theorists" the question of *how* a child acquires language becomes a non-question — how a child acquires language is simply innately given.

Nonetheless, in recent years, psycholinguists have begun to look to the context in which language is learned, including the effect of environmental factors on language development (Knapp, 1990). An old problem remains, however, one that was termed by Quine (1960) the *problem of reference*. This concerns how children learn the meaning of a word given the vast amount of stimulation in the environment. *Constraint theories* have postulated that a "hypothesis space" is restricted to salient language information (see, e.g., Markman, 1991); a constrained hypothesis space, it is said, helps explain how a child can learn word meanings. Examination of the issues surrounding these constraints suggests, however, that they may be an outcome of learning language rather than a facilitator of it (see, e.g., Bowerman, 1996; Gathercole, Thomas, Kim, 1999; Smith, 1995).

Other pyscholinguistic data have highlighted a close relationship between language development and forms of categorisation. This evidence has been corroborated in crosslinguistic studies (Gopnik & Choi, 1990, 1992; Gopnik & Meltzoff, 1987, 1992). However, psycholinguistics has largely failed to specify precisely what a word is, and how language and categorisation are related.

Skinner (1957) in *Verbal Behavior* proposed an operant account of language and provided a functional analysis of verbal behaviour. Skinner defined verbal behaviour as "behaviour reinforced through the mediation of other persons" (1957, p. 2); to Skinner the learning of both verbal and nonverbal behaviour is explained in terms of operant learning principles.

Skinner (1957) regarded the unit of verbal behaviour to be the *verbal operant*, not the word; the size of a verbal operant may vary from a single sound to a whole sentence, even to an entire paragraph of script. Skinner defined a number of verbal operants, two of which are the *tact* and the *echoic*. The tact, according to Skinner, is a reinforced response, usually vocal, evoked by a particular object or event (e.g., see shoe → say "shoe"). The echoic is an imitative response (usually vocal) that formally matches the stimulus that evoked it (e.g., hear */shoe/* → say "shoe"). Skinner maintained that all verbal operants are learned via the three-term contingency — discriminative stimulus, response, and reinforcer.

Despite the original nature of Skinner's account (Andresen, 1992; Knapp, 1992; Lee, 1984; Osgood, 1958), serious criticisms of it have been raised. For instance, Chomsky (1959) maintains that a theory of leaning cannot account for language; this is because, he states, there are too few learning opportunities in the environment and the process of reinforcement is too simplistic to account for the learning of a highly complex communicative system.

He also criticised the inability of Skinner's description of verbal behaviour to account for novel and generative performances — performances that are commonly evidenced in the use and understanding of novel sentences (and see Pinker, 1994). This criticism is exemplified by the story of how the philosopher, A. N. Whitehead, while at a dinner sitting next to Skinner, asked him to account for his behaviour while he said, "No black scorpion is falling on this table" — words that presumably had not been uttered in that sequence until that moment (Skinner, 1957). Skinner's response to that challenge was to publish *Verbal Behavior* over 20 years later. To Chomsky, Skinner failed to meet Whitehead's challenge.

According to several authors, Skinner's (1957) analysis of verbal operants can account for the formation of emergent or derived relations and symbolic behaviour (Alessi, 1987; Hall & Chase, 1991; Stemmer, 1995). However, this claim has been widely disputed. Further, such criticisms do not come only from those outside behaviour analysis: they come form inside it too (e.g., Devany, Hayes, &

Nelson, 1986; Dugdale & Lowe, 1990; Hayes, 1992; Horne & Lowe, 1996, 1997). For example, it is argued that, because Skinner's analysis of verbal behaviour is explained in terms of the unidirectional three-termed contingency, it cannot, as it stands, account for symbolic categorisation; this is because symbolic categorisation is bidirectional by definition (Devany et al., 1986). Untrained bidirectionality, it is claimed, is absent from Skinner's description of verbal operants.

This claim is supported by work on *stimulus equivalence*. If verbal humans are taught a series of related conditional discriminations in a matching-to-sample procedure, they often show new relations between the component stimuli that had not been directly trained (Sidman & Tailby, 1982). This behavioural outcome seems to show characteristics of symbolic, or untrained, categorisation (Devany et al., 1986). Additionally, due to participants demonstrating these apparent "emergent" relations, stimulus equivalence was seen as a potential avenue for the behavioural analysis, not only of symbolic categorisation, of which it is a direct test, but also of verbal behaviour (Green & Saunders, 1998).

A further reason for stimulus equivalence being of interest to the behaviour analyst is that it was not immediately obvious how the behaviour could be explained by known learning principles (Horne & Lowe, 1996; Lowe, 1986). In other words, verbal humans demonstrate behaviours that are not readily predicted by operant learning principles. This has serious implications for any behaviour analytic account that attempts to explain symbolic behaviour. Stimulus equivalence was thus seen as a symbolic remedy, not only for the deficiencies in Skinner's account, but also for the widespread opinion from non-behavioural scientists that behaviour analysis as a discipline is unable to explain complex human behaviour.

Sidman defined stimulus equivalence as stimulus-stimulus relations displaying the properties of *reflexivity*, *symmetry*, and *transitivity* (Sidman & Tailby, 1982). Reflexivity refers to generalised identity matching in a matching-to-sample procedure; in other words, matching a stimulus to an identical stimulus *in the absence* of explicit training (e.g., A → A, B → B). Symmetry refers to functional sample-comparison reversibility; that is, following the trained relation of selecting comparison B conditionally upon sample A, the relation B → A is shown in the absence of any explicit training. Transitivity refers to the phenomenon whereby, following the trained relations of selecting comparison B conditionally upon sample A and selecting comparison C conditionally upon sample B, the relation A → C is shown in the absence of explicit training. Combined transitivity and symmetry is described as *equivalence* — following the trained relations for transitivity, the relation C → A is shown, again in the absence of explicit training.

Sidman (1994) states that stimulus equivalence is "a given", an ability that people are born with; this view is known as *stimulus equivalence theory*. However, a second account emerged to challenge the Sidman view. This maintained that emergent behaviour of the type evidenced on equivalence tasks is part of a learned "arbitrarily applicable relational response" (Hayes & Hayes, 1992, p. 1389), not unlike the behavioural process of transposition (Reese, 1968). In other words, relating stimuli is part of an over-arching arbitrarily applicable learned process of relating any stimuli given the right contextual cues; thus each event is responded to in terms of another (Lipkens, Hayes, & Hayes, 1993). This account is known as *relational frame theory*. It suggests that symbolic behaviour results from a past history of the development of such relational responding (Hayes & Hayes, 1989, 1992).

Relational frames are arbitrary applicable relations that are derived, learned, and controlled by context (Hayes, 1994); they have three primary characteristics: (a) *mutual entailment*; (b) *combinatorial entailment*; and (c) *transformation of stimulus* *function* (Hayes, 1994). Mutual entailment refers to relations that are mutually entailed; if, for example, "A *is more than* B", then, by mutual entailment, "B *is less than* A" — thus mutual entailment is similar, but not identical, to symmetry as conceptualised by Sidman. Combinatory entailment refers to transitive-type relations; if, for example, "A *is more than* B" and "B *is more than* C", then by combinatory entailment "C *is less than* A" — thus combinatory entailment is similar to transitivity as conceptualised by Sidman. Within relational frame theory, transformation of stimulus function refers to functions trained or acquired by one stimulus that transform those of other stimuli in accordance with the specific relational frame that relates them. The transformation of functions of related stimuli depends on the control exerted by the specific context (Hayes & Wilson, 1996).

Thus both stimulus equivalence and relational frame theory regard the concept of equivalence as fundamental in addressing the shortcomings in Skinner's account in its failure to adequately specify what verbal behaviour is, and how emergent relations and rule governed behaviour arise (Hayes, 1992; Sidman, 1994). It was in the concept of stimulus equivalence that the answers to meaning, understanding, and symbolic categorisation were to be found.

The third account to emerge in recent years, which questions both Sidman's theory and Hayes' theory, and in many ways makes a return to Skinner's functional analysis of verbal behaviour, is the *naming account* by Horne & Lowe (1996, 1997, in press; Lowe, Horne, & Higson, 1987). Horne and Lowe (1996) define the fundamental unit of verbal behaviour as the *name relation*: "a higher order bidirectional behavioral relation that (a) combines conventional speaker and listener behaviour within the individual (b) does not require reinforcement for each new name to be established, and (c) relates to classes of objects and events" (p. 207). According to Horne and Lowe (1996), the characteristics of the name relation as defined above have direct implications for addressing the problems in Skinner's account of verbal behaviour, and for explaining "emergent" behaviours of the kind demonstrated during stimulus equivalence tests.

Skinner (1957) maintained that the behaviour of the listener is not verbal in any special sense. For example, he wrote, "Much of the behaviour of the listener has no resemblance to the behaviour of the speaker and is not verbal according to our definition" (p. 34). The behaviour of the listener in Skinner's account is seen primarily as that of the audience whose listening serves to reinforce the speaker's behaviour. Horne and Lowe (1996) also maintain that listener behaviour *in isolation* is not verbal; however, in contrast to Skinner, they maintain that listener behaviour is a *necessary element* of behaving verbally.

Drawing on the ideas of Mead (1934) and Vygotsky (1986), Horne and Lowe (1996) state that naming is responding as a speaker-listener in the same skin. To Mead, the speaker responds as a listener to his or her own speech in the same manner as another does; when humans become speaker-listeners to self they speak with understanding. According to Horne and Lowe (in press), naming is the fusion of three necessary relations: the listener, echoic, and tact. They write:

> a relation that does embody reference, representation and meaning, could however be developed from Skinner's framework if it were recognised that even during the early stages of verbal development, speakers can *listen to* their own speech, and so speak with understanding. We termed this relation *naming*. (in press; emphasis original).

Horne and Lowe's (1996) conception of the name relation also addresses the issue that Chomsky raised regarding the absence of sufficient environmental reinforcement to account for the learning of language. According to Horne and Lowe, naming is a higher order behavioural relation that does not require direct reinforcement of all the separate relations. They also maintain that naming behaviour may become self-reinforcing; this is because of the benefits entailed for individuals who behave verbally.

Skinner's (1957) account of verbal behaviour did not succeed in showing how language classifies stimuli and events. For Skinner, the tact does not embrace meaning or reference; this is because it is a unidirectional and essentially nonsymbolic relation. In Skinner's analysis, classification behaviour is not a definitive characteristic of verbal operants. For instance, Skinner saw no difference in the behaviour of a pigeon pressing a red key in response to a red light from a child saying "red" upon seeing the same light — both pigeon and child are tacting.

Drawing on the ideas of Vygotsky (1986), Horne and Lowe (1996) state that names refer to classes of objects and events. Thus a child learning to name involves the establishment of a circular relation between a class of objects and her[1] own speaker-listener behaviours. Vygotsky maintained that every word is a generalisation. Thus, to Horne and Lowe, it is the manner in which the name relation encapsulates a class of objects or events that explains so called "emergent" relations as evidenced on stimulus equivalence tests.

Aims of this thesis

According to Horne and Lowe (1996), naming is categorisation behaviour. They also maintain that only organisms that name in specific ways can categorise

[1] Unless referring to individual participants, in this thesis, children are referred to as female.

symbolically; operant principles as currently formulated do not predict such categorisation in the absence of naming behaviour. This prediction will be falsified if it is found that children categorise symbolically in the absence of naming as defined by Horne and Lowe. Testing this prediction is the first aim of this thesis.

In addition to testing this prediction, the studies reported in this thesis examine the broader issue of how young children learn to categorise formally unrelated objects, and having established stimulus classes, how they demonstrate generalisation of untrained behaviours between class members. This is the second aim of this thesis.

Thesis overview

The thesis comprises seven chapters.

Chapters 2 and 3 provide theoretical background concerning the issues and theories described above. Chapter 2 reviews attempts within developmental psycholinguistics to account for how "words" are learned. There is a selective review of constraint theories followed by relevant developmental research examining the relationship between language and categorisation. Chapter 3 describes the three behaviour analytical accounts of categorisation and symbolic behaviour: (a) Sidman's stimulus equivalence; (b) Hayes' relational frame theory; and (c) Horne and Lowe's naming account. The discussion of each asks the following questions: how is the account specified? how does it account for symbolic classification and verbal behaviour? and what are the critical issues that arise from each?

Chapters 4, 5, and 6 describe the studies designed to test the prediction that naming is necessary for the categorisation of formally unrelated objects, and to investigate how children form stimulus classes and show generalisation of untrained behaviours.

Chapter 7 discusses the results of the studies and, in light of the theoretical issues covered in Chapters 1, 2, and 3, discusses the implications of the findings for behavioural theories. Finally, the implications for future research are discussed.

CHAPTER 2

The relationship between language and Categorisation: Evidence from developmental psycholinguistics

Before proceeding to narrow the discussion to the behaviour analytic literature on naming and categorisation in Chapter 3, the present chapter provides an overview of how these issues are approached by the field of developmental psycholinguistics. The two key questions addressed concern how children learn words (or names) and how this relates to categorisation.

How do children learn words?

The problem of reference. The problem of reference (Quine, 1960) relates to how a child "knows" that a word refers to an object rather than some other property of the object—the object's colour, texture, or size, for instance. The problem comes in two parts: (a) there is the problem of selecting the appropriate information out of the vast amount of possible stimulation in the environment at any particular moment; and (b) there is the problem of how we come to hold shared meanings with others in the verbal community.

As Smith (1995) observes, the controversy centres on what is called the *problem of induction*; the assumption behind this problem is that knowledge is a set of beliefs, and thus learning is conceptualised as a process of induction. However, if learning is a process of induction, learning becomes impossible given *indeterminacy of input*; this is the assertion that there is too little information supplied in the language environment to account for the complexity of language (Smith, 1995).

Innate solutions. One way around the problem of reference is to invoke innate capacities to account for how children acquire language (e.g., Chomsky, 1959; Pinker, 1994). Nativist theories of language centre on the proposition that children learn a language by means of an innate language "module", such as Chomsky's *language acquisition device*.

For Chomsky (1980) and his followers (e.g., Pinker, 1994), the premise of the language acquisition device argument is that such a device is the only possible explanation for people's ability to speak grammatically. He says this for two reasons: (a) language is so complex it could not be learned in any other fashion; and (b) the paucity of the language input through the environment renders the possibility that language is learned incredible.

Thus, for the nativist, a child learns language for the same reasons that she grows legs—given the minimal environmental conditions, the innate language module "tunes in" and enables language to be both produced and understood. In this manner, innate theories state, in effect, that the problem of language learning is no longer a problem; because of this, many linguists concentrate only on the nature of language, not on how it is learned. The language acquisition device answer to the problem of language is therefore, it is argued, a non-explanation (see e.g., Bickerton, 1995; Deacon, 1997). On the other hand, there is evidence to suggest that environmental factors do affect the learning of language (Knapp, 1990; Moerk, 1983, 1992; Vihman, 1996). This research suggests that the explanation of language development requires a different approach than one invoking a hypothetical innate learning module.

Constraint solutions. A second way around Quine's problem is to hypothesise *biases*, or *constraints*. These constraints are said to limit the attentional processes within the language learning context. In effect, constraints focus attention on limited but highly salient information; these enable the learning of conventional object-word relations to occur. Children are said to "employ" certain constraining principles that enable them to "infer" plausible meanings for newly encountered words.

Research in recent years has evaluated how well constraint theories explain children's learning the meaning of words. Three constraints that are relevant to the present thesis are considered here: the *whole objects bias* (Markman, 1990, 1991), the *taxonomic constraint* (Markman & Hutchinson, 1984), and the *shape bias* (Jones, Smith, & Landau, 1991). The whole object bias predicts that, when a child is exposed simultaneously to a novel noun and a novel object, she will "assume" that the word refers to the whole object, not to some property of the object. For example, when hearing the word "dog" in the presence of a dog, she will "assume" the word refers to the dog, not to some other property of the dog — its size, colour, or the texture of its fur, for instance. The taxonomic bias predicts that a new word-referent relation extends to objects of the same basic level category (i.e., physically similar objects), but not to objects that are related to their referents by virtue of them having appeared together in the environment. For example, the word "dog" will extend, not only to the same breed of dog, but also to different breeds of dog; but it should not be produced as a name for the owner. The shape bias predicts that common shape will be the primary basis for objects' name generalisations.

There is evidence that children show learning biases in their learning of words. It is claimed that children interpret a count noun as referring to a class of objects (Katz, Baker, & Macnamara, 1974) and objects of a similar shape (Landau, Smith, & Jones, 1988). Given that this is so, the question arises of how such response biases develop. As Smith (1995) notes, the *fact* that children show some form of bias, or constraint, in the generalisation of their object name responses is not in debate; however, the *basis* of these constraints is.

Some have suggested that such biases have a general innate and universal basis (Golinkoff, Bailey, Wenger, & Hirsh-Pasek, 1989; Markman, 1992) and that they are not exclusive to language learning (Markman, 1989, 1992). Proponents of bias theories maintain that cognition and social input may have a role to play in word learning, but that alone they cannot account for lexical acquisition. Hirsh-Pasek, Golinkoff, and Reeves (1994) state, "Without these fundamental hypotheses for word learning, the child would be lost in a Quinean quagmire" (p.250). Hirsh-Pasek et al. maintain that without such innate biases children could never begin the language learning process. Others, however, have argued that the biases originate from language itself (Gathercole et al., 1999; Landau et al., 1988; Smith, 1995).

Evidence against innate basis. Evidence against constraint theories comes from findings that very young children do not have a shape bias in their early linguistic development (Landau, 1994). For instance, no shape bias was found in 18 month olds; however, a strong shape bias was found in 24 month olds (Smith, 1995). Further, Soja, Carey, and Spelke (1991) showed that children under 2 years do not show differential responding to mass and count nouns. Moreover, in the case of the typical child, the shape bias seems to increase with the number of words learned — after children have acquired approximately 50 object names (Landau, 1994). Thus, according to Gathercole et al. (1999), children's constraint type behaviour increases with age, and this suggests that they learn to respond in accordance with such constraints through exposure to the natural language environment (and see Smith, 1995). As Gathercole et al. (1999) observe, if such biases are supposedly employed to help children learn words, it is puzzling why they should come in only after children have learned their first words. This suggests that the shape bias may develop as a result of learning a number of shape-based category names.

According to Gathercole et al. (1999) there is mounting evidence against the proposal that children have innate or cognitive constraints or biases. They argue that there are a number of factors that influence the child's first guess about the meaning of new words. These include the child's increasing knowledge of language patterns in their mother tongue and regularities in the input of the particular language.

Crosslinguistic evidence. Crosslinguistic research has shown that each language may "cut" the environment along different lines. For, example, the use of words that describe the manipulation of objects, such as "hang up" and "hook together", are used differently in Korean and English. In Korean the verbs "kelta" and "talta" convey the method of attachment. The word "kelta" is used for describing hanging a coat on a door and hooking two toy trains together. However, "talta" is used to describe hanging a mobile on a ceiling, because in Korean, it is the method of attachment that is conveyed and not, as in English, that the object dangles with gravity. Bowerman (1996) also demonstrated that Korean and English speaking children interpret location in different ways and that their interpretation is a reflection of the use of those words in the adult language. The evidence suggests that categories denoted by language may not be given, but are imposed, or defined, by the practices of the specific verbal community. For example, Gathercole et al. (1999) note that a number of studies have identified specific regularities in the input language that are also characteristically found in the early linguistic productions of children learning a particular language.

From a behaviour analytic perspective, the taxonomic, whole object, and shape bias positions may be explained by the process of a gradual refinement in the discriminative control over verbal responses within a naming context: in the context of object naming episodes ("What's this", "Can you give me the . . .?", "This is a . . .", etc), it is the shape of a novel object that may come to exert the strongest control over newly learned tact or naming responses, not the object's colour, size, or texture. The reason why an operant account may predict this for many objects is that, with increasing examples of word-object pairings, the formal characteristics of stimuli that are often irrelevant to object naming (e.g., an object's colour, size, or texture) may come to exert less control over naming responses — this is because they are not reliable discriminative stimuli for object naming. This is not the case with the shape of many objects; this is because their shape often remains relatively constant across individual exemplars. For instance, balls may be any number of colours and sizes, but one variable common to all balls, and thus to all naming episodes involving balls, is the shape. Extension of the name "ball" to other balls thus occurs via stimulus generalisation on the dimension of shape.

Patterns in mother and child behaviour. Gopnik and Meltzoff (1992) argue that the kind of speech known as *motherese* — the specific manner in which caregivers speak to children— facilitates language acquisition. Research has uncovered a number of "regularities" in the behaviour, not only of caregivers, but also of children. These may help "scaffold" the language learning environment (Bruner, 1977). Mothers, for example, have been shown to both monitor the child's line of regard and to name objects that the child is focusing on (Bruner, 1978). For example, Harris, Jones, and Grant (1983) found that 70 percent of mothers' talk to 6 to 10 month olds referred to the objects their children were already looking at. Further, Tomasello and Farrar (1986) maintain that children show greater learning of comprehension of object names when the spoken word is presented while the infant is looking at the referent object. Caregivers also generally look at the referent and point to it during such linguistic episodes (Messer, 1978) and teach give-and-take games with objects. These allow extended opportunity for the mother to repeat the name in the presence of the object and for the child to attend to such object-name pairings (Gray, 1978). Caregivers also seem to highlight specific object functions during such situations of joint regard.

Stern, Spieker, and Mackain (1982) showed that mothers speak with an exaggerated intonation, and they argue that this may help make speech more discriminable for the child. Caregivers also speak with a reduced mean length of utterance that makes the language input both simple and salient (Newport, Gleitman, & Gleitman, 1977). These speech patterns seem to be universal across different linguistic cultures (Fernald, 1985).

Additionally, infants show specific behavioural patterns that seem to aid learning. DeCasper and Fifer (1980) demonstrated that infants as young as three days old show a preference for the voice of their mother over that of another female. Infants also learn to follow the gaze of another by the end of their first year (Scaife & Bruner, 1975). They develop communicative gestural pointing at around six months and this aids in indicating objects (Foster, 1990); further, they follow the pointing gestures of caregivers prior to pointing at objects themselves. They learn to point at objects at about 9 months (Murphy & Messer, 1977).

These "scaffolding" behaviours can be related to the problem of reference (Quine, 1960). Because caregivers and children seem to act in ways that "facilitate" children's learning of target word-object relations, explaining the problem of reference discussed by Quine becomes less problematic.

Conclusion on constraints. Much of the evidence suggests that variables that function to limit the stimuli that may be potentially related to a particular word are a function of the learning environment. This evidence argues against innately specified word constraints. A number of studies have indicated that there are extensive regularities in the input language; these regularities differ across languages, and, where they do, the differences are reflected in the manner in which children learn the referents of new words. Thus the evidence suggests that it may be the nature of the language input that gives the "biased look" in children's linguistic performances (Gathercole et al., 1999). Further, the evidence suggests that it is not only the specific language being learned that is important; it is also the general kind of scaffolding behaviours that both caregivers and children engage in which help children to learn words. This may offer a way to solving the problem of reference from a learning perspective without positing innately given abilities.

The relationship between language and categorisation: evidence from developmental psycholinguistics.

General relationship. A number of studies suggest that there is a close correlation between linguistic development and the development of other cognitive abilities in early childhood (e.g., Bowerman, 1996; Gopnik & Choi, 1990, 1992; Gopnik & Meltzoff, 1987). The relationship between language and cognitive abilities is often specific, involving the emergence of specific cognitive and specific semantic performances around the same point in infant development (Gopnik & Meltzoff, 1987). Gopnik and Meltzoff term this the *specificity hypothesis*; it states that the learning of words and the learning of related concepts proceed together and that development in one domain (e.g., categorisation) is independent of development in another (e.g., object permanence). Further, it suggests that there is a bidirectional relation between conceptual and semantic skills such that each can facilitate the development of the other (Gopnik & Meltzoff, 1992).

In a series of studies, Gopnik and Meltzoff (1984, 1986) found a close relationship between the presence of Stage 6 *means-end* abilities — conducting an action to obtain some other end, such as pulling a string in order to obtain an object — and the use of success/failure words such as "there" and "uh-oh". Likewise, they found a relationship between object permanence and the development of disappearance words such as "allgone".

Language and categorisation. In the same series of studies (see Gopnik & Meltzoff, 1992) they found a correlation between the so called *naming spurt* — the relatively rapid increase in naming ability that occurs when a child is approximately 18 months old — and the shift from *thematic* categorisation to *taxonomic* categorisation (Gopnik & Meltzoff, 1987). Thematic categorisation is the ability to categorise objects on the basis that they commonly occur together; for example, a child will place a toy cup and a toy plate in the same category because cups and plates commonly co-occur. Taxonomic categorisation is the ability to classify objects that are in the same basic level class (e.g., toy dogs of different breeds). However, Gopnik and Meltzoff did not find such a relationship between the naming spurt and object permanence, and neither did they find one between the naming spurt and means-ends abilities.

Infants typically show a developmental trend in their categorising behaviours. Infants aged between 9 and 12 months display what has been termed *single category sorting* — they touch all the identical objects in one category from an array of mixed objects (Gopnik & Meltzoff, 1992; Langer, 1982; Nelson, 1973; Roberts, 1988; Sugarman, 1983). The next stage in their categorical development, at around 15 to 21 months, is termed *serial exhaustive category touching* — they touch all the objects in one group followed by all the objects in another. At about 18 months old children develop what is termed *exhaustive sorting* — they exhaustively sort all the objects into two categories that are spatially separated (Gopnik & Meltzoff, 1987, Langer, 1982; Nelson, 1973; Sugarman, 1983). Typically, studies of this kind have used identical objects (e.g., four clay balls and four plastic pillboxes) and nearly identical objects (e.g., basic level objects such as four breeds of dog).

In the 1987 study, the categorisation test employed by Gopnik and Meltzoff was a category sorting task. In this task the children, between the ages of 15 and 20 months, were presented with two categories of four objects (either identical or basic level) and asked to, "Fix these up. Put them where they go", and were then given time to manipulate them. Gopnik and Meltzoff found that exhaustive category sorting of both basic level and identical objects was correlated with the onset of the naming spurt. Further, the children who succeeded on the exhaustive category sorting task had more names that those that failed the task. Other evidence suggests that basic level categorisation is salient in early development, and that early names refer to basic level categories (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). However, Gopnik and Meltzoff did not find any specific relationship between exhaustive category sorting of the objects and the names of those specific objects.

Crosslinguistic evidence. Other studies have concentrated on cross-linguistic similarities and differences between cognitive and linguistic development. Korean children are interesting from a cross-linguistic perspective in that the linguistic input to which they are exposed and their early language abilities are significantly different from those of English speaking children. In Korean, for example, verbs are more salient than in English — verbs occur at the end of sentences, and verbal inflections convey important information. Further, nouns, which are more salient in English, are sometimes omitted from Korean spoken sentences.

The evidence suggests that Korean children acquire verb forms and inflections earlier than their English speaking counterparts and that, conversely, English speaking children produce more nouns than their Korean counterparts (Gopnik & Choi, 1990). Gopnik, Choi, and Baumberger (1996) examined maternal speech in Korean and English mothers and found that Korean speaking mothers produce more verbs and that English speaking mothers produce more nouns. It has been suggested that verb forms may be more difficult to master than nouns (e.g., Bates, Bretherton, & McNew, 1983). The Korean studies suggest that this opinion may reflect a Western bias rather than a general language learning principle (and see Gathercole et al., 1999; Gopnik & Meltzoff, 1992).

As regards the relationship between naming and categorising, Gopnik and Meltzoff (1987) showed that English speaking children develop a naming spurt at the same time or shortly after they develop the ability to categorise. With Korean children, however, common naming typically emerges later; nonetheless, with Korean children, the research indicates a high correlation between the later emergence of the naming spurt and the corresponding later emergence of taxonomic categorisation (Gopnik & Choi, 1990).

As regards means-ends ability, there is virtually no difference between the development of means-ends and categorisation behaviours in English speaking children (average difference between the two was 2 days); however, there is a large difference between the development of these two behaviours in Korean speaking children (average difference was 82.4 days) (Gopnik & Choi, 1990). Further, Korean children are likely to use verbs to encode means-ends rather than nouns; and Korean children are significantly more advanced in their means-ends abilities than English speaking children. Thus, when verbs are more salient and common in adult language, children learn to use verbs more and earlier. These studies buttress the opinion that object names may not be the earliest and most important words per se; rather, their use may reflect salience in the particular language spoken. Notably, Gopnik & Choi found no significant difference between Korean and English speaking children on object permanence tasks.

At least half the children Gopnik and Choi (1990) studied performed the relevant "cognitive" task (i.e., means-ends, object permanence, and categorisation) and demonstrated the relevant linguistic form in the same experimental session, and of those that didn't, some children demonstrated the linguistic form before they performed the relevant task, others just after. This latter issue questions the efficacy of correlational research of this nature in making causal claims. If these behaviours sometimes occur before and sometime after the linguistic forms, the research cannot make clear claims of causality.

The fact that categorisation abilities and language are correlated developmental events is well established; however, there has been little attempt within psycholinguistics to account for the correlation. There are three common explanations: first, a "general" factor accounts for both categorisation and linguistic development; second, categorisation development precedes linguistic development; third, linguistic and conceptual development proceed together, that is, the development in one domain fuels development in the other, and vice versa.

"General" factor. A general factor could be responsible for the development of both "conceptual" and linguistic processes in children. If this is the case then the evidence should show that a number of behaviours — object permanence, means-ends, categorisation, and language, in particular — should develop at a similar rate. However, evidence against this general factor, apart from its unspecified nature, comes from studies such as those carried out by Gopnik and Meltzoff (1987, 1992). This evidence suggests that these different behavioral repertoires develop at different times within individual children. For example, some children show means-ends behaviours early and object permanence late (Gopnik &

Meltzoff, 1992). Further, not only are these specific developments related to language learning in a general sense, but as the research above demonstrates, specific behaviours seem to be correlated with the development of specific kinds of words (e.g., means-ends with success/failure words but not with the naming spurt).

Conceptual drives linguistic. One school of thought suggests that children first form "concepts" of categories, of chairs for instance, onto which the appropriate word, "chair" in this case, is mapped (e.g., Mandler, 1996; Nelson, 1974; and see Piaget, 1962). Such accounts tend to relegate the role of language to one of simple communication and expression of inner cognitions or concepts; they also tend to dismiss the importance of verbal behaviour in explanations of complex human behaviour in favour of inner cognitive constructs. On a more philosophical level, such accounts face what Harnad (1990) terms the *symbol grounding problem* — this concerns how "concepts" are grounded in the real world of objects and events, and how words are "mapped" onto existing concepts; these important conceptual issues are not specified.

A final point. If categorisation is the development of a "concept" that later gives the child an "insight" into naming, children from different cultures should show categorisation and demonstrate the naming spurt at a roughly similar age. The crosslinguistic evidence reported above does not fit well with such a view (e.g., Bowerman, 1996; Gopnik & Choi, 1990).

Interactionist perspective. The third common explanation is that language and categorisation develop together and are intimately bound. If this is the case, children exposed to different linguistic cultures, and thus different language experiences, should develop certain behaviours in differing orders and at different periods in their development (Gopnik & Choi, 1990). Further, the differences in categorisation should reflect the particulars of the specific language style (and see

Bowerman, 1989, 1994, 1996). Thus, if nouns are highly salient in a language and are intimately related to behaviours such as categorising, then children should show these behaviours earlier than children exposed to languages which do not have a "noun" focus. The correlational research seems to corroborate this. To use categorisation as an example, at whatever age basic level categorisation occurs, it is correlated with the naming spurt. This suggests that linguistic input, specifically the naming of objects, plays a significant role in the emergence of such behaviour.

Gopnik and Meltzoff regard linguistic development and conceptual development as interacting, and regard this as being consistent with a Vygotskian perspective (e.g., Vygotsky, 1978, 1986). When talking about the development of the verbal child, Vygotsky did not view concepts and language as separate functions that interact on some level, for to hold such a view presupposes that they are separable, and this is not the case once children have learned to speak. Vygotsky maintained that early in development children show both pre-intellectual speech and non-verbal thought; however, it is only with the synthesis of these two functions that thought becomes verbal and speech intellectual. From this moment they cease to be separate and become part of "one and the same complex psychological function" (p. 25). Vygotsky (1987) states:

> meaning is an inseparable part of the word; it belongs not only to the domain of thought but to the domain of speech. A word without meaning is not a word but an empty sound . . . Is word meaning speech or is it thought? It is both at one and the same time; it is a unit of verbal thinking. (p. 50).

Thus Vygotsky (1986) attributed pivotal importance to the nature of the relation between thought and language: "It would be wrong . . . to regard thought and speech as two unrelated processes" (p. 211). Vygotsky viewed the meaning of a word as the unanalysable "element" or unit of verbal thought; it is both thought and speech simultaneously, and it is the word that unites thought with speech. It follows that meaning is an essential of words.

Mead (1934) was of similar opinion: there is no separation of the "conceptual" and the linguistic in the verbal human. He states:

> I know of no way in which intelligence or mind could arise or could have arisen, other than through the internalisation by the individual of social processes of experience and behaviour . . . And if mind or thought has arisen in this way, then there neither can be nor could have been any mind or thought without language; and the early stages of the development of language must have been prior to the development of mind or thought. (pp.191-192).

To conclude:

Although there seems to be no strong evidence for innate or cognitive biases in the early learning of words, and there is extensive correlational evidence that specific scaffolding effects occur in the language learning environment, psycholinguistics has failed to provide an account of exactly what a word is, exactly how words are learnt, and how new words can generalise to new exemplars.

Similarly, that there is a clear relationship between certain abilities, such as basic level categorisation and the naming spurt, is not in debate. These correlations have been shown crosslinguistically, adding to the evidence that language and conceptual abilities are related. However, the nature of this relationship remains unclear.

A further issue that arises from the pyscholinguistic research into the relationship between categorisation and language concerns the measures of categorisation and the type of stimuli used. As discussed, most of the studies looking at early categorisation have used either identical objects (e.g., four clay balls and four plastic pillboxes) or nearly identical objects (e.g., basic level objects such as four breeds of dog). Thus the studies examining the relationship between language and categorisation have used objects that are, to differing degrees, similar to each other (i.e., formally related). From a behavioural standpoint, objects that share perceptual similarity may be classified on the basis of simple stimulus generalisation. However, in order to examine symbolic categorisation, physical similarity between class members has to be ruled out as a controlling factor.

Therefore much remains unresolved. If language is learned, and if language has a close relationship with other behaviours, such as categorisation, then a specification of what words are, exactly how they are learned, and how they interact and affect other behaviours is required. Psycholinguistics has not provided such a specification.

* * *

The next chapter turns to behavioural theories that have attempted to explain symbolic categorisation, and the relationship between language and such behaviour.

CHAPTER 3

Behaviour Analytic accounts of Language and Categorisation

Sidman's Stimulus Equivalence

Sidman and Tailby (1982) define stimulus equivalence in terms of mathematical set theory. Prior to this, stimulus equivalence had been a vaguely defined term that operated in the paired associate paradigm and was explained largely in terms of mediated generalisation (see, e.g., Jenkins, 1963). In grafting the properties of mathematical equivalence into the behavioural domain, Sidman specified a behavioural process that accounted for symbolic behaviour and offered a behavioural analysis of processes such as meaning, reference, and rule-governed behaviour.

In his earlier explanations, Sidman (1990) viewed equivalence as a given, unanalysable, "primitive" behaviour which readily "appears at the level of the four-term contingency" (p. 111) in the same manner that other primitives (conditioned reinforcement, punishment, etc.) appear at the level of the three-term contingency. Thus, like reinforcement and discrimination, equivalence is not derivable from other more basic behavioural processes (Sidman, 1986). In a later publication (Sidman, 1994), following evidence that equivalence may occur at the level of both the three-term (see Barnes & Keenan, 1993) and the two-term contingency (see Saunders & Spradlin, 1989), Sidman expands on his explanation of stimulus equivalence. In this later formulation, he suggests that equivalence relations may be an outcome of reinforcement and, as a result, equivalence may underlie not only operant but also

Pavlovian conditioning (Sidman, 1994). Thus in this formulation both stimuli (e.g., contextual, conditional, discriminative, and reinforcing) and responses become equivalent due to their participation in reinforcement contingencies. Sidman (1994) writes, "The suggestion was that we form equivalence relations because we are built that way" (p. 389).

A number of studies have demonstrated stimulus equivalence — studies that have used diverse types of stimuli, across diverse procedural conditions, and diverse populations (e.g., Dougher & Markham, 1994; Randell & Remington, 1999). Relations have been trained between auditory and visual stimuli (e.g., Sidman, 1971; Sidman & Cresson, 1973) and between visual and visual stimuli (Dixon & Spradlin, 1976). In attempts to control for similarity in the physical features of the stimuli and also in attempts to control for the participants' use of naming, research has typically used formally unrelated arbitrary stimuli (Devany et al., 1986; Eikeseth & Smith, 1992; Mandell & Sheen, 1994). Most early work on stimulus equivalence was undertaken with populations with learning difficulties (e.g., Dixon, 1977; Sidman & Cresson, 1973), or compared learning disabled with normally developing participants (e.g., Devany et al., 1986). The majority of studies with normally developing populations were conducted with verbally able adults as participants; however, some were conducted with young children (e.g., Bentall, Lowe, & Beasty, 1985; Lipkens et al., 1993).

Stimulus equivalence as an account of verbal behaviour

Stimulus equivalence is an account of how symbolic classes of stimuli and events are formed. In its attempt to account for symbolic behaviour, Sidman's analysis was extended to include, not only classification, but also other forms of symbolic behaviour, including verbal behaviour. Thus, according to Sidman, the emergent properties demonstrated on tests of equivalence are the properties that allow humans to behave verbally. Sidman (1986) argues that stimulus equivalence is a pre-requisite for the development of verbal behaviour. In his formulation, words are equivalent to their referents; thus: "By reacting to a word as to an equivalence stimulus — the meaning of the word — a person can behave adaptively in an environment without having previously been exposed to it" (p. 236).

One difficulty, however, with relating stimulus equivalence to verbal behaviour, or with attempting to explain verbal behaviour in terms of equivalence, is the different terminology used: stimulus equivalence is described in Sidman's terminology whereas verbal behaviour is described in Skinner's (1957) (Hall & Chase, 1991).

Issues that arise form Sidman's Equivalence

Is stimulus equivalence a coherent concept? Another issue that arises from Sidman's (1994) conceptualisation of equivalence as a unified behavioural primitive is the evidence that suggests that there is no coherent behavioural phenomenon that can be embraced by the term "stimulus equivalence". This evidence suggests that the method of passing equivalence tests may differ between participants and between specific conditions (Bentall, Dickens, & Fox, 1993; Fields & Verhave, 1987; Horne & Lowe, 1996, 1997; Pilgrim & Galizio, 1995, 1996). For example, Bentall et al. (1993) found different reaction times for baseline, symmetry, transitivity, and equivalence trials when participants had been trained a common name for stimuli from when they had been trained intraverbal names. Thus, when the success on matching-to-sample test is used as a measure, the performance of participants who use common names may be indistinguishable form that of those who use intraverbal names. But when reaction times are measured, as in the Bentall et al. study, there appear to be behavioural differences.

Pilgrim and Galizio (1996) maintain that studies that have looked at the changes in baseline conditional discriminations (which are the basis of equivalence class formation) raise interesting issues. For example, in their study, after equivalence classes had been formed, they reversed some of the baseline conditional discrimination relations used to establish the original class. They demonstrated that, following these reversals, inconsistencies in the relations that make up an equivalence class arise. Both initial conditional discriminations and responding on symmetry probes were sensitive to these changes in prerequisite baseline conditional discrimination. In contrast, both transitivity and equivalence relations were relatively insensitive to these changes and remained congruent with the originally trained baseline discriminations from which they had emerged.

Stimulus equivalence as a primitive. Horne and Lowe (1996) state that, if stimulus equivalence is a primitive behaviour that underlies both operant and Pavlovian responding (Sidman, 1994), given the fact that both pre-linguistic humans and other species show both operant and Pavlovian responding, both these populations should readily display equivalence.

There have been numerous studies that have demonstrated stimulus equivalence in verbally able human participants (Bentall, Lowe, & Beasty, 1985; Devany et al., 1986; Eikeseth & Smith, 1992; Sidman & Tailby, 1982). The issue of whether nonverbal humans or nonhuman species can demonstrate equivalence is more controversial. Equivalence has not been shown unequivocally in human subjects who lack functional language (Devany et al., 1986; Dugdale & Lowe 1990; Eikeseth & Smith, 1992). Similarly, unequivocal evidence that non-humans subjects demonstrate equivalence has not been reported (Lipkens, Kop, & Matthijs, 1988;

D'Amato, Salmon, Loukas, & Tomie, 1985; and see Hayes, 1989; Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982). Sidman (1994) takes the position that a number of studies (e.g., Manabe et al., 1995; Schusterman & Kastak, 1993; Vaughan, 1988; but see Horne & Lowe, 1997; Hayes, 1989) provide evidence that non-humans pass such tests and, in one respect, validate his theory. However, only one of these studies (Schusterman & Kastak, 1993) tested for symmetry and can thus be said to have demonstrated equivalence as defined by Sidman (but see Horne & Lowe, 1996, 1997); the Vaughan study, in contrast, can be said to have demonstrated only what is termed *functional equivalence*. (These issues are covered in detail in the later sections describing the naming account). Suffice to mention here that the problem for Sidman's account as regards nonhuman equivalence lies not in accommodating the few reputed examples of nonhuman equivalence, this is predicted; rather, it lies in explaining why, in the majority of studies, nonhumans fail to show equivalence (see, e.g., Dugdale & Lowe, 2000; Hayes, 1989; Horne & Lowe, 1996; Saunders, 1989)

How are equivalence classes formed? According to Sidman (1994), because equivalence classes arise from particular reinforcement contingencies, both responses and reinforcers enter into equivalence classes. Initial contingencies create one large equivalence class of all elements that have participated in a contingency. This should be especially the case when, for example, an identical selection response and/or reinforcing stimulus is used to establish two or more classes. For example, Sidman writes, "One large equivalence class *must* emerge when the establishing contingencies share the same reinforcer and defined response" (p. 408). Given this situation, as Sidman observes, a failure to find experimentally defined equivalence classes is predicted from his account.

However, as Sidman (1994) maintains, the fact that his account predicts failure raises the problem, not of accounting for the occasional failure to produce equivalence classes, but of accounting for the vast number of instances when the research *does* show equivalence class formation. For example, Sidman writes, "Bringing all components of a unit into a single large equivalence class would prevent any differential stimulus-stimulus or stimulus-response relations" (p. 409). Thus Sidman maintains that incompatibilities between the reinforcement contingencies and the formation of a single large class cause the units to result in class separation rather than class union; units can selectively "drop out" of a class.

Further, as Sidman (1994) notes, when the reinforcing contingencies establish equivalence, the distinction between stimuli and responses (and between reinforcing stimuli) is removed: they are all part of the same contingency and are thus equivalent. This removes the distinction between the behaving organism and the environment (Horne & Lowe, 1996), and it breaks down the distinction between the defining elements of an operant analysis — a reinforcing stimulus delivered by the environment is equivalent to a behavioural response emitted by the organism. As Horne and Lowe (1996) argue, Sidman's account is "an extraordinarily ambitious revision of existing behavioral theory in which the notion of equivalence becomes a explanatory construct from which is derived, not only success on matching-to-sample tests, transfer of function, and linguistic achievements but also . . . conditioned reinforcement and Pavlovian conditioning" (p. 228).

Hayes' Relational Frame Theory

In contrast to Sidman' s equivalence theory, Hayes's relational frame theory maintains that stimulus equivalence is a result of a prior learning history in specific relational responding. Fundamental to relational frame theory is the idea that such relational responding is subject to contextual control. Thus performances on equivalence tasks are explained by their context (Boelens, 1996; Hayes & Wilson, 1996): without the cues provided by framing, equivalence, and other forms of relational responding, such as naming, would not occur.

Within relational frame theory, stimulus equivalence is an example of a *frame of co-ordination.* When a frame (relation) of co-ordination is applied to two or more stimuli, the arbitrary relations of reflexivity — in relational frame theory this is similar to the concept as described by Sidman (1994) and is a special form of mutual entailment (Hayes, Gifford, & Wilson, 1996) — mutual entailment, and combinatory mutual entailment, give rise to an equivalence class.

However, though stimulus equivalence is seen as an example of a frame of co-ordination, according to Hayes (1994), stimulus equivalence research focuses too much on the formation of classes, and this is at the expense of other forms of relational responding; stimulus equivalence by itself is too narrow a concept (Hayes & Wilson, 1996). Thus Hayes (1994) sees a distinction between stimulus relations and stimulus classes: stimulus relations go beyond the conception of classes to incorporate other important relational concepts.

For example, the process of transformation of function is not limited to equivalence relations (e.g., Steele & Hayes, 1991; Dymond & Barnes, 1996), and relational frame research has sought to demonstrate symbolic categorisation and transfer among nonequivalent relations — relations such as "more than", "opposition", and "difference". According to Hayes (1992), transfer (or transformation) of function between relational frames is a new behavioural process (and see Boelens, 1996; Hayes & Hayes, 1992).

In the Steele and Hayes (1991) study, for example, during a pre-training phase, contextual cues were established by conditional discrimination training — the contextual cue of "opposition" ("O"), for instance. Thus, in the presence of the contextual cue "O", participants' selection of the comparison that was *not* in the same class as the sample was reinforced; in the context of this study this was, in effect, the opposite of that to which participants had been trained. Subsequently, and after being trained using a matching-to-sample procedure to form classes of stimuli (e.g., A1, B1, C1 and A2, B2, C2), the contextual cues were incorporated into the procedure. So, for example, in the presence of the contextual cue "O", sample A1, and given comparisons B1 and B2, B2 was the correct comparison. To give another example, if contextual cue of "same" ("S") was used, with A1 as sample and C1 and C2 as comparisons, C1 was the correct comparison. After this training, subsequent test trials employed novel stimulus arrays such that, for example, in the presence of the contextual cue "O", with A2 as the sample and C1 and C2 as comparisons, C1 was the correct selection — C1 was the comparison in the class opposite to the sample A2.

According to Steele and Hayes (1991), if the participants had been responding to the A2 sample in terms of basic equivalence, they should have selected C2 (A2 and C2 were members of the same class). Also, if the contextual stimulus "O" was the controlling factor alone, again C2 should have been selected. This was for two reasons: (a) during training C2 was the reinforced selection in the presence of A2; and (b) C2 (not C1) had been reinforced in the presence of the contextual cue "O". Therefore, in contrast to the prediction offered by equivalence theory, the authors suggest that participants selected C1 in accordance with the relational frame of opposition (Steele & Hayes, 1991). To be correct in the selection, participants had to respond to the sample in the presence of the contextual cue. Further studies along these lines (e.g., Dymond & Barnes, 1995, 1996) have shown that participants' responses can come under the control of contextual cues such as "same", "more than" and "less than". Supporters of relational frame theory thus argue that participants do not respond simply in terms of equivalence relations; rather, they respond in accordance with specific relational frames, and these relational frames are contextual in nature (Hayes & Hayes, 1992).

Relational frame theory as an account of verbal behaviour

How does relational frame theory account for verbal behaviour? In the account, relational frames are the defining characteristics of verbal behaviour. Wulfert and Hayes (1988) state, "The word is a symbol for the referent and the referent is the meaning of the word because both are members of the same equivalence class. In this sense, stimulus equivalence transforms the nonlinguistic conditional discriminations into semantic processes" (p. 129). In the relational frame account, the symmetrical (or mutually entailed) relations between a word and its referent, established by framing, embody meaning. Hayes (1994) further states that stimulus equivalence is a model of semantic meaning, and because stimulus equivalence is an example of a basic type of relational frame, relational frames may be a defining characteristic of verbal events (and see Hayes & Hayes, 1989).

Thus, in this account, stimulus equivalence, some forms of exclusion, and verbal behaviour are generalised examples of such arbitrary applicable relational responding. According to relational frame theory, communication can be both verbal and non-verbal. If communication is dependent upon relational frames then it is verbal (Hayes, 1994). As Hayes et al. (1996) state, "[relational frame theory] has attempted to integrate such diverse phenomena as stimulus equivalence, naming, mutual exclusion, rule-governance, verbal behavior, understanding, and the like" (p. 280). Therefore verbal behaviour is framing events relationally, and verbal activity is activity based on relational frames (Hayes, 1992).

Issues that arise from Relational Frame Theory

The relation between relational frame theory and stimulus equivalence. Relational frame theory relies on stimulus equivalence in order to account for verbal behaviour. Barnes and Roche (1996) note that contextual cues are likely to participate in equivalence relations with previously acquired contextual cues or verbal symbols — the words "same" and "opposite", for example. It is also clear that the terms used to describe the relations, such as mutual entailment and combinatorial entailment, are an adaptation from the terminology of the equivalence paradigm (see Hayes & Wilson, 1996). Although Hayes has disputed the conception that relational frame theory is an adaptation from equivalence theory (Hayes & Wilson, 1996), this is arguably the case given the description of both mutual and combinatorial entailment.

This reliance on stimulus equivalence as a basic concept is highlighted in the research into relational frames. For example, pre-training in arbitrary applicable relational responding (AARR) — "sameness", for example — provides the participants with the reinforcement history for applying the relational frame of co-ordination to stimuli in the presence of some arbitrary experimentally defined contextual cues (such as "££££"). Subsequently, these relational frames come to participate in an equivalence relation with already established "contextual cues or linguistic symbols" (Steele & Hayes, 1991, p. 491). Thus, according to Barnes and Roche, "In effect, the pre-experimentally established functions of these linguistic symbols, including their control over AARR, will transfer to the experimental contextual cues" (1996, p. 492).

What is the history that establishes relational frames? Relational frame theory is described as a learned operant account of relational responding. However, one can ask what exactly is the history that gives rise to relational frames?

There have been a number of suggestions from proponents of relational frame theory. Hayes (1989), for example, maintains that an extensive reinforced history of symmetrical relational responding (i.e., A → B and B → A, B → C, and C → B etc.) may occasion the conditions for nonhumans to pass equivalence tests with novel stimuli. In a later article, Hayes argues, a similar extensive reinforced history in the defining characteristics of relational frames — mutual entailment, combinatorial entailment, and transformation of function — may occasion novel performances on equivalence tests (Hayes, 1991). Hayes and Wilson (1996) write, "Proponents of RFT *have* argued that generalized symmetry is possible merely with training in symmetry. Generalised symmetry *might* be enough to produce equivalence, but RFT holds that at least some training in combinatorial entailment will probably also be needed to produce a relational frame." (p. 231; emphasis original). As Horne and Lowe (1996) argue, the theory itself does not specify which of these histories is sufficient to yield equivalence: there is a need for relational frame theory to be more specific.

Hayes (1989) maintains that one such history concerns how a child can learn a name. He suggests that, in a normal verbal environment, a child's verbal developmental history includes an extensive training in word-referent bidirectional relations. Children may learn a unidirectional relation (e.g., a tact), but they also have a reinforcement history that enables them, given certain contextual cues, to do the reverse. Lipkens et al. (1993) elaborate on this history of training. They maintain that the child is exposed, in certain "naming" contexts (e.g., "What's this?"), to reinforced examples such that eventually the child learns the relation between specific objects and specific utterances. Also, the child learns to select or orient to these objects on hearing the name spoken by a caregiver. Thus, according to Lipkens et al., "we might suppose that with enough instances of such training the child begins to derive name-object relations given only training in object-name relations and vice versa" (p. 203).

However, as Hayes and colleagues have realised, there is a problem with both the conception of symmetry from equivalence theory and the mutual entailment from relational frame theory as regards providing an adequate description of how children learn to name (Hayes, 1992; Lipkens et al, 1993). Hayes (1992) writes:

> Suppose in a new situation with a verbally competent child I say "truck!" and promptly pull out a truck from behind my back. We may say that I have trained this relation: "hear 'truck', see truck." Now I find that the child calls a truck a "truck". Strict symmetry would lead to the derived relation "see truck, hear 'truck'" not "see truck, say 'truck'". This would present a problem except that the child has already learned to imitate and thus can "hear word, say word. (p. 110).

In the context of naming, the contextual cues or frame of co-ordination may be, for example, "is a" (or "is called a"). Thus a child learns that, after being taught a unidirectional relation (e.g., hear /*truck*/ - see object truck), and given the frame of co-ordination "is a", the child also does the reverse (i.e., says "truck" on seeing a truck).

However, Hayes (1992) makes clear that, by itself, the frame of co-ordination as applied to a child learning a name leads to logical problems. In the case of a child learning the name "truck", an additional generalised behavioural relation is required (in this case generalised vocal imitation) to bridge the gap between the listener relation hear */truck/* - see truck, and the speaker response of saying "truck" upon seeing a truck.

Hayes (1992), by necessity, introduces generalised vocal imitation (or the echoic) to bridge this gap. But in strict terms, even when echoic responding is imported to assist the frame of co-ordination, this would result only in the child displaying two relations — in Skinner's terminology, the listener response and the echoic response; there would, nonetheless, be no necessary relation between the object and the vocal response. How does this come about? There are two ways this could come about: via conditioned hearing and via the establishment of a tact relation.

Lipkens et al. (1993) favour the first explanation. In their account, when presented with the object truck and asked "what's this?", a child first hears */truck/* (conditioned hearing) and then says "truck" (generalised vocal imitation). Thus, when the child sees an object and says its name, the object is not evoking the utterance: it is the conditioned hearing stimulus that is the controlling stimulus. Thus, in this account, the object itself does not evoke the utterance; instead "Saying the word seemingly requires some echoic or imitative repertoire (hearing the name to oneself and then saying the name)" (Lipkens et al., p. 216). However, Lowe and Horne (1996) argue that the conditioned hearing argument for learning a name is problematic because, in the course of everyday life, the seeing of specific objects is not predictive of hearing their names (but see Carr & Blackman, 1996; Dugdale, 1996; Remington, 1996). If a conditioned stimulus is to evoke a conditioned response, simple contiguity may not be sufficient; the latter must be reliably predicted by the former (see, e.g., Lieberman, 1990; Rescorla, 1966).

The second manner in which the see object → say name relation can be brought about is via the establishment of a tact as defined by Skinner (1957). As Hayes (1992) describes the learning of a name, the listener relation hear */truck/* → see truck is acquired simply: the child has a generalised echoic repertoire and thus she can say "truck" on hearing */truck/*. Thus the conditions are present whereby she says "truck" in the presence of a truck, and therefore whereby a truck can become discriminative for saying "truck"; that is, a tact relation. Further, a benefit that the learning of a tact relation has over the conditioned hearing explanation is that, unlike conditioned hearing, there are ample opportunities for learning such relations within the normal verbal environment.

Given that the frame of co-ordination is insufficient, and that the conditioned hearing explanation is problematic, the strongest case for the development of a see object → say name relation from a relational frame perspective is the second formulation; that is, listener and echoic relations provide the conditions whereby a tact can arise. The three relations — listener, echoic, and tact — allow for the learning of both a hear word → see object (listener) and a see object → say word (speaker) relation to arise. It is not clear where the frame of co-ordination fits in this account, or, indeed, whether it is necessary.

The establishment of non-linguistic contextual cues for arbitrary applicable relational responding. The fact that relational frame theory requires contextual cues to explain relational responding is problematic for an account of verbal behaviour. This is because an adequate account of verbal behaviour must detail, not only how relational responding arises, but also how such relational responding becomes "free" from direct environmental control. How would a child naming a ball, for example, learn such relations between the object and the word "ball" in the absence of the frame of co-ordination "is a" or "is called a"? These must be provided by another member of the verbal community.

As described by Steele and Hayes (1991), one of the features of research into relational frames is the aim to establish the importance of nonlinguistic contextual cues. One can question whether this aim has been fulfilled. Numerous studies have investigated relational frame theory, and, because frames underlie verbal behaviour, an important aspect of these studies is the verbal sophistication of the participants. As Saunders (1996) has argued in the contest of the Barnes and Roche (1996) study, the experimenters could have bypassed the lengthy establishment of contextual control by simply instructing participants as to the nature of the nonsense symbols that function as contextual stimuli. To say that the contingencies of reinforcement during the pre-training conditions of these studies rule out participants explicitly describing the rules would be inconceivable given the age of the participants and the methodological design. This point is relevant to other relational frame theory research (see, e.g., Dymond & Barnes, 1994; Steele & Hayes, 1991), and researchers have recognised it (see, e.g., Barnes & Roche, 1996).

As Saunders (1996) states, "the stimulus acquires the same function that certain words have already acquired" (p. 483). The question is one of parsimony: do the procedures used in this kind of research occasion non-linguistic arbitrary applicable relational frames that participate in equivalence relations with already established linguistic symbols (i.e., other relational frames), or does their training history allow verbally sophisticated humans to describe the experimental contingencies?

Mapping behavioural with mathematical abstractions. What is apparent from the description of relational frame theory is that it is an account of language relations of the "if . . . then" type. This is true of both the defining relational concepts of mutual entailment and combinatorial entailment. Thus, as with equivalence, relational frame theory, albeit implicitly, imports mathematical formulae to explain the learning of specific types of relations in the behavioural domain.

Horne and Lowe (1997) observe that research into transitive inferences of the type that are described by combinatorial mutual entailment (e.g., if A is bigger than B, and B is bigger than C, by combinatorial entailment, C is smaller than A) shows that only five percent of seven to nine year olds pass such tests (Chapman & Lindenberger, 1988). Thus it appears that even verbally sophisticated children find difficult the types of relations that relational frame theory maintains are the basis of verbal learning.

Additionally, problems for explanations in terms of relations such as mutual entailment as a basic model of verbal relations comes from evidence that, in normal linguistic development, certain words, such as "more" are learned before other, logically entailed words such as "less" (Gathercole, 1979, 1985). According to Horne and Lowe (1997), in a relational frame account such words should be demonstrated at the same level of linguistic development because one mutually entails the other.

Horne and Lowe's Naming Account

Horne and Lowe (1996) provide an account of how children learn verbal behaviour. Their thesis is that such behaviour develops by means of a fusion of *listener behaviour*, *echoic behaviour*, and *tact behaviour*. United, these three relations make up what Horne and Lowe term the *name relation*, which they propose is a higher order behavioural relation. Each of the three relations is described in detail below.

Listener behaviour. Horne and Lowe (1996) emphasise the critical importance of the listener and argue, "it is only through an analysis of listener behaviour that we can establish what . . . constitutes linguistic or verbal behaviour" (p. 10). The name relation involves the speaker responding as listener to her own speaking. Much research indicates that children learn to listen before they learn to speak; in the terminology of psycholinguistics, children's comprehension (listener behaviour) precedes production (speaker behaviour) (see Vihman, 1996). Skinner (1957) does not consider listener behaviour to be verbal in any special sense. In contrast, Horne and Lowe maintain that listener behaviour, although not verbal in isolation, is a *necessary* component of verbal behaviour.

According to Horne and Lowe's (1996) account, the caregiver produces a simple auditory stimulus, in the presence of both the child and an object or event,[2] while concurrently teaching the child conventional listener behaviours in relation to the object. Conventional listener behaviours can be divided into a number of classes of behaviours. These include *generalised listener behaviours*, such as orienting, pointing, selecting, and giving (Horne & Lowe, 1996. p. 196), and *object or event specific listener behaviours*, such as rolling a ball, shaking a rattle, and using a spoon — specific listener behaviours can be object related, event related, or both. Because the auditory stimulus reliably precedes these conventional listener behaviours, the conditions are present by means of which the auditory stimulus can become discriminative (S^D) for those listener behaviours; and this is the case for both generalised and specific listener behaviours (see Figure 3.1). This is in accordance with basic learning principles (see Catania, 1998a; Skinner, 1974).

---

[2] In some circumstances, the child is part of the event, as when, for instance, she falls over.

From this point, the child's behaviour towards objects and events increasingly becomes functionally, and specifically, controlled by the conventions of the verbal community. During the early learning of listener relations, the caregiver reinforces and models these conventional behaviours. Later, the caregiver gradually fades out both the modelling and the explicit reinforcement. This fading continues until the child responds conventionally to a verbal stimulus alone. In a similar manner, the object, through the natural training of listener relations, also becomes a discriminative stimulus for socially conditioned and conventional listener behaviours associated with that object or event. Thus, although *explicit* reinforcement is said to be faded during this process, such events do not lose their reinforcing properties. Throughout the process, reinforcement becomes neither less prevalent nor less effective as a determinant of behaviour. Lowe and Horne (1996, p. 338) argue for an analysis that recognises automatic, implicit, self, as well as overt forms of reinforcement (and see Palmer, 1996).

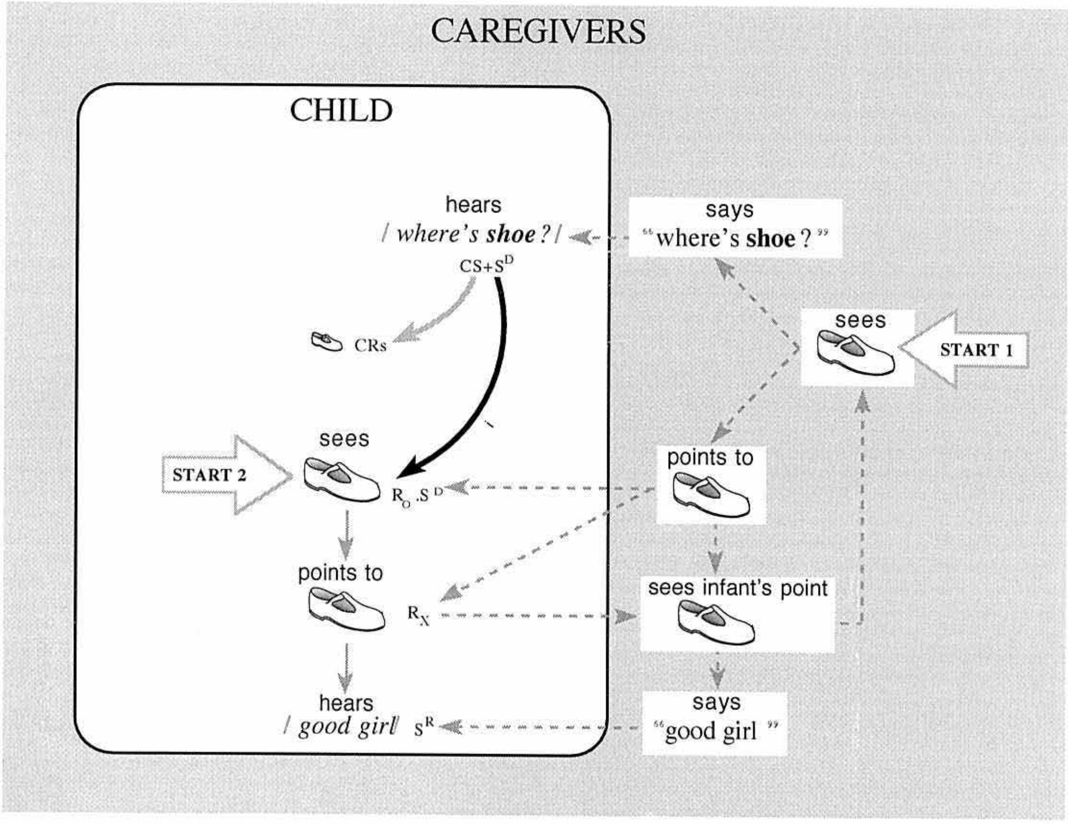


Figure 3.1

Figure 3.1 (from Horne & Lowe, 1996, p. 195). The figure represents a schematic description of the development of listener behaviour in the child. The process begins when, on seeing a shoe, the caregiver says "where's shoe?" (START 1). The child hears */shoe/*, which functions as a discriminative stimulus (SD) for the child's orienting listener behaviour (RO), and other conventional listener behaviours, such as pointing (RX). Hearing */shoe/* may also act, in accordance with the classical conditioning paradigm, as a conditioned stimulus (CS) evoking conditional responding (CRs), such as visualising a shoe. The correspondence between "where's shoe?" and the child's listener behaviour is reinforced by the caregiver's verbal praise "good girl" (SR). A similar process may also be evoked by the child seeing the shoe first, and then pointing to it (START 2). The solid arrows represent the child's listener behaviour and the broken arrows represent the caregiver's interactions with the child.

Listener behaviour and stimulus classes. Vygotsky (1986) comments, "A word does not refer to a single object, but to a group or to a class of objects. Each word is therefore already a generalisation" (p. 6). Similarly, Horne and Lowe (1996) maintain that when a child hears, for example, the word "shoe", she learns to orient to any number of objects that have been labelled *individually* and *specifically* "shoe" by the verbal community. Thus the child begins to learn the relation between vocal stimuli produced by another and the conventional object and event related behaviour that such stimuli evoke. Increasingly, on hearing a word, the child orients to a culturally defined class of objects and events and emits culturally defined behaviours with respect to those class objects and events — putting on a number of different shoes, or floating toy boats in water, for instance (see Figure 3.2). When the caregiver's vocal behaviour has gained control over the child's object and event related behaviours, the child is behaving as a *listener*; this is because the behaviour is evoked by the auditory stimulus of another (Horne & Lowe, 1996, p. 194). (However, it is not a necessary condition that a listener stimulus is conveyed through the auditory modality. For instance, with deaf people the listener stimulus is conveyed through the visual modality; in cases in which the listener is both deaf and blind, the modality is touch.)

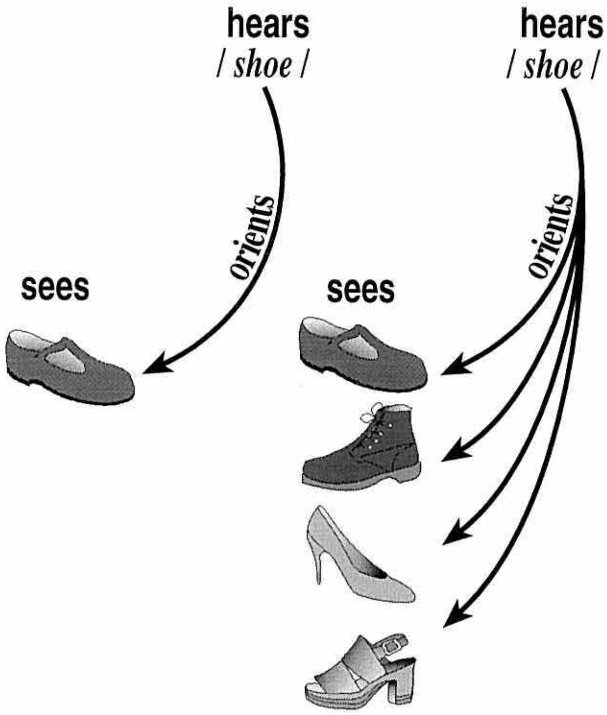


Figure 3.2 (from Horne & Lowe, 1996, p. 196). In accordance with the conventions of the verbal community, the child later learns, not only to orient to a particular shoe, but also to a culturally determined class of objects that are denoted by the name "shoe".

At this stage, according to Horne and Lowe (1996), the child has not learned verbal behaviour; nor can we say that she has learned symbolic categories. This is despite the fact that she may respond to objects in manners that are topographically indistinguishable to the responding of members of the verbal community who have learned to categorise arbitrary objects and events. The child's responding at this stage is unidirectional; that is, the object or event has become discriminative for specific behaviours that have been reinforced in accordance with basic learning principles. In a similar manner, a dog may be trained to fetch and bring a ball on hearing his owner say "ball". Training unidirectional relations separately to a number of objects does not imply that any stimulus class, as such, has been established (Hall & Chase, 1991; Horne & Lowe, 1996).

Echoic behaviour. Towards the end of the first year, the child begins to show differential and non-delayed echoic responding to the vocal sounds she hears (Anisfeld, 1984). The child learns, through reinforcement of successive approximations, to echo the sounds of the caregiver, and through this she builds up what Skinner (1957) called a "minimal echoic repertoire" (p. 62) of the sound units of the mother tongue. Arbitrary echoic responding may be a necessary precursor to the development of language, and this may become intrinsically reinforcing to the child. According to Poulson, Kymissis, Reeve, Andreatos, and Reeve (1991), this echoic responding may become *generalised echoic responding*; the occasional reinforcement of some echoic responses may be sufficient to produce similar generalised responding in the absence of direct and continual reinforcement.

In contrast to Skinner (1957), Horne and Lowe (1996) emphasise the importance of listener behaviour in the development of echoic responding. For instance, if the caregiver asks, "Where's the shoe", the child may echo "shoe", and this behaviour may be reinforced by the caregiver. Horne and Lowe maintain that the child starts to emit self-echoic behaviour, and that her self-vocalisations act as discriminative stimuli for her learned listener responding in the same way as do her caregiver's vocalisations — the child becomes a listener to her own speaker behaviour, or a listener-to-self. Thus the child not only echoes what a caregiver says, she also echoes what she herself says, and she responds conventionally to her echoing (see Figure 3.3).

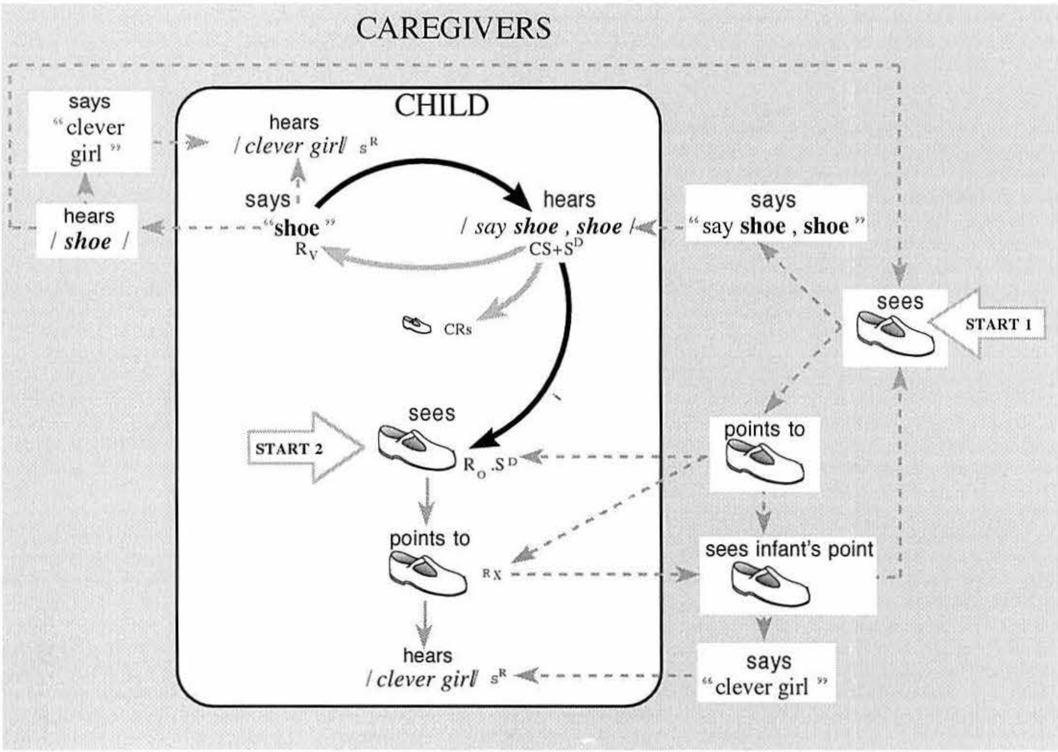


Figure 3.3

Figure 3.3 (from Horne & Lowe, 1996, p. 198). The figure represents a schematic description of the development of echoic behaviour in the child. The caregiver (START 1) points to and encourages the child to echo the verbal response "say shoe, shoe" (RV), and verbally reinforces the child's attempts (SR). After repeated exposure, the caregiver verbalisation of */shoe/* becomes a discriminative stimulus (SD) for the child's echoing response "shoe". The child now emits self-echoic behaviour in that she responds as a listener to her own response "shoe" in much the same way as she responds to the caregiver's verbal utterances. The process may also be evoked by the child first seeing the shoe (START 2). The solid arrow represent the child's self-echoic behaviour (and the listener behaviour, see Figure. 3.1). The faded arrows represents the child's echoic response to the caregiver's verbalisation "shoe".

For example, if she has learned to point to a toy ball on hearing, "Where's the ball?", and if she has learned to echo "ball" upon hearing the caregiver's utterance, she may start to re-echo "ball" while engaged in searching for the ball. The conditions are thereby present for her echoic responding to become discriminative for the pointing or searching behaviour. These self-vocalisations seem to become intrinsically reinforcing, and they appear to be vital for normal speech acquisition (Mowrer, 1958; Simner, 1971; Skinner, 1957). Additionally, the reinforcement for such echoing and re-echoing may be intrinsic to the situation. Using the above example, the reinforcement is delivered when the child finds the ball. This emphasises the point that reinforcement is often subtle: it need not be delivered directly by another person for it can be intrinsically derived from the behaviour that it strengthens (Vaughan & Michael, 1982).

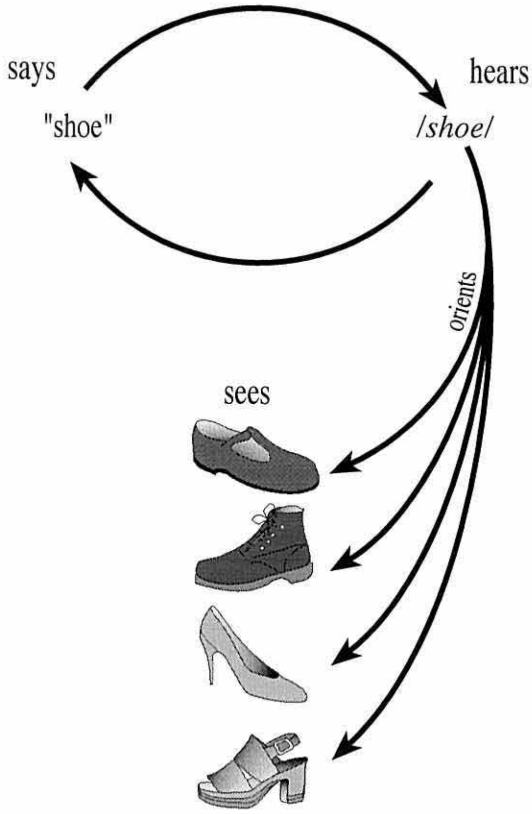


Figure 3.4

Figure 3.4 (from Horne & Lowe, 1996, p. 199). With the introduction of the child's echoic behaviour, when the child hears the caregiver say "shoe", and echoes her own auditory stimulus */shoe/*, this comes to occasion her orienting listener behaviour to any number of shoes that make up her existing listener class.

Tact Behaviour. At this point in the child's linguistic development, she is not controlling her own behaviour: she is merely responding to a caregiver's auditory stimulus; the controlling listener stimulation is always external to the child. According to Horne and Lowe (1996), the establishment of a tact response is the final "link" in the formation of the symbolic name relation.

Skinner (1957) defined the relation between an object or event and a word as a *tact*, "a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event or properties of an object or event" (pp. 81- 82). The tact is a three-termed contingency relation and, perhaps erroneously, has been equated with symbolic naming (see, e.g., Ristau & Robins, 1984).

In describing how the tact response is established, Horne and Lowe (1996) maintain that, in the presence of the object, the caregiver's verbal stimulus occasions the child, not only to orient to the object, but also to echo the caregiver's vocalisation. In this way, the sight of a shoe becomes a frequent antecedent for the child's echoing of the utterance "shoe". Following repeated exposure, when the child sees a shoe, it evokes the verbal response "shoe" and the appropriate conventional listener behaviours. From this point, the child, according to Horne and Lowe, has learned to *name* shoes (see Figure 3.5).

Thus when a child sees a shoe (object), which is a discriminative stimulus for the her verbal response "shoe" (tacting), the child hears her own utterance "shoe", and this in turn can act as a discriminative stimulus for her generalised and object-event specific listener behaviour towards shoes. It is therefore a circular relation between "seeing" (object), "saying" (tact), "hearing" (own utterance), and then "seeing" (conventional listener behaviours) once more.

Importantly for the present thesis, however, when the child says "shoe" and hears */shoe/*, this can cause the child to orient back, not just to one shoe, but to any number of shoes in her listener class. Naming is therefore defined as object and event controlled behaviour; it is behaviour that is unlike tacting because it is circular: the object or event can evoke the word, and the word can evoke both generalised and object-event specific listener behaviours related to that object. This marks a qualitatively new relation in the behavioural repertoire of the child.

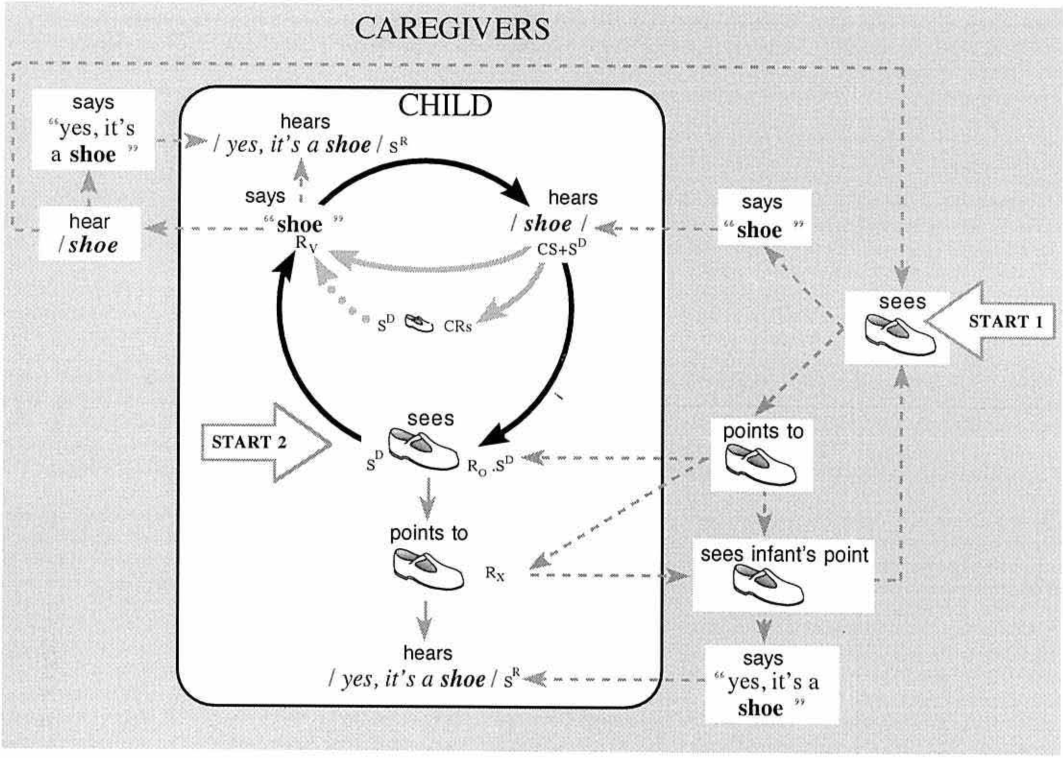


Figure 3.5

Figure 3.5 (from Horne & Lowe, 1996, p. 200). The figure depicts the final stage of the development of the name relation in a child who has already learned to echo and to listen to the auditory stimulus */shoe/*. The sequence begins (START 1) when the caregiver points to a shoe and says, "shoe". The auditory stimulus /shoe/ now occasions the child to look at the shoe while she echoes and re-echoes "shoe". The sight of the shoe becomes a frequent antecedent of, and discriminative (SD) for, the child's verbal response "shoe". Henceforth, when the child sees a shoe (START 2), this occasions her verbal response (RV) "shoe" (tacting), she hears herself say shoe, which in turn occasions her orienting listener behaviour; so she orients back to the object shoe. The name relation may now be evoked by the child hearing "shoe" (START 1), or by the child seeing a shoe (START 2). The shoe may also be visualised (CRs) when it is not present (such conditioned "seeing" being evoked by a reliably accompanying object, e.g., a sock); the resultant stimulation (SD) may also occasion the utterance "shoe" (grey dotted line).

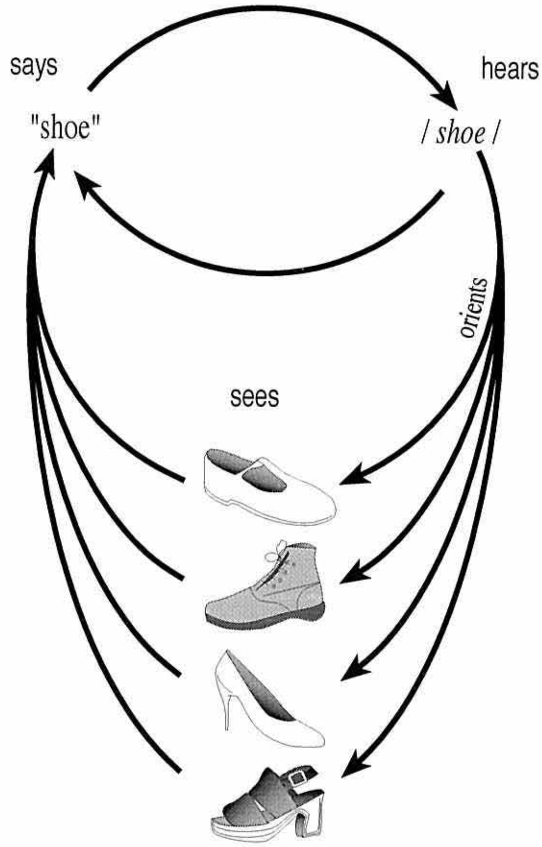


Figure 3.6

Figure.3.6 (from Horne & Lowe, 1996, p. 201). When the child sees a shoe to which she had previously responded to as a listener this evokes the response "shoe". Upon hearing her own auditory stimulus */shoe/* she orients, not just to one shoe, but to any of the shoes in her environment that are a part of her existing listener class. The child's seeing a shoe evokes her verbal response "shoe". Naming may thus be evoked by either seeing the shoe, or by hearing /shoe/, and may be re-evoked either by seeing a shoe again or via the self-echoic relation. This process describes the bidirectional relations between a class of objects and the speaker-listener behaviours they evoke.

How does naming account for symbolic classification?

According to Horne and Lowe (1996), naming is categorisation. They give the example of a child learning the name "dog". If the child has learned, for example, to name a picture of a dog, and later sees a real dog, the visual similarity between the picture of the dog may be sufficient to evoke the verbal response "dog". As Horne and Lowe (in press) state, "In conformity with the behavioural principle of stimulus generalization, once the name relation has been established with one exemplar of a class of objects, it should extend to other stimuli that physically resemble that exemplar." Thus, according to the naming account, the categorisation of formally related stimuli occurs because the novel stimulus evokes an existing name, and thus enters into that name relation; the novel object or event will from then on occasion all or some of the history of listener responding entailed within that name relation. Additionally, when novel exemplars are brought within an existing name relation, they may further develop the behaviours associated and evoked by that name. As Horne and Lowe argue, additional stimuli and events may enter into and occasion a verbal utterance "and there are concomitant changes in the listener behaviour that the utterances evoke" (1996, p.203).

This is one manner in which names may develop; it is also the means by which Horne and Lowe (1996) explain the learning of socially shared listener behaviours (and see Mead, 1934). However, there remains the problem of explaining how objects that are formally unrelated enter into a class. Horne and Lowe state, "The verbal community instructs the child not only which objects with similar appearance have the same name but also assigns common class names to objects that, although they may have little in common physically, serve a shared cultural function" (p. 204).

The child extends culturally specified behaviours to novel examples of objects and events that are given a particular name by the verbal community. Thus Horne and Lowe (1996) state, "having been taught to sit on what the caregivers call a "chair," the child adopts the cultural function of chairs in general when she adopts the name and extends it" (p.205). Additionally, chairs may enter into a class denoted by the name "furniture". Thus chairs may enter into a class of stimuli composed of culturally specified objects that may not share physical properties (e.g., a lamp, a table, or a book stand). However, when such items are named "furniture" they may become *functionally equivalent* in certain contexts (Horne & Lowe, 1996). Thus, no matter how different stimuli are physically, once a caregiver has named an object, that object "may come to be incorporated into the child's own name relation. A common name relation of this kind is a functional unit with extraordinary generative power" (Horne & Lowe, in press).

Naming and emergent behaviour. According to Horne and Lowe (1996), the fact that names refer to classes of objects and events has direct implications for emergent or untrained behaviours such as those evidenced in stimulus equivalence research. If a child is taught a common name, "two", separately for three different stimuli (e.g., the letters "TWO", two dots "• •", and the numeral "2"), she may come to treat these disparate stimuli as "equivalent". Thus if, for example, she is given the letters "TWO" and asked to select "the one that goes with this" from a number of other stimuli that contains the numeral "2" (or "• •"), she may pick the correct match. Horne and Lowe maintain this happens because the stimulus "TWO" evokes her saying "two", which occasions her previously established listener responding of selecting "2" (or "• •"). Thus, by teaching the child a common name for the three stimuli, up to six apparently untrained relations can arise; this is because all three stimuli evoke the same name, and thereby the same listener behaviour (Horne & Lowe, 1996).

Many equivalence studies have used auditory–visual matching-to-sample procedures (e.g., Sidman, 1971; Sidman & Tailby, 1982). In such procedures, a dictated name is used as a sample stimulus and visual stimuli are used as comparisons. Horne and Lowe (1996) maintain that the auditory–visual matching-to-sample method is an ideal manner in which to establish both common names, and the conditions whereby participants classify stimuli.

However, many studies have shown equivalence class formation by training only visual-visual stimuli, where the contingencies of reinforcement neither require names nor involve them explicitly in the procedure (Saunders, Saunders, Kirby, Spradlin, 1988). These studies are more difficult to interpret in terms of the naming account. For example, Saunders and Green (1992) used squiggly line drawings as stimuli that had no existing conventional names. A number of researchers have, however, noted that even seemingly arbitrary stimuli (or parts of those stimuli) may nonetheless evoke naming behaviour, and thus enable success on such equivalence tests (Horne & Lowe, 1996; Wulfert, Dougher, & Greenway, 1991).

Horne and Lowe (1996) also observe that, because auditory–visual procedures are more conducive to evoking naming (because the auditory stimulus is explicitly provided), they should be generally easier and more successful at establishing equivalence classes. The data from most studies suggest that participants find auditory-visual relations easier to learn than visual-visual matching-to-sample relations. For instance, Sidman and Cresson's (1973) data suggest that normally developing participants enter experiments showing better auditory-visual than visual-visual matching. Studies that have required auditory-visual pre-training indicate that participants have shown better maintenance of criterion levels for continuation in studies than those employing visual-visual pre-training requirements (Dixon, 1977; Dixon & Spradlin, 1976; Stromer & Osborne, 1982). Further, Green's (1990) data indicate that auditory-visual classes emerge rapidly but visual-visual classes emerge, for the most part, only after repeated training and testing.

A second manner in which Horne and Lowe (1996) maintain that naming can bring about, and enhance, emergent or seemingly untrained behaviours is via *intraverbal naming* — the use of more than one name in combination. Anisfeld (1984) notes that children, after learning on average 50 words, begin to combine these words, first in pairs, and later in extended combinations. Skinner (1957) characterises the *intraverbal* as a reinforced verbal response that is evoked by a specific verbal stimulus. Thus, for example, commonly heard sequences of words, such as "knife" and "fork", may become related in an intraverbal. Horne and Lowe maintain that with the introduction of the echoic, such intraverbal pairing may become reversed. With the echoic repetition of "knife fork knife fork", the child may say "fork knife"; an intraverbal is not a static unidirectional relation because it may develop bidirectional characteristics. As Horne and Lowe argue, with continual repetition the child may emit intraverbals such as "knife fork spoon" in any combination of the separate names. Further, the child may relate other singular names into intraverbal sequences so that they become bidirectionally related such that one name can evoke any of the others in the intraverbal sequence. They state, "upon seeing a spoon the child may say 'spoon fork' and, in the absence of the fork, search for it" (p. 210).

This type of intraverbal has particular relevance to stimulus equivalence. For instance, Lowe and Beasty (1987) (see Dugdale & Lowe, 1990; Horne & Lowe, 1996) recorded all the spontaneous verbal behaviour of two to five year olds during a visual-visual matching-to-sample procedure. The study indicated that all the children that passed the test for equivalence had shown both naming of the individual stimuli during training and intraverbal naming of the correct sample and comparison pairs. Thus, as with the example above, the children had evidenced intraverbal naming such that any one of the individual stimulus names could evoke the names of the other class stimuli. In a matching-to-sample procedure, given a previously trained comparison stimulus as a sample, the name of that stimulus evokes the other class names and selection of the correct comparison stimulus; this type of intraverbal naming thus shows how naming, according to Horne and Lowe, can occasion the symmetrical and transitive "emergent" responding seen on tests of stimulus equivalence.

As regards emergent or untrained behaviour, Horne and Lowe (1996) note that these terms are most often used when there is a failure to identify the controlling variables. Emergent behaviour as explained by the naming account, however, is not unspecified; rather, it is a result of the circular nature of naming and the importing of previously established listener behaviours through the application of a name (Horne & Lowe, 1996).

Naming and rule governed behaviour. One of the problems within the equivalence literature is the extent to which other behaviour comes under control of verbal behaviour. Skinner (1969) drew a basic distinction between contingency-shaped and rule-governed behaviour. Contingency-shaped behaviour is behaviour under the direct control of environmental contingencies. Rule-governed behaviour, according to Skinner, is behaviour under the control of prior contingency-specifying stimuli. However, as many have noted (e.g., Hayes & Hayes, 1992; Horne & Lowe, 1996), this definition is problematic. Skinner did not elaborate on the process by which specifying stimuli gain their specifying functions and neither did he describe what he meant by "specifying".

Horne and Lowe (1996) maintain that names are the principle way by means of which stimuli are specified. According to Horne and Lowe's account, it is not that names specify contingencies — this may or may not be the case; what names specify is a person's own listener behaviour to objects and events. Thus Horne and Lowe maintain the naming account provides a solution for the problem of specifying what "contingency-specifying stimuli" are — an issue that is not resolved in Skinner's (1957) account. According to the naming account, names are the basic component of rules, and it is only through naming that the effects of rules on behaviour can be understood.

Horne and Lowe (1996) give the example of a child who has recently learned to name a boat and has previously been taught the relevant listener behaviour appropriate to boats. All the listener behaviour that has been previously paired with boats generalises to novel objects that are named "boat" by the verbal community. This may occur even if the novel object is not a boat. For example, if the caregiver names a plastic bowl "boat", the child may show all or some of the listener behaviours towards the bowl that were specified in her past learning history towards boats — this past learning history has been brought to bear on the novel object through the application of a name. It is in this way that names may be said both to control or specify behaviour and to enable a generalisation of existing behaviour between formally unrelated objects.

Naming and generalisation of novel behaviour ("transfer of function"). A number of studies have demonstrated that a response, provided it has been trained to one member of an equivalence class, may generalise to other members of the existing class without direct training (Catania, Horne, & Lowe, 1989; Dougher & Markham, 1994; Dymond & Barnes, 1995; Wulfert & Hayes, 1988). Such generalisation of untrained behaviour must be a defining part of any adequate account of symbolic classification.

Along these lines, a number of studies within the area of stimulus equivalence research have looked at what has been termed *transfer of function* (Dymond & Barnes, 1995, 1996; Roche & Barnes, 1997; Smeets, Schenk, & Barnes, 1994; Wulfert & Hayes, 1988). Transfer of function refers to the untrained emergence of stimulus functions among members of an existing class; if a variable is applied to a subset of the class, other untrained members may also come to exert control over this function without direct training. Dougher and Markham (1996) observe, the term transfer of function usually refers to functions that are independent of the stimulus functions that define the existing class.

Sidman (1994), however, has objected to the term transfer because, he argues, it is unnecessary to refer to another process when transfer of stimulus function is a defining part of the concept of a class. Therefore it is not the transfer per se that is important; rather, it is the manner in which formally unrelated stimuli enter into a class — a class by definition shares stimulus functions. Thus, when studies report to be addressing transfer of function (e.g., Dymond & Barnes, 1995, 1996), they are not examining an auxiliary process that may be linked to classifying behaviour; rather, they are examining evidence for the existence of a class. A more appropriate term for the process may be a generalisation of behaviour via class inclusion. As such, the method of demonstrating the so called "transfer of function" can be utilised as a method for testing for the presence or absence of classes of stimuli (Dougher & Markham, 1996; Stromer & Mackay, 1996).

Another objection to the use of the term "transfer" as a technical term comes form the problem of specifying what transfer is. If it is seen as a new behavioural process, it is in need of specification; if it is not, there is a danger that the term will be used, not only to describe outcomes, but also to explain them (Sidman, 1994).

According to the naming account, a child may be taught to name any number of objects (e.g., shoes) with the same name (e.g., "shoe"). Horne and Lowe (1996) write:

> As a consequence, new listener behavior trained with just one or two members of the named class may come to be occasioned by any one or all of the others, and training a common name for a number of different objects results in the child treating them interchangeably in certain contexts." (p. 207).

Consistent with Horne and Lowe's (1996) account, in this thesis the term *verbal generalisation* is adopted to describe untrained behaviours that, via the application of a name or other verbal behaviour, are evoked by novel stimuli.

Key issues that arise from the naming account

What is categorisation? To Horne and Lowe (1996), naming is a specific form of categorisation behaviour — when people name they categorise. However, although they concentrate on verbally generated categorisation, there are other ways in which organisms form stimulus classes. For example, stimulus generalisation, in which stimuli share physical properties, is a basic process that is involved in many forms of categorisation, both verbal and nonverbal.

Dougher and Markham (1996) argue that there has been inconsistent use of terms in attempts to describe the formation of different types of classes. This inconsistency has resulted in the same term being used for distinct types of classes, and different terms being used for the same type of class; this may have contributed to conceptual confusion in the behavioural study of symbolic class formation.

For example, Dougher and Markham (1994) define three broad class types: *stimulus classes*, *stimulus equivalence classes*, and *functional equivalence classes*. Because these three types of class are common in the behavioural literature concerning symbolic behaviour their definitions are examined next.

Stimulus classes. Stimulus classes have been defined as classes in which stimuli share a common function over some behaviour. Arguably, as Dougher and Markham (1994) note, this definition of stimulus classes is too vague, and is based on topographical rather than functional evidence (see Skinner, 1935). Catania (1998a, 1998b) offers no technical definition of a stimulus class. Thus stimulus class is a term that is interchangeable with the term "class" and is not a technical term for a specific type of classification behaviour or for a specific outcome on a particular test for classes. (This is highlighted by Catania's, 1998b, use of the term in his definition of stimulus equivalence — see below).

Equivalence classes. Stimulus equivalence classes are those in which reflexivity, symmetry, and transitivity have been demonstrated, and are characterised by stimulus substitutability. Catania (1998b) defines an equivalence class as:

> a stimulus class with at least three members, usually produced through conditional discrimination in matching-to-sample, in which the relations among the members are characterised by the properties of reflexivity, symmetry, and transitivity, especially when at least some of the relations are emergent rather than directly trained. (p. 413).

This conforms to Sidman's definition (see e.g., Sidman, 1994). Catania (1998a) maintains that stimuli that are members of an equivalence class are also likely to be functionally equivalent. Further, Catania, in the same text, defines the term equivalence relation as:

> a term with various usages, including functional equivalence (the relation between stimuli that have become members of a *functional class*) as well as the mathematical relations that define an *equivalence class* (especially the CA relation). The terminology of equivalence relations has often been interchanged with that of equivalence classes, but functionally equivalent stimuli needn't be members of an equivalence class. (p. 388; emphasis original).

Thus stimulus equivalence is characterised by functional substitutability (and see Dougher & Markham, 1996). Other characteristics include the conditional discrimination training and the method of testing, that is, matching-to-sample (and the relations this method by necessity demonstrates).

Functional classes. According to Dougher and Markham (1996), functional equivalence classes are reserved for those that conform to Goldiamond's (1966) definition that (a) all members of the class share a common stimulus function, and

(b) any contingencies applied to a subset tend to generalise to other members without direct training. Catania (1998a) defines a functional class as:

> a class the members of which have common behavioral functions, either produced by similar histories or acquired through emergent relations. If two stimuli are members of a functional class, then the behavior occasioned by one will be occasioned by the other; such stimuli are sometimes said to be functionally equivalent. (p. 415).

Catania's definition of a functional class maps onto Goldiamond's (1966) definition noted above. Donahoe and Palmer (1994) define a functional class as comprising stimuli "that may differ physically but have similar uses and control common responses" (p.357). Sidman (1986) observes that functional equivalence occurs when two or more stimuli control a common response. The definition noted above raise three issues.

First, although the distinction between formally related and formally unrelated stimuli is usually implicit in the research conducted into these types of classes (in the sense that, in order to separate symbolic from nonsymbolic behaviour, the process of stimulus generalisation has to be ruled out), the definitions do not make such a distinction. In Donahoe and Palmer's (1994) definition, for example, it is not a necessary condition for the stimuli to be formally unrelated. Similarly, there is no such distinction in Catania's (1998a) definition. This raises the problem of determining the manner in which symbolic classes are formed. One requirement of explanations of classification is a broad distinction between classes comprised of perceptually, or formally, related stimuli and classes comprised of perceptually, or formally, unrelated stimuli. As Dougher and Markham (1996) argue, the interesting issue concerns how untrained stimulus functions are acquired by class members. For formally related stimuli, such functions can be acquired via stimulus generalisation; although such processes are an integral part of how both verbal and nonverbal organisms categorise much of their world, stimulus generalisation is a relatively uninteresting issue in attempts to explain emergent or symbolic behaviour.

Second, as highlighted by Catania's (1998a) definition of a functional class, there is the problem of whether the common behavioural relations that functional class stimuli evoke are a consequence of a direct training history or are an instance of untrained or emergent relations. Hall and Chase (1991) write:

> Functional equivalence may involve either verbal of nonverbal relations and may or may not involve conceptual relations [for conceptual read class]. Functional equivalence does not have to be a concept because two or more stimuli may come to control a common response through direct training. To demonstrate conceptual or abstract control, emergent relations are needed. (p.115).

Third, there is the problem of whether behavioural and functional definitions should specify a distinction between behaviour as a process and behaviour as a product. Vygotsky (1978) alludes to explanations, not in terms of products, but in terms of how functions develop. He writes: "It follows, then, that we need to concentrate not on the *product* of development but on the very *process* by which higher forms are established" (p. 64; emphasis original). Skinner (1969) termed this as the *formalistic fallacy*.

According to Dougher & Markham (1996) the extent to which distinctions are made between stimulus, functional, and equivalence classes may therefore lie at a pragmatic level, depending upon whether a particular distinction is useful in generating useable data. The distinction between equivalence and functional classes made up of formally unrelated stimuli may reflect a distinction in the methods of establishing the class, the number of stimuli used to make up the class, and the method used for testing. What distinguishes them is the *specific functions* shared by the members (Dougher & Markham, 1994), but it is not clear whether the distinction reflects separate and distinct behavioural process.

An important distinction when explaining the formation of classes is the distinction between symbolic and non-symbolic categorisation. This distinction requires an adequate specification of what it means to categorise symbolically. From a naming perspective, symbolic classification requires that objects and events are related via participation in a verbal episode. The basic unit of this episode is defined as the name relation (Horne & Lowe, 1996). This is accomplished by speakers listening to their own speech. However, to effectively test this empirically, the above three considerations need to be born in mind.

Is naming necessary for symbolic categorisation?

Evidence from verbal participants. A number of studies investigating the role of language in equivalence relations have reported a close correlation between success on equivalence tests and the development of verbal behaviour (e.g., Barnes, McCullaugh, & Keenan, 1990; Bentall, Lowe, & Beasty, 1985; Devany, et al., 1986; Eikeseth & Smith, 1992; Lowe & Beasty, 1987).

For instance, Lowe and Beasty (1987) tested three different age groups and found that children who were successful on equivalence tests either had a common name for the stimuli or linked them via an intraverbal chain. The Lowe and Beasty study further showed that young children who had previously failed equivalence tests later went on to succeed after being taught to name the sample-comparison stimulus pairs. A similar result was obtained by Eikeseth and Smith (1992) with pre-school autistic children: children who were taught a common name for the stimuli in each class went on to pass tests of equivalence that they had previously failed.

In a study designed to specifically investigate the role of naming in equivalence, Mandell and Sheen (1994) varied the pronounceability of sample stimulus pseudo-words. Thus they postulated, if naming is a crucial factor in equivalence formation, less pronounceable pseudo-words should make equivalence class formation more difficult. The results of the Mandell and Sheen study lend support to the naming account in at least three ways: (a) their participants did find equivalence class formation more difficult with less pronounceable pseudo-words; (b) in order to facilitate their performance, the participants tended to invent idiosyncratic names for the difficult-to-name stimuli; and (c) in an expansion of the original study, half the participants were exposed to a read aloud pre-training phase for non-phonological stimuli, and this tended to facilitate naming production — the pre-training group made fewer errors than those who received only the pre-exposure.

In a more recent study, Randell and Remington (1999) examined the role of rhyme in the formation of equivalence classes. In the study participants were divided into three conditions: a rhyme condition and two control conditions — one orthogonal, the other diagonal. In all conditions participants were exposed to a matching-to-sample procedure with different combinations of the same formally unrelated pictorial stimuli to create classes of four stimuli. In the rhyme condition, participants were trained to select comparison stimuli that always rhymed with the sample (e.g., sample A1 = boat, correct comparison is B1 = goat). In the two other control conditions the sample and comparison stimuli did not rhyme. In the orthogonal condition the comparison stimuli rhymed with each other but neither did with the sample (e.g., A1 = boat; B1 = flea; B2 = tree). In the diagonal condition, sample and comparison stimuli were allocated in a pseudo-random manner such that one of the incorrect comparisons always rhymed with the sample but never with either the correct comparison nor with the two incorrect comparisons.

Randell and Remington (1999) found that the stimulus names and phonological properties of those names facilitated the formation of equivalence classes. The results indicated that baseline discrimination learning was significantly quicker for the participants in the rhyme condition than either of the two control conditions; the ease of learning did not differ significantly between the two control conditions. All participants in the rhyme condition formed equivalence classes on initial testing. Of the participants in the two control conditions, even though baseline conditional discrimination learning was intact, only 3 (of 20) passed the equivalence test. Further, 10 of the 17 participants who failed the initial emergent tests subsequently showed maintenance of the baseline discriminations; that is, the basic discriminations required to show equivalence class formation were in place. On the second run of emergent testing, of the 17 who failed initially, only 2 from the orthogonal condition passed; the remaining 15 never showed emergent stimulus equivalence class formation.

Randell and Remington (1999) conducted post-equivalence tests of naming; the findings indicated a high degree of normative naming for the participants in the non-rhyme condition. However, the rhyme participants showed no non-normative naming. Although there were some variations among the names given, these variations were class related, such as “mouse” and “rat”. In the early stages of the experiment, some of the participants in the rhyme condition used names for the rhyme stimuli that were incorrect — "yacht" instead of "boat" for example. Nonetheless, all the rhyme participants changed these during the course of the experiment.

Randell and Remington (1999) report that a number of participants in the study used intraverbal sequences to solve the experimental tasks set them; however, this did not occur in the rhyme condition, suggesting that once the "rhyme" rule had been learned that other, more complex, verbal solutions were not required. According to Randell and Remington, the facilitating nature of the rhyme condition depended to some extent on the participants' covert verbal behaviour and could not have occurred in the absence of such naming: once the rhyme rule had been learned, novel comparisons were categorised correctly in accordance with the rhyme. This suggested to Randell and Remington that, in this particular study, the participants' behaviour was largely verbally controlled.

Because all of the stimuli used in the Randell and Remington (1999) study were easily nameable, the stimuli would have evoked names during the training of the baseline discriminations. Further, because in the rhyme condition the correct comparison names always rhymed with the sample stimulus, the conditions were present for the participants to verbally describe the experimental contingencies, for example, rules such as "the ones that rhyme go together". Once the participant had described the contingencies in this way, subsequent responding would have come under verbal control of the "rhyme" rule. If, however, this were the case, the naming account would predict a similar performance of selecting stimuli that rhymed for novel stimuli. In a final stage of their study, Randell and Remington introduced a generalisation phase that involved novel stimuli, and in the rhyme condition participants made significantly fewer errors on the generalisation phase than did both control groups.

Further, according to the naming account, such generalised novel performances under verbal control may not require any additional experimental reinforcement (Horne & Lowe, 1996). A further study conducted by Randell (2000, Study 5), using a similar procedure to that described in the Randell and Remington (1999) study, showed that even in the absence of direct experimental reinforcement, participants' behaviour came under verbal control, and that they responded on equivalence tests in accordance with the "rhyme" rule.

Evidence from non-humans. Skinner (1938) writes:

> Whether or not extrapolation (from the behaviour of the rat) is justified cannot at present be decided. It is possible that there are properties of human behavior which will require a different kind of treatment. (pp. 441-442).

Behaviour analysis is concerned with identifying general principles of behaviour — relations between cause and effect — and, because of this, behaviour is not seen as a biological property of organisms; instead, it is seen as a function of the interaction of the organism and environmental stimulation (Smith, 1994).

This highlights one of the assumptions of behaviour analysis — *the continuity assumption.* This assumption states that there is continuity in the behaviour across difference species. Morris (1992), for example, states, "the organism that actually does the behaving, be it a rat, pigeon, primate or human, is irrelevant, since behaviour is not 'in the organism' but is instead a dynamic stream of environmental events and interactions" (p. 14). Further, Smith (1994) maintains that the degree to which the principles identified by behaviour analysis generalise across species has proved to be remarkably robust.

Evidence of stimulus equivalence. There have been a number of claims of nonhuman species showing evidence of success on equivalence tasks. The most important of these is the study with the sea lion "Rio" (Schusterman & Kastak, 1993). Schusterman and Kastak trained both symmetry and transitivity on 12 out of a possible 30 three-stimulus classes; the remaining 18 were reserved for testing for equivalence. First, they trained A → B and B → C relations with all the 30 classes of stimuli. Then they trained all the component relations required for demonstrations of equivalence with the 12 "training" classes. Thus they trained B → A and C → B symmetry, A → C transitivity, and C → A symmetry for all 12 classes. They then tested for C → A equivalence in the remaining 18 "test" classes. Schusterman and Kastak maintained reinforcement throughout testing and, taking the first correct response for each of the 18 classes, Rio scored a total of 16 out of 18 correct. To Schusterman and Kastak, and others (e.g., Fields, 1996; McIlvane & Dube, 1996; R. Saunders & Green, 1996; K. Saunders & Spradlin, 1996), this was a demonstration of stimulus equivalence in a nonhuman participant, and more important, a demonstration in a nonverbal organism.

Horne and Lowe (1996, 1997) have offered an explanation of Rio's results in terms of a combination of a transfer of stimulus reinforcement within a stimulus compound and positive Pavlovian conditioning. Siemann, Delius, Dombrowoski, and Daniel (1996), for example, demonstrated that pigeons presented with two stimuli, of which the selection (e.g., pecking) of only one is reinforced, will, on unreinforced testing trials, nonetheless show responding to the neutral stimulus of which selection had not been previously reinforced; this is by virtue of its relation to the stimulus of which selection had been reinforced. Thus some of the reinforcing properties of a stimulus "transfer" to a present, but neutral, stimulus. This has been termed *value transfer theory* (Zentall, Sherburne, Roper, & Kraemer, 1996).

The procedure employed by Schusterman and Kastak (1993) was unusual in that it didn't follow that which is employed in most matching-to-sample procedures. In their study, the sea lion was always presented with the same sample-comparison pair. This involved the sea lion being reinforced for correct comparison selection in the presence of the same sample. Therefore, in light of the Siemann et al. (1996) data and value transfer theory, it would be expected, by virtue of its relation to the comparison stimulus selection of which had been reinforced, that the sample would acquire some of the reinforcing stimulus functions (and see Horne & Lowe, 1997). Thus, although the sea lion appeared to show equivalence, there may have been more basic learning processes operating in the procedure used by Schusterman and Kastak.

Symbolic transfer of function in non humans. There have been a number of studies purporting to show symbolic abilities or transfer effects in nonhumans (e.g., Urcuioli, 1996; Urcuioli, Zentall, & DeMarse, 1995; Zentall, 1996). These transfer effects have been variously described as acquired equivalence, derived transfer of function, and functional equivalence. A number of researchers have made direct comparisons between the results found in these transfer studies, predominantly conducted with pigeons, and the results found in stimulus equivalence research conducted with humans (e.g., Fields, 1996; McIlvane & Dube, 1996; Stromer & MacKay, 1996; Tonneau & Sokolowski, 1997; Urcuioli & Lionello-DeNolf, in press; Zentall, 1996). It is thus suggested that the transfer effect found in pigeons is the same behavioural process by means of which human participants pass tests of equivalence and show functional equivalence (Urcuioli & Lionello-DeNolf, in press).

According to Urcuioli (1996), a growing body of research points to the fact that animals other than humans can show stimulus equivalence. Similarly, Zentall (1996) maintains that pigeons have shown all the necessary component relations — reflexivity, symmetry, and transitivity — that are required for stimulus equivalence. However, as he notes, this has only occurred in separate studies; that is, none of the relations have occurred together in the same study, and neither have they occurred with the same birds. Zentall's claims are thus weakened by the difficulty of obtaining all the characteristics within the same study.

In general, the research has demonstrated transfer of derived sample-comparison relations when using a many-to-one procedure. This has proved more difficult when using a one-to-many procedure (Urciouli, 1996; but see Zentall, Sherburne, Steirn, Randall, Roper, & Urcuioli, 1992 for evidence of transfer using a one-to-many procedure). The many-to-one procedure involves training two or more sample stimuli to the same comparison stimuli; that is, many samples to the one common comparison. One-to-many, on the other hand, involves training only one sample to a number of different comparisons.

The Urcuioli et al. (1995) study is typical. It compares the transfer of function in many-to-one and one-to-many procedures. Figure 3.7, below, illustrates the typical relations trained in these two procedures. Phase 1 training sessions comprised 96 random left-right sample-comparison configurations, and criterion for the training was correct responding at the 90 percent level of accuracy or above for six consecutive sessions. Pigeons were then over-trained for at least 20 sessions (i.e., at least 1920 trials following criterion performance). Phase 2 training involved matching two of the original samples to new comparisons (many-to-one) or two of the original comparisons to new samples (one-to-many). (Note: Figure 3.7 illustrates only one of these relations for each conditions). Phase 2 training consisted of 100 trials per session and each Phase 2 session was alternated with sessions of Phase 1 maintenance training. Criterion level in Phase 2 was as with Phase 1. The testing for acquired equivalence (transfer) involved the novel sample-comparison pairing (see Figure 3.7). Each test session comprised 100 trials at the same levels of continuous reinforcement as used in training phases.

Phase 1	Phase 2	Transfer Test
Many-to-one		
A → B	A → D	C - -> D
C → B		
One-to-many		
A → B	C → B	C - -> D
A → D		

Figure 3.7. The trained and tested relations in many-to-one and one-to-many procedures.

The average number of session required to reach criterion in Phase 1 for the many-to-one birds in the Urcuioli et al. (1995) study was 43.0 (i.e., 4,128 trials). Some birds required as many as 57 sessions (5,472 trials) and some did not reach criterion even after 125 sessions (12,000 trials). For the one-to-many birds the average number of sessions to reach criterion in Phase 1 was 24.8 (2,380 trials). During the Phase 2 training the many-to-one birds required an average of 12.4 sessions (1,240 trials) and the one-to-many birds an average of 28.0 sessions (2,800 trials). Thus the average bird in the many-to-one condition received 7,288 training trials prior to tests for transfer and the average bird in the one-to-many condition received 7,100 training trials.

Evidence of acquired equivalence or functional equivalence, by Urcuioli et al. (1995) is indicated by demonstrations of transfer of function. The tests of transfer of function typically used are the first-test session accuracy (i.e., 100 reinforced trials) and the rate of learning over 10 reinforced "test" sessions. The first-test session performances were calculated for each individual bird in a group. There were five birds in the many-to-one and four in the one-to-many. Four of the five many-to-one birds matched at above 50 percent on the first session with an average of 64 percent (range of 49 – 82). For the one-to-many birds the first session score was 51.5 percent (range 47 – 60). Although not statistically significant, when one of the "outliers" was removed from the many-to-one group, the difference between many-to-one and one-to-many was significant. The second analysis of the results looked at the matching accuracies over repeated "test" sessions (Sessions 1 to 10). The data likewise revealed no overall significant difference between many-to-one and one-to-many procedures; but a session-by-session analysis using a "pooled error-means and a correction for the corresponding degrees of freedom" (p. 165) showed a matching accuracy significantly higher in the many-to-one birds as a group on Sessions 2 and 3 only (i.e., 2 sessions from 10).

Although the demonstration of acquired equivalence (indicated by transfer effects) from this study is not particularly convincing, other similar studies arguably provide stronger evidence. In their second study, Urcuioli et al. (1995) used a "consistent versus inconsistent" procedure in which samples that had originally been associated with different comparisons were exchanged (many-to-one) and comparisons that had originally been associated with different samples were exchanged (one-to-many). These exchanges were predicted to yield "negative transfer of performance if functional equivalences had formed between samples or between comparisons" (p.167) during the training. Urcuioli et al. found that many-to-one birds matched significantly less accurately after the exchange of the samples (i.e., inconsistent pairings), but there was little change in the one-to-many when the comparisons were inconsistent. Again, the results of the second study indicate acquired equivalence (demonstrated by transfer effects) in pigeons as a result of the order of training specific conditional relations.

Similarly, Zentall, Sherburne, and Urcuioli (1993) used a consistent/inconsistent design with pigeons showed that those that acquired the many-to-one conditional discriminations demonstrated facilitation of delayed matching, and that this was disrupted when an interpolated stimulus was incompatible with the class.

A number of studies explain the failure to demonstrate transfer effects, or the weak demonstrations of transfer, by the difficulty of learning conditional discriminations (e.g., Urcuioli et al., 1995; Zentall, Steirn, Sherburne, & Urcuioli, 1991). However, if the conditional discriminations are established to a high degree of accuracy (i.e., the birds reach criterion responding in the training phases at above 90 percent for 6 consecutive sessions), the difficulty in reaching criterion should not affect derived performances on testing: they should demonstrate acquired equivalence (better than average first test scores, or savings in learning over the first 10 sessions) because the stimuli are supposedly functionally equivalent.

Additionally, if the stimuli are functionally equivalent following training, given that in order to reach criterion the pigeons are responding above 90 percent accuracy to the trained relations, it should be expected that they show such criterion responding on the first session of testing. However, on the first session of the many-to-one conditions in the Urcuioli et al. (1995) study, the average responding was 64 percent — markedly lower than criterion performance. It took a further seven sessions of reinforced trials (100 trials per session) for the birds in the Urcuioli et al. study to reach responding of over 90 percent, and the pigeons maintained this performance for Sessions 8, 9, and 10 also (i.e., 4 sessions). Thus, the pigeons in this study never reached criterion responding by Urcuioli et al.'s standard because the birds were only tested for 10 sessions; therefore the criterion of above 90 percent responding for 6 consecutive sessions was not met. If Urcuioli et al. had maintained the test sessions for the required 6 sessions, the pigeons may have maintained this responding and reached criterion in a minimum of 12 sessions (i.e., Session 7 through 12 at or above 90 percent). Importantly, the average number of sessions to reach criterion on the Phase 2 training was 12.4 for these same birds (Phase 2, as with the testing phase, required the learning of two novel sample-comparison pairings). In light of this data, the savings in learning demonstrated in the "test" sessions do not seem remarkable.

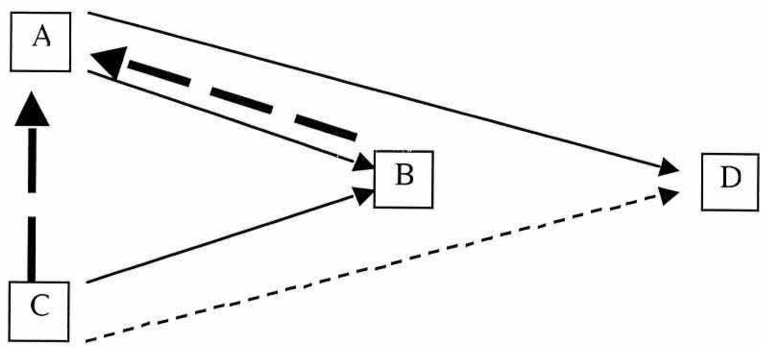
Equating with stimulus equivalence and failure to show symmetry. Although the terms used for these transfer effects are equated with stimulus equivalence, they do not show the required properties of Sidman's equivalence. This is because derived symmetry is necessary to demonstrate stimulus equivalence by Sidman's definition. In order to show derived transfer, participants have to show evidence of derived symmetry between the B as sample and the A as comparison (see Figure 3.8). Although there is no direct test for symmetry between the stimuli in the transfer studies with pigeons, there is extensive evidence that such relations do not readily occur in nonhuman participants (D'Amato et al., 1985; Dugdale & Lowe, 2000; Hogan & Zentall, 1977; Lipkins et al., 1988; Roberts, 1988; Sidman et al., 1982). Similarly, explanation of these transfer outcomes in terms of backward conditioning is problematic because, as Urcuioli et al. (in press) note, like symmetry, research has shown little evidence of such responding in nonhumans (but see Hearst, 1989).

Further, as can be seen from Figure 3.8 below, if derived symmetry (or backward conditioning) was responsible for the transfer effect, pigeons should also show transfer on one-to-many procedures; this is because the trained and testing relations are identical, only the order of the trained relations differs. Such explanations are thus immediately challenged by the lack of evidence for symmetrical-type responding within the animal kingdom.

This lack of symmetrical responding in nonhumans renders as largely speculative the assertion that the processes being studied by Urcuioli, Zentall, and colleagues are the same behavioural processes being studied by stimulus equivalence researchers using humans as participants. Urcuioli et al. (in press) claim that because competing explanations of transfer (e.g., mediated generalisation) are laden with questionable assumptions, evidence of transfer effects from pigeons on many-to-one studies may be evidence for Sidman's stimulus equivalence as a basic behavioural process. For example, because of the problems with competing explanations of transfer, they write, "Sidman's (1994) position that equivalence is best viewed as a basic stimulus function — not derivable, in other words, from other processes — would look increasingly attractive." The problem for such an assertion, however, lies in accounting for the difficulty in demonstrating stimulus equivalence in nonhumans.

Figure 3.8.

Many-to-one



One-to-many

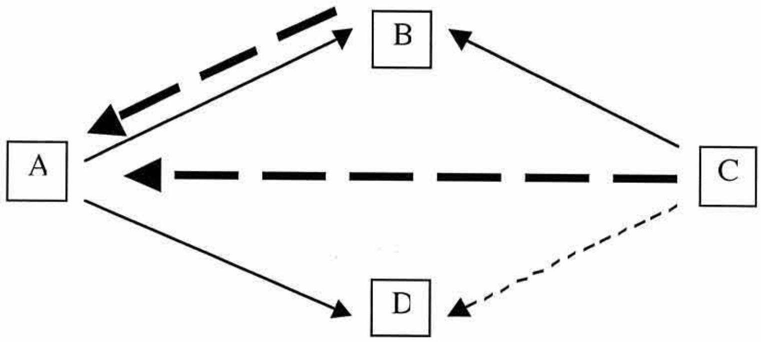


Figure 3.8. The relations trained and tested in the many-to-one and the one-to-many procedures. Solid arrows indicate the trained relations and dashed thin lines the tested relations. The dashed thick lines indicate the backward conditioning or symmetrical-type relation (B → A) and the transitive-type relation (C → A) required to demonstrate a direct route from the C to the D stimuli.

Explanations of acquired equivalence in terms of mediated generalisation. Urcuioli (1996) offers a mediational account of acquired equivalence that also explains pigeon success on transfer of function tasks (and see Zentall, 1996). Mediated accounts of equivalence, he states, are based on the implicit secondary generalisation theories of Hull (1939). Mediated generalisation suggests that when two or more sample stimuli are trained to an identical comparison, both samples acquire the capacity to evoke implicit components of the common comparison stimulus. Thus when being trained the relations A → B and C → B, for example, what is really being conditioned is A → "b"B and C → "b"B, where "b" is the implicit component of the overt common B comparison. As a result, both A and C become associated, not only with overt B, but also covert "b".

According to Urcuioli et al. (1995), this account can explain the differences observed between many-to-one and one-to-many procedures. Thus on many-to-one, pigeons should form an A → "b"B, and C → "b"B relations in initial training. In the second phase of training, the A"b" → D relation sets the occasion for a directly reinforced relation between the implicit "b" and the D stimuli. The conditions are thereby present for the C"b" → D relation to emerge during novel testing. However, this is less likely to occur in the one-to-many procedures, according the Urcuioli et al., because it is, "unclear whether the A sample in phase 1 [sic] . . . gives rise to only one mediator on each trial ("b" or "d") or perhaps to neither or to both, given that the correct comparison on a one-to-many trial cannot be predicted from the samples" (p. 174). Thus one-to-many should not give rise to transfer because the initial training occurs concurrently. According to Urcuioli et al., however, if the initial relations on the one-to-many are trained in sequence (i.e., A → "b"B followed by A"b" → D), the conditions may be right for the linking of the implicit "b" and overt D stimulus.

A potential problem with this account is that the concurrent training in these studies should allow for this to occur; this is because only one sample-comparison pair can be presented at any one time during the Phase 1 training. The distinction between separate trials in Phase 1 on many-to-one and between Phase 1 and Phase 2 on one-to-many training may be only a matter of degree. If this were the case, and if mediated generalisation were responsible for transfer, then one-to-many procedures should show transfer as readily as many-to-one procedures.

Accounts of class formation in terms of mediated generalisation (Hull, 1939; Jenkins, 1963; Urcuioli, 1996) must also incorporate either some form of hypothesised entity — implicit stimulus coding in the case of Hull (1939) — or backward conditioning of some sort. As noted, the evidence for the latter is scant, and the former is criticised for hypothesising unobservable processes (Skinner, 1953). Additionally, as Urcuioli (1996) states, some effects reported in the literature are not explained well by mediated generalisation; however, according to him, to reject the concept because it does not explain all the available data may be premature. However, to *accept* the concept when it does not explain the available data may also be premature.

Methodological issues. There are a number of differences in the design of the many-to-one and one-to-many procedures that may prove relevant in explaining acquired equivalence and the disparity evidenced between many-to-one and one-to-many procedures.

Research has indicated that, in certain circumstances, an instrumental discriminative stimulus and a Pavlovian conditioned stimulus may share functions (Davidson, Aparico, & Rescorla, 1988; Ross & LoLordo, 1987). For example, Davidson, et al. (1988) demonstrated that a previously established Pavlovian facilitator can function as a discriminative stimulus in an instrumental procedure and that, similarly, a previously established discriminative stimulus can function as a Pavlovian facilitator in a classical conditioning procedure. However, for a Pavlovian conditioned stimulus to be effective, it has to be predictive of the unconditioned stimulus (Lieberman, 1990; Rescorla, 1966). The sample stimulus (A) in the one-to-many procedure is predictive of the B stimulus on 50 percent of trials and of the D stimulus on the other 50 percent of trials (see Figure 3.8). In contrast, both the A and the C sample stimuli on the many-to-one procedure are 100 percent predictive of the B stimulus. This may result in Pavlovian conditioning between the sample and comparisons during the many-to-one procedure such that the sample stimulus functions as a Pavlovian predictor.

Evidence also suggests that differential reinforcers may become cues for solving conditional discriminations (Edwards, Jagielo, Zentall, & Hogan, 1982). Given that many-to-one comparisons are reinforced on average for 50 percent of trials (i.e., there are two comparison stimuli), they may become, via Pavlovian conditioning, conditioned reinforcers in the presence of certain discriminative stimuli (i.e., each of the two sample stimuli). They may also, because they are physically different, become differential conditioned reinforcers. Thus, during interpolated training trials with the A → B and the C → B, both the A and the C stimuli may become predictive of the B stimulus. Later training with the A → D may also enable the C → D relation to be learned in a more rapid manner than a completely novel sample-comparison pairing. In contrast, this would not be expected in the one-to-many procedure because each comparison stimulus is reinforced on average only for 25 percent of trials (i.e., there are four comparisons stimuli), and each sample is discriminative for two comparison stimuli. Thus the comparison stimuli may not become a conditioned reinforcer in the same manner as may occur in the case of many-to-one procedures.

The predictability of reinforcement may also be important in the difference between these designs (DeLong & Wasserman, 1985). For example, DeLong and Wasserman found that pigeons on a matching-to-sample task responded more often to a sequence that was followed by a 1.0 probability of reinforcement than on a 0.2

probability. Thus, under certain circumstances, animals respond to maximum reinforcement probabilities.

To summarise:

Whether the above variations in procedure explain the different outcome in the many-to-one and one-to-many procedures is an empirical matter. However, the claim made by Urcuioli and colleagues that the transfer evidenced with pigeons is equated with stimulus equivalence is hampered by both the lack of symmetry in the animal kingdom and by the failure to demonstrate conclusive tests results that would be expected if the stimuli involved were "equivalent". Similarly, as Urcuioli et al. (in press) note, mediated generalisation is an inadequate explanation for the data on these tests of transfer. Urcuioli et al. are thus in the position in which neither explanation, stimulus equivalence or mediated generalisation, is an adequate explanation of the transfer effects evidenced on studies with pigeons. These claims thus may be premature.

Putting the naming account to the test

The review of the literature in this chapter highlights the fact that behaviour analysis has seen an explosion in the study of emergent and symbolic behaviour; this explosion was fuelled by Sidman's seminal work on stimulus equivalence (e.g., Sidman & Tailby, 1982). Horne and Lowe (1996) maintain, however, that much of the research has been overly concerned with the notion of stimulus equivalence as a model of symbolic abilities. They, in contrast, argue for a developmental approach to the problem of explaining symbolic abilities, including symbolic categorisation (Horne & Lowe, 1996, 1997, in press).

One clear prediction follows from the naming account: naming is necessary for the categorisation of formally unrelated objects and events. Thus classifying behaviour occurs only when a child is behaving as both listener and speaker; if the child is not behaving as both listener and speaker at the time of categorising, categorisation of physically dissimilar arbitrary objects cannot occur. This prediction has been put to the test in a series of studies conducted by Harris, Randle, Horne, and Lowe (2000) and Randle (1999) (and see Horne & Lowe, in press).

In the first of these studies, Harris et al. (2000) taught common speaker behaviour to nine children aged between 2 years 3 months and 4 years and 3 months. Six arbitrary wooden shapes were divided into three pairs, each pair consisted of one "zag" and one "vek" stimulus. Each child was taught to say "zag" in response to one of the stimuli in each pair and "vek" to the other; that is, each child was taught to respond as a speaker. This training continued until each child could respond reliably to all six stimuli. In the category test phase, all six stimuli were presented to the child. The experimenter randomly targeted one of the stimuli and asked, "Look at this, can you give me the others?" According to the prediction of the naming account, the training of the common vocal response (zag or vek) would be sufficient to establish a class with those stimuli. Thus, when a child is presented with one of the stimuli (e.g., a zag) in a category test and names it, this likely to evoke her selection of other objects named "zag". Of the 9 children, 3 passed the category test comprised of 18 unreinforced trials. The remaining six children initially failed to categorise the stimuli and responded unsystematically; however, when this instruction was changed to include the prefix "What is that" (followed by "Can you give me the others?"), this prompted the children to make an overt common name response and all six children then went on to pass the category test.

In contrast to Harris et al. (2000), Randle (1999) taught common listener behaviour to nine children aged between 1 year and 7 months and 4 years and 1 month. Thus, instead of being required to respond with "zag" and "vek", the children were required to *select* the correct object on hearing the word spoken by the experimenter; that is, to respond as a listener. Each stimulus pair, consisting of one zag and one vek, was placed in front of the participants and the experimenter prompted a selection response by asking the child "Where is the zag/vek?" Correct selections of the stimulus that had been experimentally defined as zag (or vek) were reinforced, incorrect selections were not. After reaching criterion with all three experimental pairs of stimuli, as with the Harris et al. study, the child was given the same categorisation test. Of the nine children tested, none passed the test for categorisation after demonstrating only common listener responding to the arbitrary stimuli. After the categorisation test, a tact test was conducted (18 unreinforced trials); none of the children passed the test, and therefore, by Horne and Lowe's (1996) definition, naming had not being established. As predicted by their account, categorisation did not occur. Further, the nine children were then trained to emit a common speaker response to the stimuli, and subsequently given another categorisation test; six of them passed the test.

These two lines of research directly tested predictions from the naming account concerning categorisation. The Harris et al. (2000) study showed that after learning a common speaker response, and thus common naming, to three arbitrary objects, children passed tests of categorisation. Further, although the children were taught only a unidirectional tact relation, the performances on the test show all the features of "emergent" responding described in the literature in terms of stimulus equivalence or relational frames. Unlike equivalence accounts, however, the naming account specifies the learning history and explains these "emergent" outcomes as a direct result of training particular kinds of verbal behaviour.

Conversely, Randle's (1999) studies indicated that after demonstrating common listener behaviour alone (in the absence of speaker behaviour, and thus naming) children do not categorise arbitrary objects. The findings of both lines of research are consistent with the predictions of the naming account (Horne & Lowe, 1996).

* * *

The principal aim of the studies reported in this thesis is to further test key aspects of the theoretical account of naming proposed by Horne and Lowe (1996). In order to falsify the account, categorisation behaviour must be shown to occur *in the absence of naming*. Thus, in the studies reported here, participants were trained in either common listener relations (as in Randle, 1999) or common speaker relations (as in Harris et al., 2000). Categorisation should not occur unless *both* listener and speaker behaviour (i.e., naming) are present.

Both the Randle (1999) study and the Harris et al. (2000) study used the *categorisation by selection* method of testing. In this method, children are required to select other class members on presentation of one example of that class. The studies reported in this thesis, in contrast to both the previous lines of research, used the *categorisation by generalisation* method of testing for evidence of classes. In this method, a novel behaviour is trained to one exemplar of a potential class, and the categorisation test measures if that behaviour generalises to the other stimuli without direct training. If the behaviour does generalise to the other untrained stimuli, by definition they are members of the same class.

In a general sense, comparisons are possible between Harris et al.'s (2000) and Randle's (1999) studies because the former trained common speaker relations and the latter common listener relations. Both also used the categorisation by selection test as a method for testing for the existence of classes. However, robust comparisons between the two studies are hampered by certain procedural and methodological differences. For instance, in the Harris et al. studies there was an additional stage that incorporated training the first two pairs of stimuli together prior to training the third stimulus pair. This phase was absent from Randle's study. Further, comparisons were also hampered by practical difficulties in matching the procedures that occurred because of the relation between the two training procedures and the categorisation by selection tests. For example, in the Harris et al. procedure there was a stage prior to the test in which all stimuli appeared together, and each was targeted ("what's this") in order to ensure that the child could respond to all six stimuli with the correct vocal response. Given the nature of common listener training, this stage could not be incorporated into Randle's procedure because it would in effect be a directly prompted categorisation test.

As far as possible, in attempts to compare the two training methods, both listener and speaker training procedures should be identical, differing only in listener and speaker functions. In the present experiments, therefore, the corresponding common listener and common speaker procedures are closely matched. All the studies reported in this thesis followed a symmetrical order; that is, each study that incorporated a common listener procedure was matched with a similarly designed study that incorporated a common speaker training procedure. Because of this direct comparisons can be made between the two modes of training as regards the outcomes on the tests for categorisation.

Experiment 1a of this thesis investigated whether generalisation occurs only if the listener element of the name relation (but not the speaker element) are trained to members of a potential class.

CHAPTER 4

Study 1a: Categorisation Following Common Listener Training in 2.5 to 4 Year Olds.

Study 1a investigated generalisation in 2.5 - 4 year-old children. Six differently shaped wooden blocks were used as stimuli, three of which were randomly designated as "zogs" and three as "veks". The children underwent *common listener training* with pairs of shapes, each pair consisting of a zog and a vek stimulus. During common listener training, each child was trained to select the correct shape when presented with the auditory stimulus (i.e., either */zog/* or */vek/*).

After criterion had been reached on common listener training, unreinforced tact test trials were introduced in order to test for the emergence of untrained speaker relations. The children were then trained to emit a new behaviour (e.g., clapping) when presented with one of the zogs, and another new behaviour (e.g., waving) when presented with one of the veks.

Following this training, a categorisation test, Generalisation Test 1 (i.e., production) was conducted. In this test, the remaining shapes were presented in order to determine whether presentation of the untrained zogs stimuli would evoke clapping and the untrained veks waving. A further categorisation test, Generalisation Test 2 (i.e., comprehension), tested whether production of the behaviours (i.e., either clapping or waving) demonstrated by the experimenter would also evoke selection (i.e., listener behaviour) of the objects. In other words, would seeing the experimenter clapping evoke selection of the zog stimuli, and seeing the experimenter waving evoke selection of the vek stimuli?

GENERAL METHOD

There were two general training procedures employed in all the studies described in this thesis; these were: *common listener training* and *common speaker training*. The common listener training procedure is described in detail below in Study 1a. In all subsequent studies incorporating the common listener training procedure, deviations from the general procedure are described separately. The common speaker training procedure is described in detail in Study 2.

Participants

The participants in this and all subsequent studies were recruited from the Tir na N'Og Day Care and Child Development Centre run by the School of Psychology, University of Wales Bangor. Recruitment was conducted via letters to parents, nursery directors, and the nursery manager. A Griffiths Mental Development Scales (Griffiths, 1954) assessment was carried out, when possible, with the children during the procedure in order to asses their general development relative to their age group. The General Quotient scores for the participants are reported in the results section for the individual participants; all children tested scored within the normal range for children of that particular age group.

Four participants, CG, MD, SO, and PW, took part in Study 1a. Their ages ranged from 31 to 48 months old at the start of the procedure (see Table 4.1).

Table 4.1. Participants' sex, age at start of procedure, age at first test and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days	Griffiths GQ score
CG	M	48; 02	51; 16	120
MD	M	36; 12	38; 23	-
SO	F	31; 03	32; 24	119
PW	F	35; 30	37; 21	116

F = Female; M = Male. (-) = Data not available

Apparatus and Setting

The training and test procedures for this and all of the subsequent studies were carried out in one of three research rooms located in the nursery, namely:

Research Room 1: This had a floor area of 3.25m x 3.60m and a height of 3.35m. It was equipped with two Vista V28551A video cameras; both of these cameras were remote controlled from a central audio-visual console located in the nursery *audio-visual research room*. The cameras were wall mounted on Viacom slant and tilt V30308PT brackets on two of the diagonally opposed corners of the room, one at a height of 1.65m from the floor and the other at 2.39m (see Figure 4.1 for an example of the experimental setting).

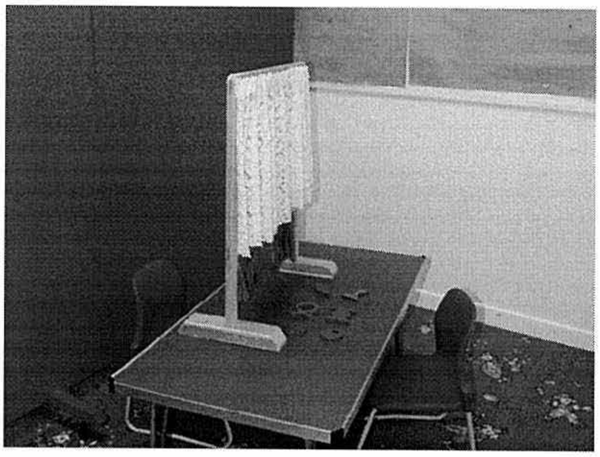


Figure 4.1: The experimental setting with testing screen.

Research Room 2: This was similar to Research Room 1 except that it had a floor area of 3.25m X 2.90m, and the two cameras were at a height of 1.63m and 2.34m from the floor.

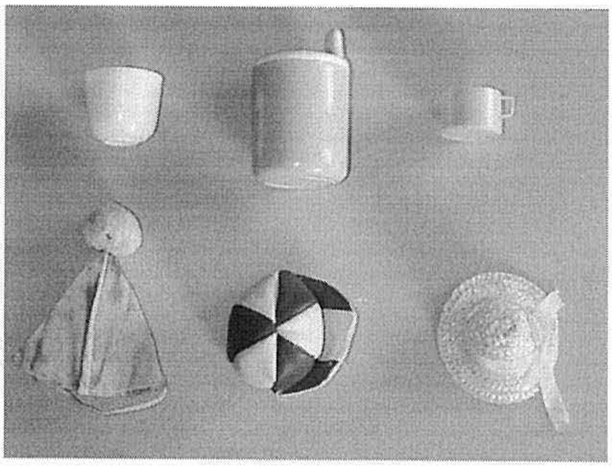
Research Room 3: This was one of five specially designed research rooms situated in an auxiliary building to the main Day Care Centre. The room area was 3.25m x 2.16m with a height of 2.49m. The room was fitted with one Panasonic f15 camera fixed onto a Panasonic WV/PH pan/tilt head bracket. A Panasonic VHS Nv-100 video recorder unit was linked to the camera for recording all sessions.

In the three research rooms an identical table measuring 110 cms length x 45 cms width with a height suitable for a young child was placed in the middle of the room. Two small children's chairs were situated at the centre of opposing sides (length) of the table facing each other.

Audio-visual Research Room: The audio-visual research room was equipped with video and audio recording equipment, a visual and audio mixer, Wharfedale speakers, and CCTV facilities. A Microvitec CVB 653 monitor was linked to each of the Panasonic VHS SR-L 900E video recorders located in the room for recording all experimental sessions and for viewing sessions real-time. During the sessions the experimenter wore a remote Beyerdynamic RTD 3406 VHS wireless microphone; this transmitted to a Beyerdynamic S170 True Diversity Receiver located in the nursery audio-visual research room.

Stimuli: The stimuli used in this and subsequent studies were of two sorts. The first consisted of six familiar toy objects — three different hats and three different cups (see Figure 4.2). These stimuli were used to familiarise the participants with the experimental procedure using the arbitrary objects.

Figure 4.2



The second consisted of 13 arbitrary wooden shapes of identical green colour and approximately the same size (see Figure 4.3). Three of these were randomly designated as "zog" and three as "vek" for each participant.

Figure 4.3

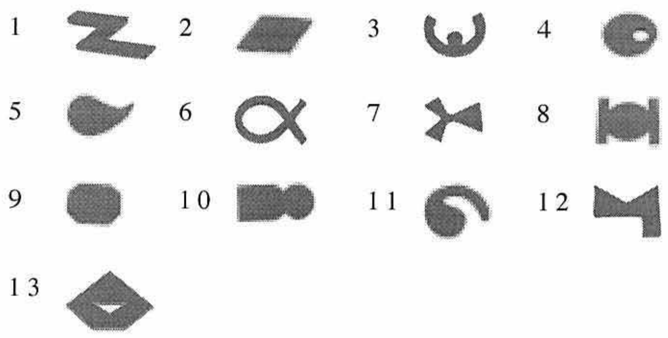


Figure 4.3. The arbitrary wooden shapes used in the discrimination training from which the stimuli were randomly chosen for each participant.

The individual stimuli were randomly selected from the pool of 13 to make up the three pairs for each of the participants in Study 1a.

In all studies a 60 cms x 70 cms one-way screen (see Figure 4.1) was used to conceal the experimenter during the test trials; it was placed on the table between the participant and the experimenter. The screen was a frame constructed from 5 cms x 2.5 cms wood. It had a 50 cms x 20 cms gap at its base section; this was partially covered by crepe paper strips, thus allowing the experimenter to freely move stimuli from behind the screen. The top section of the frame was fitted with a clear perspex window measuring 50 cms x 40 cms and was covered with a net curtain; this enabled the experimenter to partially view the procedure without being seen by the participant. Two fixed stabilisers made from the same wood and measuring 30 cms in length were attached at the base of the screen in order to allow it to stand securely on the table.

Procedure

Familiarisation Procedure. In this and all subsequent studies the experimenter was present at the Day Care Centre on most days and was therefore well known to all the children and the nursery staff. Before commencing work with a participant, the experimenter spent some one-to-one time with the participant until he or she was comfortable with the experimenter. The child would then be accustomed to going into the research room with the experimenter before the procedure commenced. Experimental sessions were carried out on the days that the participant attended the nursery; each lasted between 5 and 15 minutes. Figure 4.4 represents all the phases of Study 1a.

Reinforcement. Social reinforcement (SR) was relied on throughout the training period as the main source of reinforcement. Each correct response (trial) was reinforced with praise, and corrective feedback was provided for each incorrect response (during the training phases only). Nonsocial reinforcers were kept to a minimum and introduced into the study only when necessary. Nonsocial reinforcements were individually tailored and consisted games or other play items but primarily of sticker books; the experimenter would read from the book for approximately 5 minutes at the end of each session. This was to attempt to make the situation reinforcing as well as educational for the child. This reinforcement procedure was adhered to as much as possible although at times it was adapted, for example, when the child was particularly inattentive. At the end of the experiment with the permission of the child's parents each child was given a toy of their choosing for taking part in the experiment.

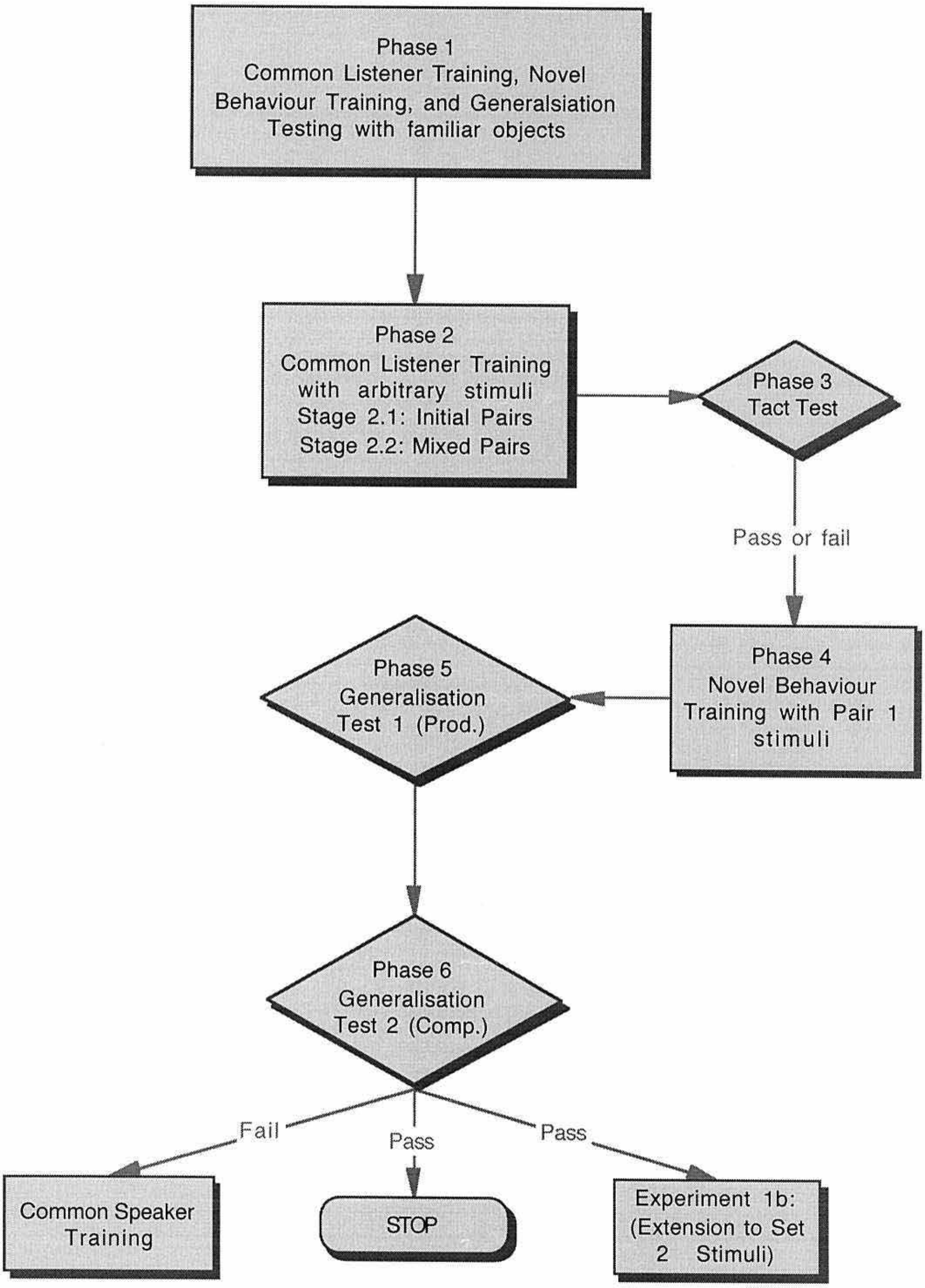


Figure 4.4: Flowchart representation of the procedure of Experiment 1a

Phase 1: Common Listener Training, "In-repertoire" Behaviour Training, and Testing with Familiar Objects

Stage 1.1: Common listener training with familiar objects. Three hats (H1, H2, & H3) and three cups (C1, C2, & C3) were used throughout Phase 1. The stimulus pairs were made up of one stimulus from each category (i.e., H1-C1, H2-C2, & H3-C3). A trial consisted of one stimulus pair being presented on the table in front of the child, one hat and one cup. Only one of the stimuli was targeted on each trial, and both stimuli were removed from the table and repositioned for each successive trial. The stimuli were positioned equidistant from the child's midline about 20 cms apart and approximately 20 cms away from the table edge closest to the participant. Trials were organised into blocks of eight; they were counterbalanced within each block such that each trial type appeared twice in each block and the same trial type did not appear twice in succession. Throughout the procedure there were four trial types used in all of the training blocks. They were coded as follows:

1. The hat was target and placed on the left; the cup was placed on the right.
2. The hat was target and placed on the right; the cup was placed on the left.
3. The cup was target and placed on the left; the hat was placed on the right.
4. The cup was target and placed on the right; the hat was placed on the left.

The experimenter ensured that the child was attending, placed the first pair of hats and cups (H1-C1) on the table, and said, "Look at these; can you give me the hat/cup?"

The experimenter responded with social praise (e.g., "Clever girl/boy") if the child responded correctly. If the participant failed to give the hat/cup, the experimenter provided corrective feedback, saying, "No, that's not the hat/cup; can you give me the hat/cup"; and if necessary demonstrated the correct response. The stimuli were then removed from the table and repositioned in their pre-specified position for the following trial.

Criterion was reached when the participant responded correctly on seven out of the eight trials within a block over two consecutive blocks. Training then proceeded to Pair 2 until criterion had been reached, and then to Pair 3 in the same manner as described above.

Stage 1.2: Training the in-repertoire behaviours to a subset of the stimuli. Only the Pair 1 stimuli were used in this phase (i.e., H1-C1). As before, the two stimuli were placed in front of the participant and the experimenter targeted one of the stimuli and said, "Look at this; it goes like this." The experimenter then modelled the action either for the hat, by placing the hat on his head, or the cup, by modelling drinking behaviour (i.e., the in-repertoire behaviours appropriate to those objects). This was followed by, "Can you show me how this goes?"

The experimenter reinforced correct responses with social praise. If the participant did not respond or responded incorrectly, the experimenter gave corrective feedback saying, "It goes like this [the experimenter then modelled the correct action]; can you show me how it goes?" Once the participant had successfully responded to this instruction reliably for both the H1 and C1 stimuli, subsequent instructions were shortened to, "Can you show me how this one goes?" The presentation of trials within a block and the learning criterion were as in Stage 1.1.

Stage 1.3: Testing for the occurrence of the 'in-repertoire' behaviour to the untrained stimulus pairs. The one-way screen was placed on the table between the participant and the experimenter. The Pair 2 stimuli were placed on the table in front of the participant, and the experimenter pointed to the target stimulus and said, "Can you show me how this one goes?"

Each stimulus was targeted four times in one block of eight test trials. The same procedure was carried out with the Pair 3 hat and cup stimuli. No reinforcement was given during this test stage.

If the child passed the Stage 1.3 test, the procedure went on to Phase 2. If the child did not pass the Stage 1.3 test, the trials were repeated with reinforcement until the child responded 100 percent correct over one block for each of the Pair 2 and Pair 3 stimuli.

Phase 2: Common Listener Training with Arbitrary Objects

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. After completing the Phase 1 procedure, the arbitrary stimuli were introduced to the child. Six stimuli were selected at random from a pool of 13 to make up the *initial pairs* selection for each of the participants. The stimuli were designated into three initial pairs each comprising one zog and one vek stimulus; these were coded for experimental purposes as initial zog 1 (iZ1) initial vek 1(iV1), iZ2-iV2, and iZ3-iV3. A trial consisted of one stimulus pair being presented on the table in front of the child, that is, one zog and one vek. Trials were organised into blocks of eight and were randomly counterbalanced within each block. Only one of the stimuli was targeted on each trial, and both stimuli were removed from the table and repositioned for each successive trial given the instruction, "Look at these; can you give me the zog/vek?"

As with Stage 1.1, the experimenter responded with social praise if the child was correct, or, if incorrect, provided corrective feedback. Criterion was reached when the participant responded correctly on seven out of eight trials within a block of eight trials over two consecutive blocks. After criterion had been reached with the Initial Pair 1 stimuli (i.e., iZ1/iV1), the training procedure was repeated with the Initial Pair 2 stimuli and then the Initial Pair 3 stimuli.

Stage 2.2: Common listener training: Mixed pairs. After the participant had reached criterion with all three of the initial stimulus pairs, the pairs were randomly mixed in order to enhance control by the individual stimuli. For instance, iZ1 might be paired with iV3, iZ2 with iV1, and iZ3 with iV2. In all other respects the training and learning criterion for each pair was identical to that of Stage 2.1. The stimulus pairs remained in the new arrangement (i.e., mixed pairs) for the remainder of the procedure; after here they are denoted by Pair 1, 2, or 3, or individually as Z1/V1, Z2/V2, or Z3/V3.

Stage 2.3: Reduction to zero reinforcement. This stage was identical to that of the previous training stages except that trials were conducted without reinforcement (i.e., under extinction).

If a child did not maintain criterion performance on a zero percent reinforcement schedule, the reinforcement schedule was increased to a 50 percent schedule (i.e., a VR2 schedule) until criterion had been reached; then it reverted back to zero percent. Reinforcement levels refer to the number of correct responses that were reinforced within a block of trials. Reduction in reinforcement was carried out with Pair 1 until criterion, followed by Pair 2 and finally Pair 3.

Phase 3: Tact Test

After reaching criterion without reinforcement, the child was tested to determine whether he or she could produce the appropriate untrained speaker behaviour (i.e., "zog" or "vek") to the experimental stimuli after being trained to select only the stimuli on hearing the listener stimulus */zog/* or */vek/*. Each pair was placed on the table separately, and the experimenter targeted one of the stimuli and asked, "What's this?" The child was given approximately four seconds to respond, and, if no response was given, the question was repeated and a further four seconds were given for the participant to respond.

Pair 1 stimuli were presented for four trials, each stimulus being targeted twice, once on the right and once on the left in a pre-specified random order. This was followed by four trials with Pair 2 and then Pair 3. This procedure was repeated in order that each stimulus had been targeted four times in all. No reinforcement was given during this or any other test stage. Participants were deemed to have named the stimuli if they scored three out of four correct responses for each stimulus.

Phase 4: Training a Novel Behaviour to a Subset of the Stimuli

Stage 4.1: Novel behaviour training. Clapping and waving were selected as the novel behaviours to be trained because they are in the behavioural repertoire of most young children; also, they can be emitted in response to different kinds of stimulus events. One of the behaviours (either clapping or waving) was randomly assigned to the zog stimulus (Z1) and one to the vek (V1) stimulus for each child; the novel relations were trained only to the Pair 1 stimuli.

As before, the two stimuli were placed in front of the participant. The experimenter targeted one of the stimuli by pointing to it and said, "Look at this; it goes like this." The experimenter then modelled the action for the zog or vek stimulus (i.e., waving or clapping as appropriate). This was followed by, "Can you show me how it goes?"

If the child emitted the modelled behaviour in response to the target stimulus the experimenter responded with social praise or provided corrective feedback as previously described if the participant failed to do so. Once the participant had responded reliably across one block of trials to the above instruction, subsequent instructions were shortened to, "Can you show me how this one goes?" Block structure and criterion levels were as previously described in Stage 2.1.

Stage 4.2: Reduction to zero reinforcement. Trials continued as described in Stage 4.1, but reinforcement was reduced to zero (see Stage 2.3).

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

To minimise the possibility of experimental cueing, a second experimenter (Experimenter 2) was introduced for all test sessions. Experimenter 2 was familiar with the participant and with the general experimental procedure but was not aware of either the assigned labels given to the experimental stimuli, or the novel behaviours assigned to the Pair 1 stimuli. Prior to each test session, Experimenter 2 was given a sheet of paper on which the trials were listed; because of this she knew exactly which stimulus pair to use for each test trial, and which of the two stimuli to point before instructing the child. Experimenter 1 sat behind the participant while Experimenter 2 conducted the test trials.

Stage 5.1: Maintenance of training. Prior to each of the test sessions, in order to ensure all of the trained relations were intact, unreinforced listener behaviour test trials (i.e., those that utilised the request, "Can you give me the zog/vek") were conducted with each of the three pairs of stimuli. These were followed by four test trials of the novel behaviours trained to Pair 1 (i.e., two trials with the Z1 stimulus and two with the V1 stimulus accompanied by the request, "Can you show me how this one goes?").

Stage 5.2: Testing for generalisation of the novel behaviour to the untrained stimuli. This stage, as with all subsequent test stages, was conducted by Experimenter 2 with the one-way screen in place. One of the two test pairs was placed on the table in front of the child in a pre-specified random order. Experimenter 2 ensured the participant was attending, and whilst pointing to the target stimuli asked, "Look at this; can you show me how it goes?"

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 32 test trials, each stimulus was targeted 8 times, 4 times on the left and 4 times on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4; see Stage 1.1) appeared twice in each block; also, the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond, the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions.

The number of trials that could be conducted within a particular session was often dependent on the individual child, and ranged from 8 to 32. In each of the test sessions, the Phase 5 procedure was repeated in full; that is, both Stage 5.1 and Stage 5.2.

Mastery criterion on Generalisation Test 1: Binomial probability distribution statistics were calculated in order to determine the probability of scoring a specific number of correct trials by chance (see Howell, 1992). The Binomial probability distributions statistic is mathematically defined as:

$$p(X) = \frac{N!}{X!\,(N - X)!}\, p^{X} q^{(N-X)}$$

where:

$p(X)$ = The probability of X successes.

N = The number of trials. The standard number of test trials was 32, 16 trials for each of the two stimulus pairs where each stimulus was targeted eight times in all.

p = The probability of success on any one trial; that is, the probability of showing the correct behaviour to the target stimulus. On any trial there was a possibility of two responses, either clapping or waving. Therefore the constant p was set at 0.5.

q = $(1 - p)$ The probability of a failure on any one trial, that is, 0.5.

By applying the Binomial distribution probabilities for any given pair of stimuli, the criterion selected was a score of 12 out of 16, or 75 percent, correct responses ($N = 16, p = 0.5$; $P(12) = 0.02 < 0.05$). There was an additional constraint: a score of six out of eight was required for each stimulus within a pair.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

The procedure in this stage was similar to that of Phase 5 except that all three pairs were used to test for the emergence of listener behaviour (i.e., comprehension of the novel behaviour). Pair 1 was included in Phase 6 because only the production (i.e., a speaker behaviour) of the novel behaviour had been trained directly to the Pair 1 stimuli during Phase 4. As with Phase 5: Generalisation Test 1, prior to each of the test sessions, unreinforced listener behaviour test trials were conducted followed by four test trials of the novel behaviours trained to Pair 1 (see Stages 5.1 for detail).

One of the three pairs was placed on the table in front of the participant in a pre-specified random order. Experimenter 2 ensured the participant was attending and asked, "Can you give me the one that goes like this (i.e., either clapping or waving)?" Experimenter 2 then modelled one of the behaviours.

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 24 test trials, each stimulus was a target four times, twice on the left and twice on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4; see Stage 1.1) appeared twice in each block; also, the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions. Participants were deemed to have passed the Generalisation Test 2 if they scored three out of four correct responses for each stimulus within a test pair.

Interobserver Reliability Ratings

Twenty-five percent of the training sessions were selected randomly and re-scored by a second observer from the video recordings. The same reliability procedure was carried out for all children. For all the children who participated in the research reported in this thesis, a total of 1608 training trials and 3568 test trials were re-scored (100% of test trials were similarly re-scored). There was a high level of inter observer agreement; 96.4 percent agreement was found across the training trials and 100 percent agreement across the test trials.

RESULTS

All four participants completed all phases of the study.

Phase 1: Common Listener Training, "in-repertoire" Behaviour Training and Testing with Familiar Objects

Table 4.2 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common listener training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 4.2 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

During Stage 1.1, all participants reached criterion performance in either one or two blocks of training for each of the three stimulus pairs. All four children learned the "in-repertoire" behaviour to criterion performance within one block, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 4.2

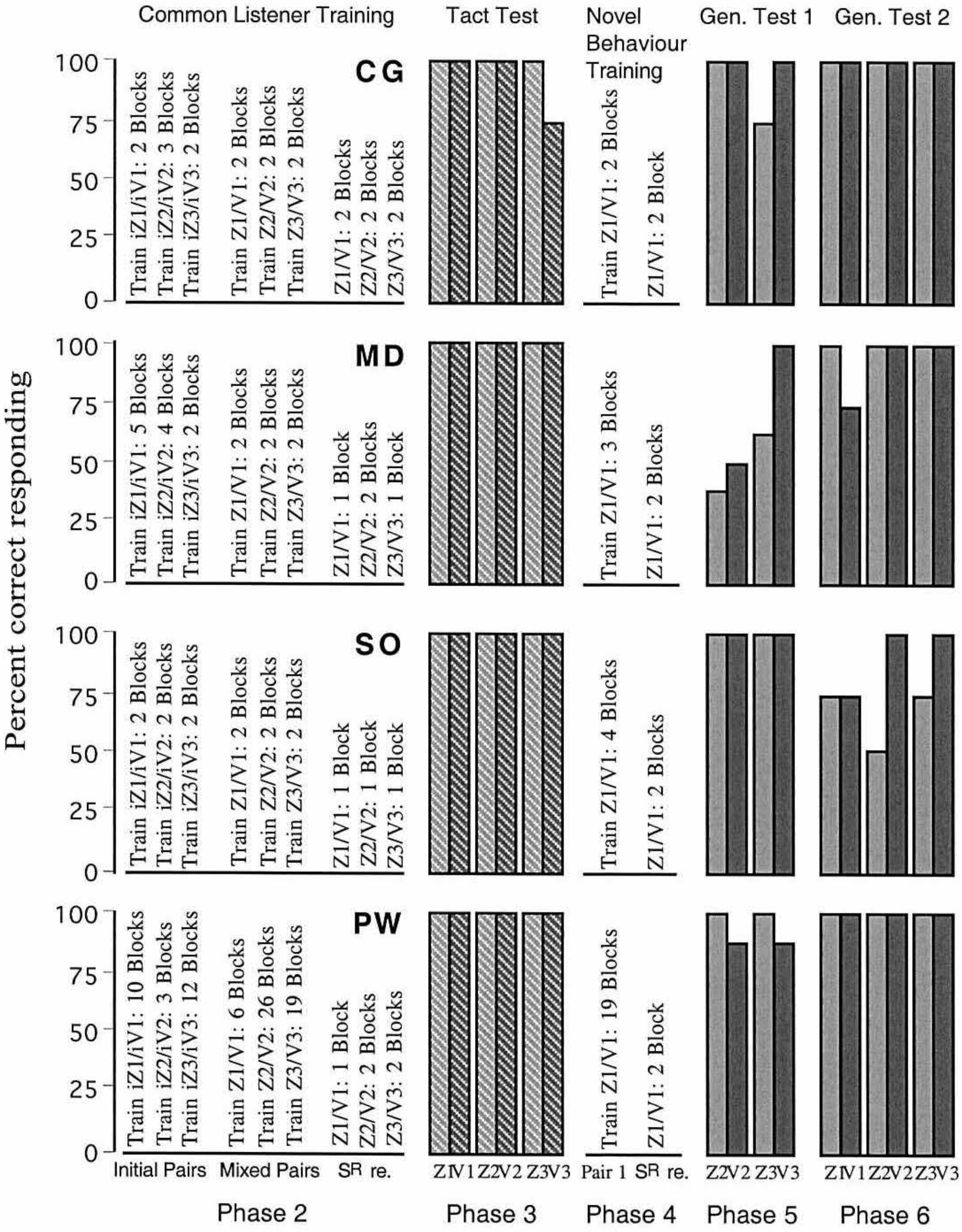
Results of Phase 1: Common Listener Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, and H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common listener training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
CG	1	1	1	1	1	1
MD	1	1	1	1	1	1
SO	1	1	1	1	1	1
PW	2	2	2	1	1	1

Figure 4.5

Figure 4.5. Performance of participants CG, MD, SO, and PW on Phases 2 through 6. Phase 2: Common Listener Training, number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 3: Tact Test, percent correct responses, out of 24 trials, 4 trials for each stimulus. Phase 4: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 5: Generalisation Test 1, percent correct responses, out of 32 trials, 8 for each stimulus. Phase 6: Generalisation Test 2, percent correct responses, out of 24 trials, 4 trials for each stimulus.

Figure 4.5


Common Listener Training
Tact Test
Novel Behaviour Training
Gen. Test 1
Gen. Test 2
Percent correct responding
CG
MD
SO
PW
Initial Pairs
Mixed Pairs
SR re.
Pair 1 SR re.
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6

Phase 2: Common Listener Training with Arbitrary Objects

The results for Phase 2 through Phase 6 are represented in Figure 4.5. The data presented for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. Participants CG and SO required two blocks of training trials for each stimulus pair (i.e., iZ1/iV1, iZ2/iV2, and iZ3/iV3). Participant MD required five blocks of training to criterion on the Initial Pair 1 stimuli, and four blocks for both the Initial Pair 2 and two for the Initial Pair 3 stimuli. PW required 10 blocks for Initial Pair 1, three blocks for Initial Pair 2, and 12 blocks for Initial Pair 3.

Stage 2.2: Common listener training: Mixed pairs. Participants CG, MD, and SO required only two blocks to attain criterion performance for each of the mixed pairs stimuli (i.e., Z1/V1, Z2/V2, and Z3/V3). Participant PW reached criterion for Pair 1 in 6 blocks, Pair 2 in 26 blocks, and Pair 3 in 19 blocks.

Stage 2.3: Reduction to zero reinforcement. The number of blocks required to achieve criterion performance (seven out of eight trials correct) under a zero reinforcement schedule is shown in Figure 4.5. All the children maintained criterion performance under a zero reinforcement schedule and therefore none required a return to a 50 percent or 100 percent schedule during the reduction to zero reinforcement procedure (see Stage 2.3).

After reaching criterion with each stimulus pair during Stage 2.2, participant CG maintained criterion performance without reinforcement across two blocks of trials for each stimulus pair. MD required one block for unreinforced trials for pairs 1 and 3 and two blocks for Pair 2. Participant SO required one block of trials for each stimulus pair, and PW required one block for Pair 1 and two blocks for Pairs 2 and 3.

The mean number of blocks required for the four participants to meet the criteria for all three stages of Phase 2 was 34.5 (range 15 - 83). Participant CG required a total of 19 training blocks, MD 21 blocks, SO 15 blocks, and PW 83 blocks.

Phase 3: Tact Test.

The performance on the tact test (Phase 3) of each participant is shown in Figure 4.5; this presents percent correct responses over the 24 test trials, four trials for each of the stimuli. The criterion for successful tacting was set at 75 percent (see Procedure, Phase 3), or three correct responses out of four for each stimulus, for both the zog and for the vek stimuli.

Participant CG showed 100 percent correct responses with all three zog stimuli, the V1, and the V2 stimuli, and 75 percent correct with the V3 stimulus. Participants SO, MD, and PW made no errors on any of the 24 test trials. These results indicate that all participants also learned appropriate speaker behaviour; thus, by Horne and Lowe's (1996) definition, naming had been established, by the Phase 2 training, the tact test itself, or a combination of both.

Phase 4: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figure 4.5 shows the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 4.1: Novel behaviour training. Participant CG reached criterion on the novel behaviour training in two blocks of eight trials, SO in four blocks, MD in three, and PW in 19.

Stage 4.2: Reduction to zero reinforcement. All four participants achieved criterion responding in the absence of reinforcement for the novel behaviour training in two blocks of trials.

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figure 4.5 shows the percentage of correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted eight times. The criterion level for Generalisation Test 1 was set at 75 percent for each stimulus in a test pair.

Participant CG completed all 32 test trials in one session, and scored 100 percent correct with the Pair 2 stimuli and 87.5 percent correct with the Pair 3 stimuli; that is, 87.5 percent with the Z3 stimulus and 100 percent with the V3 stimulus. Participant MD completed all 32 test trials over two test sessions, each session comprising 16 trials, and he scored 44 percent correct with the Pair 2 stimuli and 81 percent correct with the Pair 3 stimuli. For the individual class stimuli this translates as 37.5 percent correct with the Z2 stimulus, 62 percent correct with the Z3, 50 percent correct with the V2, and 100 percent correct with the V3 stimulus. MD thus failed to meet the generalisation criterion with the Pair 2 stimuli. Participant SO completed 32 test trials over one test session and made no errors.

Participant PW completed all 32 test trials in one test session, and scored 94 percent correct for both Pair 2 and Pair 3 stimuli; that is,100 percent with both the zog stimuli and 87.5 percent with both the vek stimuli. These results indicate that all participants showed evidence of generalisation of the novel behaviour.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figure 4.5 shows for each child the percentage of correct trials over the 24 test trials in Phase 6, four trials for each of the six test stimuli. The criterion level for the Generalisation Test 2 was 75 percent correct responses for each of the stimuli in a test pair.

The four participants completed all 24 test trials in one session. Participants CG and PW made no errors throughout the test session. MD scored 100 percent correct responses for Pairs 2 and 3, and 82.5 percent for Pair 1; that is, 100 percent for all target stimuli, except stimulus V1, on which he scored 75 percent correct responses. Therefore, CG, PW, and MD met the criterion for success on the test. Participant SO scored 75 percent correct responses for Pairs 1 and 2, and 82.5 percent correct responses for Pair 3; that is, she scored 50 percent correct responses with Z2, 75 with the Z1, Z3, and V1 stimuli, and 100 percent correct responses with the V2 and V3 stimuli. Thus SO showed criterion performance on Pairs 1 and 3 only.

Spontaneous verbal behaviour

All participants' verbalisations made during common listener training (Phase 2) are indicated in Table 4.3, including the verbal prompt that preceded the vocalisation and the stimuli present at the moment the verbalisation was made.

Participant CG made one idiosyncratic verbalisation to the V2 stimulus () calling it "a raindrop". All the vocalisations he made were during the Phase 2 training. He produced the verbalisation "zog" on three occasions; all of these were made on trials when one of the zog stimuli was the target (i.e., given the instruction, "Can you give me the zog?"). He produced the verbalisation "vek" on six occasions; all were made on trials when one of the vek stimuli was the target (i.e., given the instruction, "Can you give me the vek?"). At the start of the Phase 2 (initial pairs) training session with the Initial Pair 1 stimuli, CG pointed to each of the stimuli in turn and said, correctly, "That's the vek; that's the zog". On the first session with the Initial Pair 2 stimuli he said, "They've got the same names". On the first session with the Pair 2 stimuli he said, "You have mixed them up". The evidence from CG's verbalisations suggests that he had learnt to name the stimuli, and his Phase 3 tact test results confirmed this. He went on to pass both tests of generalisation; he did not, however, produce the names for any of the stimuli during the test sessions.

Table 4.3. Children's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during Common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
CG	iZ1/iV1	Can you give me the zog?	zog
		No prompt	That's the vek; that's the zog (pointing to both in turn).
		Can you give me the vek?	vek x 2
	iZ2/iV2	No prompt	They've got the same names.
		Can you give me the zog?	zog; Is this the zog?; This is the zog (pointing to the stimulus); This one is the zog (pointing to the stimulus); It's a vek x 2 (pointing to the stimulus - incorrect).
		Can you give me the vek?	vek x 2; Is this the vek? (pointing to the stimulus); This is the vek x 2 (pointing to the stimulus); I gave you the vek; That's the vek x 3 (pointing to the stimulus).
	iZ3/iV3	Can you give me the vek?	This is the vek isn't it? (pointing to the stimulus).
	Z1/V1	Can you give me the zog?	zog
		Can you give me the vek?	vek x 2
	Z2/V2	Can you give me the zog?	zog
		No prompt	You mixed them up
	Z3/V3	Can you give me the zog?	zog
		Can you give me the vek?	vek
PW	Z1/V1	Can you give me the zog?	zog
		Can you give me the vek?	vek x 3
	Z2/V2	Can you give me the zog?	zog; That's the zog (pointing to the zog).
		Can you give me the vek?	vek x 2; That's the vek (pointing to the vek).
	Z3/V3	Can you give me the zog?	zog; That's the zog (pointing to the zog); A kite
		Can you give me the vek?	vek; That's vek (pointing to the vek); It's a number.
MD	iZ1/iV1	Can you give me the zog?	zog x 5; This zog x 2 (pointing to the stimulus).
		Can you give me the vek?	vek x 7; This vek x 2 (pointing to the stimulus).
	iZ2/iV2	Can you give me the zog?	zog x 3; This zog (pointing to the stimulus).
		Can you give me the vek?	vek x 3; This vek (pointing to the stimulus).
	iZ3/iV3	Can you give me the vek?	vek x 5
	Z1/V1	Can you give me the zog?	zog x 6
		Can you give me the vek?	vek x 3
	Z2/V2	Can you give me the vek?	vek x 6; This vek (pointing to the stimulus)
	Z3/V3	Can you give me the zog?	zog
		Can you give me the vek?	vek x 3

Participant PW made two idiosyncratic verbalisations: to the Z3 stimulus () she said, "A kite", and to the V3 stimulus () she said, "It's a number". Both these stimuli resemble these real world objects: the Z3 stimulus resembles a kite and the V3 stimulus the digit "6". During the Phase 2 training (mixed pairs) PW produced the verbal response "zog" on three occasions, once to each of the three stimulus pairs during trials when the zog stimulus was the target. Similarly, she said "vek" on six occasions, at least once in the presence of each of the three stimulus pairs during trials when the vek stimulus was the target (see Table 4.3). The evidence of PW's verbal behaviour also suggests that, at least for some of the stimuli, she had learned the names; again this was confirmed by the tact test results. PW went on to pass both the tests of generalisation but did not make any verbalisations during the two generalisation tests.

Participant MD's first language was Spanish. He made no idiosyncratic verbalisations during the procedure. During the Phase 2 training, he produced the verbal response "zog" on 15 occasions, at least once to each of the three stimulus pairs during trials when the zog stimulus was the target. He said "vek" on 21 occasions, at least twice to each of the three stimulus pairs during trials when the vek stimulus was the target (see Table 4.3). During Phase 4: Novel behaviour training ("Can you show me how this goes?") he said "vek" to the V1 stimulus. Thus again the evidence suggests MD had learned to name the stimuli, and this was confirmed by his tact test results. MD went on to show generalisation but did not make any verbalisations during the two generalisation tests.

Participant SO made no idiosyncratic verbalisation during the procedure. Neither did she make any experimentally relevant verbalisations during the Phase 2 training. During Phase 4: Novel behaviour training ("Can you show me how this goes?") she produced the verbal response "zog" on seven occasions, all on trials when the zog was a target. Similarly, she said "vek" on four occasions on trials when the vek was a target. During the Phase 5: Generalisation Test 1, she called the Z2 stimulus "zog". SO did not make any further verbalisations during the two generalisation tests. From her verbalisations there was no strong evidence that SO had learned to name the stimuli during the Phase 2 training. However, she did pass the tact test and went on to pass the generalisation tests.

DISCUSSION

The aim of Study 1a was to show generalisation of a novel behaviour after training only common listener relations (i.e., without corresponding speaker relations, and hence naming). Data from the tact test (Phase 3) showed that, after learning a common listener relation, all four children, CG, SO, MD, and PW also showed appropriate speaker behaviour; further, three of these, CG, SO, and PW, subsequently showed clear evidence of generalisation of the novel behaviour to untrained stimuli during both tests (Generalisation Test 1 and Generalisation Test 2). One participant, MD, failed to generalise to all stimulus pairs in Test 1 (i.e., 75 percent correct responses for each of the stimuli in a pair), but he did show criterion generalisation on Test 2.

Thus, of the four participants who had shown evidence of naming, as defined by Horne and Lowe (1996), all showed that they had formed two classes of stimuli; this was demonstrated in Phases 5 and 6 with participants CG and PW, in Phase 5 with participant SO, and in Phase 6 with MD. These results are consistent with the prediction that naming arbitrary stimuli forms a class with those stimuli. However, the principal aim of Study 1a was to train *only* listener relations; this did not occur, and thus the critical conditions for falsification were not met in this study.

As noted, MD scored 100 percent correct responses on the tact test, and thus had shown evidence of naming prior to the tests of generalisation. However, he failed to reach criterion performance of 75 percent correct responses for both Pair 2 and Pair 3 on Generalisation Test 1 (see Figure 4.5). On Generalisation Test 2, however, he showed criterion generalisation for all three test pairs.

Participant MD's failure to show criterion performance on Test 1, coupled with his criterion performance on Test 2, suggests that the failure may have been due to extraneous variables acting during the first test—the time he would attend to the experimental task, for example (MD was an extremely active child and found it difficult to sit for more than a few minutes at a time). The animal sticker books used for most of the children in this research did not function as an effective reinforcer for his participating in the sessions (after some experimentation, ball playing at the end of the session helped to extend the time he would sit in the chair and attend to the learning tasks). In addition, the test sessions were, unavoidably, long; this was due in part to the need to establish criterion responding to the trained relations prior to test for generalisation.

Another possible explanation for the disparity in performance on the two tests is that MD was able to respond only as a listener to the stimuli but not as a speaker. This is suggested by the difference between his performance on the two tests: Test 1 required evidence of speaker behaviour, Test 2 evidence of listener behaviour. An explanation of this sort would raise problems for the Horne and Lowe (1996) account. This is because MD had demonstrated categorisation as a listener (selection based Generalisation Test 2) but not as a speaker (production of behaviour in Generalisation Test 1) and, according to the naming account, in order for categorisation to occur, the child must be behaving as both listener and speaker at the time of categorisation.

This explanation seems unlikely. This is for three reasons. First, the explanation that he could respond as a listener but not a speaker is not supported by his performance on the tact test (see Figure 4.5, Phase 3); as the data show, MD was able to name the stimuli reliably and had shown good evidence of both speaker and listener behaviour to all of the experimental stimuli. Second, and more important, he had shown evidence of production on the Phase 4 training of the novel behaviour to the Pair 1 stimuli (i.e., a speaker behaviour). Third, his performance on Generalisation Test 2 does not indicate whether he was responding as both speaker and listener; this is because it was not necessary for him to *overtly* respond as a speaker in order to succeed on the selection based test. A more likely explanation therefore for his failure during Generalisation Test 1, is that there were undefined sources of control that interfered with control by stimuli and/or control by naming.

These results for MD on the Generalisation Test 1 indicate that, while naming may be necessary for categorisation, it is not sufficient to bring it about. It may be necessary for children to engage in naming in order to categorise arbitrary stimuli, but the fact that the child shows evidence of naming stimuli in certain contexts may not be enough: he or she may have to actually name the stimuli, overtly or covertly, *at the time of categorising*.

Naming or other verbal behaviour does not guarantee generalisation (and the establishment of classes of arbitrary or formally unrelated stimuli), but this fact does not logically reflect on whether naming or other verbal behaviours is necessary: responses may or may not occur during a specific context, and whether they do will depend on the reinforcement history of that behaviour within that context; this is because behaviour is multiply determined. Skinner made a similar point about rules, "Whether a rule is followed depends not upon whether 'the person believes that the rule is true' but upon past experiences in using the rule or other rules offered by the same authority" (1988, p. 265).

As noted in the Results section, MD used an idiosyncratic tact, "elephant", in reference to the V3 stimulus, and after this tacting event he went on to say "elephant" on each occasion when the V3 stimulus was a target before he said "bek". Further, his responses were 100 percent correct to this stimulus throughout the trials on both Test 1 and Test 2. This suggests the possibility that he used some form of verbal strategy when responding to this stimulus. For instance, he may have responded using both "elephant" and "bek" for the one stimulus, an intraverbal chain, such as "elephant – bek", or a verbal rule, such as "the elephant is a bek" (see Horne & Lowe, 1996; Randell & Remington, 1999).

Participant SO also showed evidence of naming and met the criterion for generalisation on Test 1. Interestingly, on Test 2, SO showed imitation of the "novel" behaviour modelled by the experimenter on every test trial; that is, when the experimenter modelled one of the behaviours (either waving or clapping) she imitated this behaviour before orienting towards the stimuli and selecting one of them.

This has implications for the Horne and Lowe (1996) account of naming. In their account, Horne and Lowe specify that, in order to classify objects, a child must be behaving as both listener and speaker at the time of categorisation. Thus, SO's object related behaviour, and, for that matter, similar object related behaviour in any child, could evoke the name of an object. So, in the novel behaviour training with the Pair 1 stimuli (Phase 4), the trained behaviour would have reliably preceded, and thus could have become discriminative for, the child's utterance (covert or overt) of the objects' name. Thus, in the test situation, SO was responding by producing the novel behaviour (i.e., behaving as a speaker), and this in turn may have provided the stimulus to evoke the class name and subsequent selection of the appropriate test stimulus (i.e., a listener response).

The point is this. Naming is *multimodal.* It incorporates listener and speaker functions involving all the senses — visual, auditory, tactile, taste, and olfactory. Therefore one may theorise that, given that the novel behaviour in Study 1a reliably accompanied and entered into the name relation, novel behaviour can evoke listener responding in the same manner as the vocal name. The novel behaviour may have been used by SO as a full symbolic gesture.

* * *

The naming effects established in Study 1a embraced two three-stimulus classes. Study 1b investigated whether the three-member classes would extend to six-member classes.

Study 1b: Extension of Three-member Classes to Six-member Classes Following Common Listener Training

Following common listener training in Study 1a, all four children showed appropriate speaker behaviour on the tact test, and all four subsequently showed a generalisation of a novel behaviour to untrained class members on initial test. The next question was, given the exposure to training in Study 1a, would the children now form a larger six-member class following similar training with a novel set of stimuli (Set 2) in Study 1b?

METHOD

Participants

Three of the participants in Study 1a went on to participate in Study 1b. Their ages ranged from 33 to 51 months at the start of the procedure (see Table 4.4).

Table 4.4. Participants sex, age at start of procedure and age at first test.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
CG	M	51; 18	52; 16
SO	F	33; 20	33; 04
PW	F	37; 22	37; 21

F = Female; M = Male

Apparatus and Setting

These were identical to those described in Study 1a.

Stimuli: These were identical to those described in Study 1a. The experimental stimuli used in Study 1b were chosen from the seven remaining stimuli from the original pool of 13 used for that particular child in Study 1a.

Procedure

Figure 4.6 represents all the phases of Study 1b. The procedure in Study 1b was similar to that of Study 1a (common listener training). The differences between the two procedures are noted below for each of the separate phases. The trial format, reinforcement schedules, and criterion level were identical to those described in Study 1a. However, there was no training with the familiar objects as took place in Study 1a; therefore the procedure for Study 1b began with the training of the arbitrary stimuli.

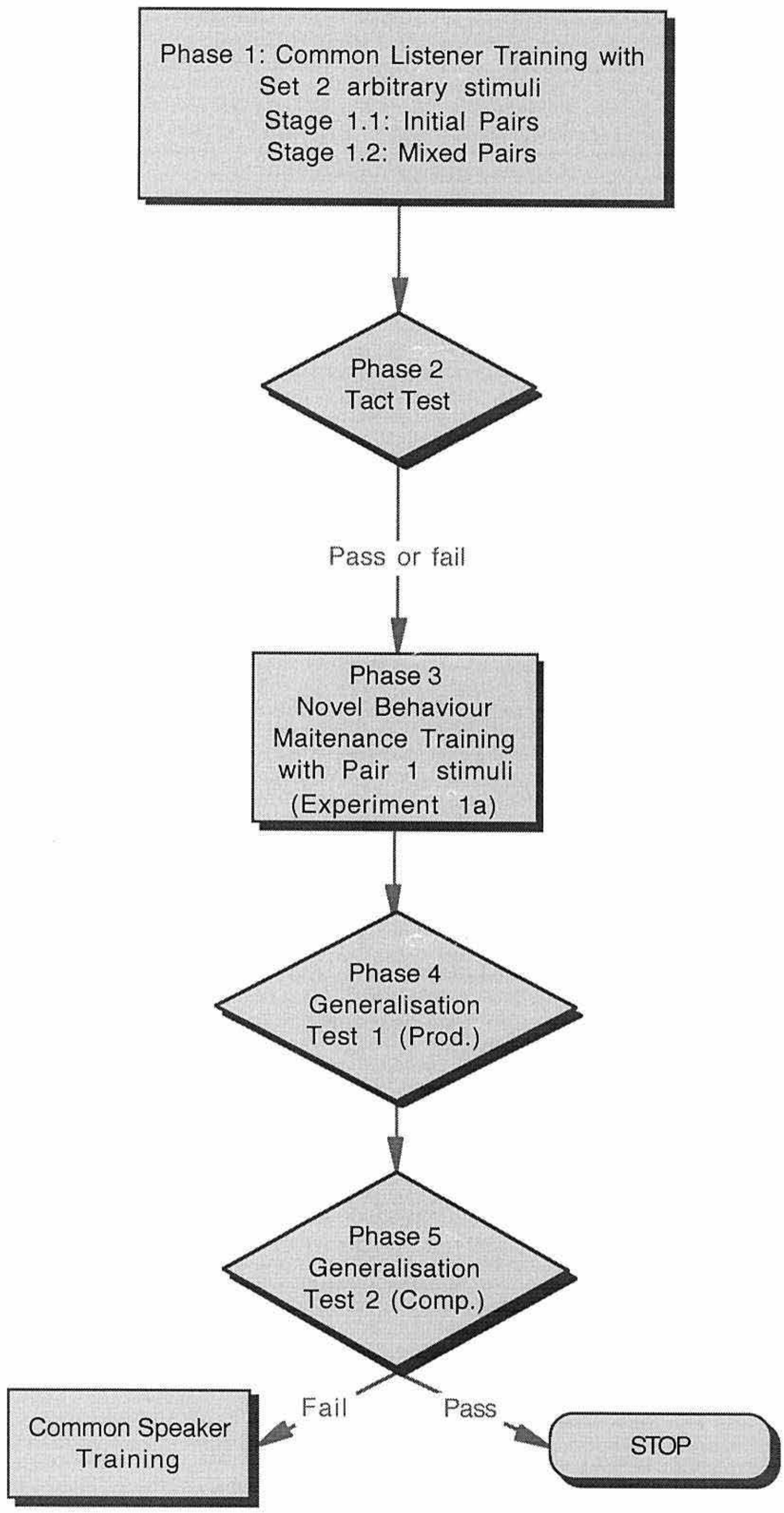


Figure 4.6: Flowchart representation of the procedure of Experiment 1b

Phase 1: Common Listener Training with Arbitrary Stimuli

Stage 1.1: Common listener training with arbitrary objects: Initial pairs. Six stimuli from the seven remaining from the pool of 13 were randomly designated into three initial pairs, each made up of one zog and one vek stimulus; these were coded for experimental purposes as follows: initial zog 4 (iZ4) initial vek 4 (iV4), iZ5-iV5, and iZ6-iV6. In all other respects the training was identical to that described in Stage 2.1 of Study 1a.

Stage 1.2: Common listener training: Mixed pairs. After the participant had reached criterion with all three of the initial stimulus pairs, the pairs were randomly mixed, as with Study 1a, in order to enhance control by the individual stimuli. For example, iZ4 might be paired with iV5, iZ5 with iV4, and iZ6 with iV5. In all other respects the training and learning criterion for each pair was identical to that of Stage 2.2 of Study 1a. The stimulus pairs remained in the new arrangement (i.e., mixed pairs) for the remainder of the procedure; after here they are denoted by Pair 4, 5, or 6, or individually as Z4/V4, Z5/V5 or Z6/V6.

Stage 1.3: Reduction to zero reinforcement. This was as described in Stage 2.3 of Study 1a.

Phase 2: Tact Test.

This was as described in Phase 3 of Study 1a.

Phase 3: Maintenance of Novel Behaviour Training to a Subset of the Stimuli

Stage 3.1: Novel behaviour maintenance. Because the novel behaviours (clapping and waving) had been trained to the Pair 1 stimuli (i.e., Z1/V1) in Study

1a, none of the six stimuli used in Study 1b were trained directly with these behaviours. However, maintenance trials were conducted with the Pair 1 stimuli (and only the Pair 1 stimuli) from Study 1a throughout Study 1b. This was in order to ensure that the learning of the novel behaviour remained intact with respect to the Pair 1 stimuli. To this effect, every fourth day (or nearest to) unreinforced maintenance trials were conducted with the Pair 1 stimuli from Study 1a. As usual participants were given the instruction, "Can you show me how this goes?" The details of the procedure for these maintenance trials was as described in Phase 4 of Study 1a.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

The procedure for Phase 4 was similar to that of the Phase 5 of Study 1a; the differences are noted below.

Because none of the stimuli in Study 1b were trained directly with the novel behaviour, all three pairs were tested for the generalisation of the behaviour that was trained to the Pair 1 stimuli during Study 1a.

Stage 4.1: Maintenance of training. Prior to each of the test sessions, in order to ensure all of the trained relations were intact, unreinforced listener behaviour test trials (i.e., those that utilised the request, “Can you give me the zog/vek”) were conducted with each of the three pairs of stimuli (i.e., Pair 4, 5, and 6). This was followed by four test trials of the novel behaviours trained to the Pair 1 stimuli in Study 1a (i.e., two trials with the Z1 stimulus and two with the V1 stimulus accompanied by the request, “Can you show me how this one goes?”).

Stage 4.2: Testing for generalisation of the novel behaviour to the untrained stimuli. This stage, as with all subsequent test stages, was conducted by Experimenter 2 with the one-way screen in place. One of the three test pairs was placed on the table in front of the child in a pre-specified random order. Experimenter 2 ensured the participant was attending, and, whilst pointing to the target stimuli, asked, "Look at this; can you show me how it goes?"

Experimenter 2 waited for the participant to respond, and when he or she did so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 48 test trials, each stimulus was targeted eight times, four times on the left and four times on the right. As described in Study 1a, trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4) appeared twice in each block; also, the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond within four seconds the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions.

Mastery criterion on Generalisation Test 1: This was as described in Study 1a.

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

This was identical to that of Phase 6 of Study 1a.

RESULTS

The three participants completed all phases of the Study. There was no training or test with the familiar objects as with Study 1a.

Phase 1: Common Listener Training with Arbitrary Objects

The results for Phase 1 through Phase 5 are represented in Figure 4.7. The data presented for Phase 1 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 1.1: Common listener training with arbitrary objects: Initial pairs. Participant CG required three blocks of training on the Initial Pair 4, and two blocks of training for both the Initial Pair 5 and Initial Pair 6 stimuli. Participants SO required two blocks of training trials for each stimulus pair (i.e., iZ4/iV4, iZ5/iV5, and iZ6/iV6). Participant PW required four blocks of training for the Initial Pair 4 stimuli, and six blocks of training for both the Initial Pair 5 and Initial Pair 6 stimuli.

Stage 1.2: Common listener training: Mixed pairs. Participant CG required two blocks of training for the Pair 4 stimuli, and three blocks for both Pairs 5 and Pair 6. Participant SO required only two blocks to attain criterion performance for each stimulus pair (i.e., Z4/V4, Z5/V5, and Z6/V6). Participant PW attained criterion performance in four blocks for Pair 4 and three blocks for both Pair 5 and Pair 6.

Stage 1.3: Reduction to zero reinforcement. The number of blocks required to achieve criterion performance (seven out of eight trials correct) under a zero reinforcement schedule is shown in Figure 4.7. All three participants maintained criterion performance under a zero reinforcement schedule and therefore none required a return to a 50 percent or 100 percent schedule during the reduction to zero reinforcement procedure (see *Study 1a: Stage 2.3* for details). After reaching criterion with each stimulus pair during Stage 1.2, all three participants maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

Figure 4.7

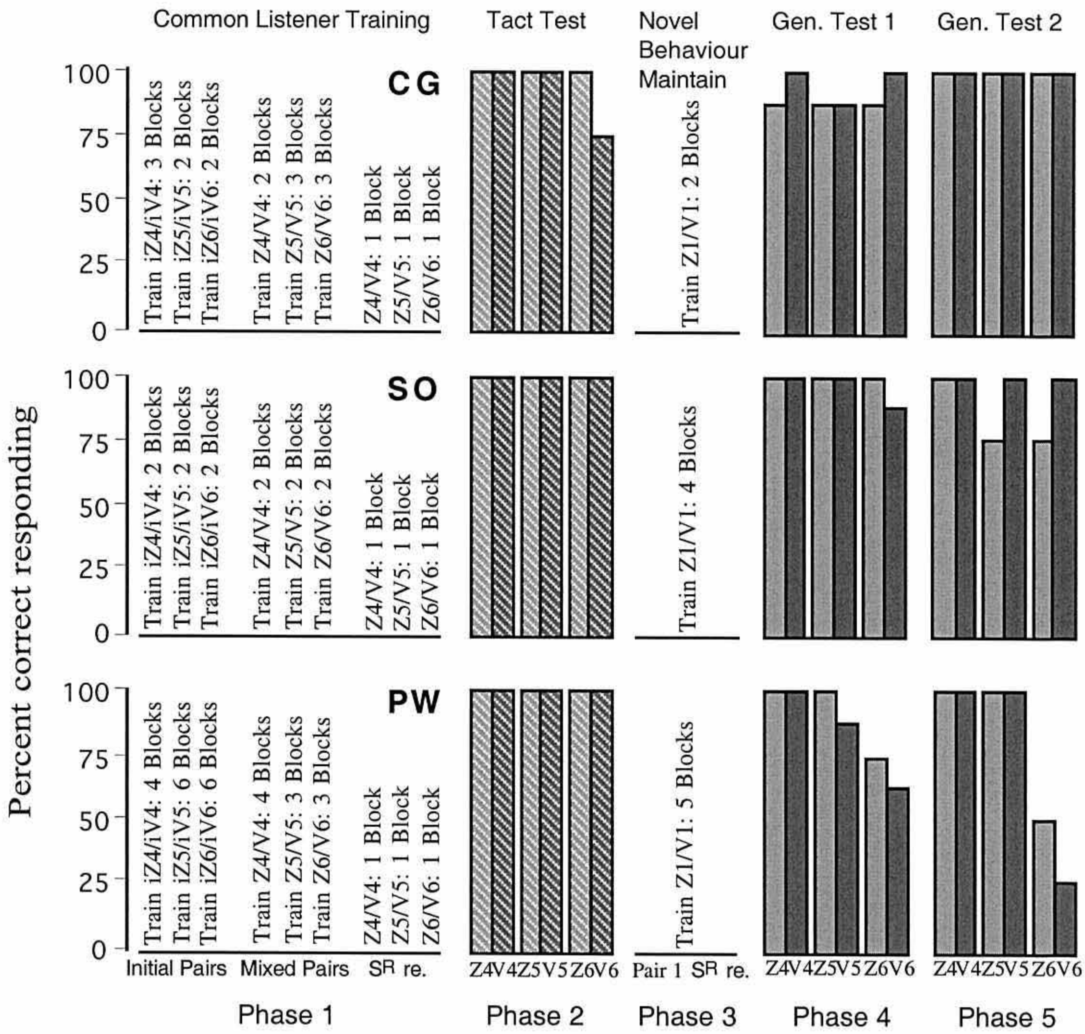


Figure 4.7. Performance of participants CG, SO, and PW on Phases 1 through 5. Phase 1: Common Listener Training, number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 2: Tact Test, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 3: Maintenance of Novel Behaviour Training, number of blocks of maintenance of learning trials conducted with Pair 1 of Experiment 1a. Phase 4: Generalisation Test 1, percentage correct responses, out of 48 trials, 8 for each stimulus. Phase 5: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus.

The mean number of blocks required for the three participants to meet the criteria for all three stages of Phase 1 was 20.7 (range 15 - 29). Participant CG required a total of 18 training blocks, SO 15 blocks, and PW a total of 29 training blocks.

Phase 2: Tact Test.

Performance on the tact test (Phase 3) of each participant is shown in Figure 4.7, which presents percent correct responses over the 24 test trials, four trials for each of the individual stimuli. Criterion for tacting was set at 75 percent, or three correct responses out of four for each stimulus, for both the zog and vek stimuli.

Apart from CG's performance on stimulus V6, on which he scored 75 % correct responses, all participants showed 100 percent correct responses across all trials of the tact test. These results indicate that all three participants also learned appropriate speaker behaviour. Thus by Horne and Lowe's (1996) definition, naming had been established.

Phase 3: Maintenance of the Novel Behaviours Training to the Pair 1 Stimuli.

Figure 4.7 shows the number of blocks of maintenance trials conducted with the Pair 1 stimuli from Study 1a during the Study 1b procedure. This comprised blocks of eight trials with the Pair 1 stimuli given the instruction, "Can you show me how this goes?" Two maintenance training blocks were conducted with Participant CG, four with SO, and five with PW.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Production of the Novel Behaviour to the Untrained Stimuli.

Figure 4.7 shows percent correct responses over the 48 test trials of Phase 4, 16 trials with each stimulus pair; thus each stimulus was targeted eight times. The criterion level for Generalisation Test 1 was set at 75 percent for each of the stimuli in a test pair.

Participant CG completed all 48 test trials in one session and scored 94 percent correct for Pairs 4 and 6, and 87.5 percent correct for Pair 5 stimuli; that is, 100 percent for the V4 and V6, and 87.5 for all other stimuli. Participant SO completed 48 test trials in one test session and scored 100 percent correct responses for Pairs 4 and 5 and 94 percent correct responses for the Pair 6 stimuli. Participant PW completed all 48 test trials in one test session and scored 100 percent correct responses for the Pair 4 stimuli, 94 percent for the Pair 5 stimuli, and 69 percent for the Pair 6 stimuli.

The results of Generalisation Test 1 show that all three participants demonstrated evidence of generalisation of the novel behaviour, although PW failed to reach criterion with the Pair 6 stimuli.

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figure 4.7 shows for each child the percent correct responses over the 24 test trials in Phase 6, 4 trials for each of the 6 test stimuli. All three participants completed all 24 test trials in one session. Participant CG scored 100 percent correct responses for all three pairs. Participant SO scored 100 percent correct responses with Pair 4, and 87.5 percent correct responses with Pairs 5 and 6; that is, 100 percent for the Z4, V4, V5, and V6 stimuli, and 75 percent for the Z5 and Z6 stimuli. Participant PW scored 100 percent correct responses with Pairs 4 and 5, and 37.5 percent correct responses with Pair 6. All three participants thus demonstrated generalisation of the comprehension of the novel behaviour, although PW again failed to do so with the Pair 6 stimuli.

Spontaneous verbal behaviour

All participants' verbalisations made during common listener training (Phase 2) are indicated in Table 4.5, including the verbal prompt that preceded the vocalisation and the stimuli present at the moment the verbalisation was made.

From the evidence of his verbalisations, CG had named at least some of the stimuli; this was confirmed by his tact test results. He did not make any verbalisations during the test sessions. Notably, CG emitted considerably less verbalisations during Study 1b than he did during Study 1a.

Participant PW made one idiosyncratic verbalisation, calling one of the stimuli "T-shirt" and one "a triangle"(see Figure 4.5). She did not make any verbalisations during the test sessions.

Participant SO made no verbalisations during the procedure.

Table 4.5: Children's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during Common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
CG	iZ4/iV4	Can you give me the zog?	That's the zog (pointing to the stimulus)
	Z5/V5	Can you give me the zog?	zog; That's the zog and that's the vek (pointing to the stimuli); That's not the vek (pointing to the stimulus)
	Z6/V6	Can you give me the zog?	That's the zog; zog-vek x 5 (pointing to the stimuli)
PW	iZ5/iV5	Can you give me the zog?	T-shirt x 2 (pointing to the zog
		Can you give me the vek?	vek; bek; triangle (pointing to the vek stimulus - )

DISCUSSION

The aim of Study 1b was to determine whether the two three-member arbitrary classes formed in Study 1a would extend to two six-member classes following common listener training with a further set of arbitrary objects. Data from the tact test showed that, after learning a common listener behaviour to a new set of arbitrary stimuli, all three participants showed appropriate speaker behaviour. All three went on to show clear generalisation of the novel behaviour in Generalisation Test 1. Thus all three children showed that, given common listener training with additional arbitrary stimuli, these stimuli would enter into, and extend, the existing class established in Study 1a.

Participant CG showed some evidence of spontaneous naming of the experimental stimuli during the common listener training during Study 1b. However, this was far less evident than in Study 1a. This is interesting in that it points to the possible occurrence of covert naming during the training. Covert naming may be inferred because of CG's 100 percent correct responses on the tact test. One can assume that, because the contingencies present in the research did not specify (i.e., reinforce) overt naming, the participant's naming became or remained covert. This has implications for the naming account because, at a functional level, Horne and Lowe (1996) specify that naming can be overt or covert. It also serves to highlight the issue of covert naming in general. This is because covert naming can be undetectable during learning trials; thus it is often ignored in a functional analysis of behaviour (this has been especially the case in research that investigates emergent or symbolic learning). This is surprising given the obvious involvement of verbal behaviour at some level in such learning (Pilgrim, Jackson, & Galazio, 2000; Randell & Remington, 1999).

Participant SO showed perfect performance on all tact test trials of Phase 2, and thus had shown naming of all the experimental stimuli prior to the categorisation tests. However, she did not show any overt naming of the experimental stimuli during common listener training; thus, as with participant CG, covert naming during the training stages can only be inferred from her performance on the tact test.

On Generalisation Test 1, PW scored above criterion performance on both Pair 4 and Pair 5. However, for the Pair 6 stimuli she made 5 errors out of 16 (see Figure 4.7). On Generalisation Test 2, a similar result occurred: on the Pair 4 and Pair 5 stimuli she achieved 100 percent correct responses, but she failed to achieve such high results with the Pair 6 stimuli, scoring only 50 percent correct responses for the Z6 stimulus, and 25 percent correct for the V6.

It is likely that confounding variables interfered with generalisation responding with this stimulus pair. This because the failure to respond correctly occurred with the same stimuli over 2 distinct tests and over 24 test trials in total. With hindsight, it would have been interesting to incorporate an additional tact test following these results in order to ascertain whether the naming of these particular stimuli had broken down; because this was not conducted, it is not clear which factors were responsible for the failure with the Pair 2 stimuli.

All three children showed evidence of the extension of existing three-member classes to six-member classes given common listener training. A conclusion that might follow from this is that the participants had formed a common name relation, "zog" and "vek", that included the stimuli trained in Study 1a; notably, when the new stimuli were trained in Study 1b to the same listener stimulus, they too entered into the existing name relation and therefore into the same common class. Thus any behaviours or functions that were directly trained to any of the individual objects within that class also entered into the name relation of that class.

The implication of the above is that any subsequent objects that are named come to share all of the behaviours encompassed within that name relation; this is true even when they are not directly trained with those behaviours. This is one demonstration of "verbal generativity" discussed in Horne and Lowe (1997). However, it is also possible that common listener relations alone (in the absence of appropriate speaker relations, and hence naming) may also account for these findings. Unfortunately because all participants named the stimuli, the conditions were not present to test this.

* * *

As noted, naming is the fusion of basic listener and speaker relations. All the studies reported in this thesis have been designed around this definition; that is, all studies that used a common listener training procedure were mirrored, and as a far as possible matched, with an study using a common speaker training procedure. Studies 1a and 1b investigated categorisation by generalisation following common listener training. Thus, in Study 2, categorisation by generalisation was investigated following common speaker training.

Study 2: Categorisation Following Common Speaker Training in 2.5 to 4 Year Olds.

According to Horne and Lowe (1996), categorisation of formally unrelated objects occurs only when the child is behaving as both listener and speaker. Study 1a and 1b investigated categorisation after training only a common listener relation to three arbitrary objects. During Study 1a and 1b, all children showed evidence of appropriate speaker behaviour, and, subsequently, categorisation.

The naming account specifies that if the child is behaving only as a speaker, and not a listener, categorisation of formally unrelated objects should not occur. This was the focus of investigation in Study 2. Study 2 was similar to Study 1a except for the fact that the children underwent *common speaker training* with pairs of shapes. As in Study 1a, six differently shaped wooden blocks were used as stimuli, three of which were randomly designated into three pairs of zogs and veks. During common speaker training, the child was trained to say "zog" when presented with the zog stimulus, and "vek" when presented with the vek stimulus.

After criterion had been reached on common speaker training, unreinforced listener behaviour test trials were introduced in order to test for the emergence of untrained listener relations. The children were then trained, in an identical manner to that described in Study 1a, to emit a new behaviour (e.g., clapping) when presented with one of the zogs, and to emit another new behaviour (e.g., waving) when presented with one of the veks.

Following this training, as with Study 1a, Generalisation Test 1, was conducted. In this test the remaining shapes were presented to determine whether presentation of the untrained zogs stimuli would evoke clapping and the untrained veks waving. A further categorisation test, Generalisation Test 2, tested whether production of the behaviours (i.e., either clapping or waving) demonstrated by the experimenter would also evoke selection (i.e., a listener behaviour) of the objects. In other words, would seeing the experimenter clapping evoke selection of the zog stimuli, and seeing the experimenter waving evoke selection of the vek stimuli?

GENERAL METHOD

As noted in Study 1a, there were two general procedures employed in all of the studies described in this thesis: common listener training and common speaker training. The common speaker training procedure is described in detail below. In all subsequent studies incorporating the common speaker training procedure, deviations from the general procedure are described where appropriate.

Participants

Four participants took part in Study 2. Their ages ranged from 32 to 46 months at the start of the procedure (see Table 4.6).

Table 4.6. Participants sex, age at start of procedure, age at first test and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days	Griffiths GQ score
TO	M	46; 26	51; 16	109
CH	F	42; 26	44; 07	121
BH	F	36; 18	43; 17	132
JA	M	32; 15	39; 17	103

F = Female; M = Male

Apparatus and Setting

These were identical to those of Study 1a.

Stimuli

These were identical to those of Study 1a.

Procedure

Study 2: Common Speaker Training was similar to that of Study 1a: Common Listener Training in terms of general experimental design and format. The differences between the two procedures are noted below for each separate stage (see Figure 4.8).

Phase 1: Common Speaker Training, "In-repertoire" Behaviour Training and Testing with Familiar Objects

Stage 1.1: Common speaker training with familiar objects. The stimuli, block format, trial type, and, criterion level were identical to that of Stage 1.1 of Study 1a: Common Listener Training.

The experimenter ensured that the child was attending, placed the first pair of hats and cups (H1-C1) on the table and said, "Look at this, it is a hat/cup, can you tell me what it is?"

The experimenter responded with social praise (e.g., "Clever girl/boy") if the child responded correctly. If the participant failed to respond with the correct verbal response, the experimenter provided corrective feedback saying, "It's a hat/cup, can you say hat/cup?" The stimuli were then removed from the table and repositioned in their pre-specified position for the following trial.

Criterion was reached when the participant responded correctly on seven out of the eight trials within a block over two consecutive blocks. Training then proceeded in the same manner as described above, first, to Pair 2 until criterion had been reached, and then to Pair 3.

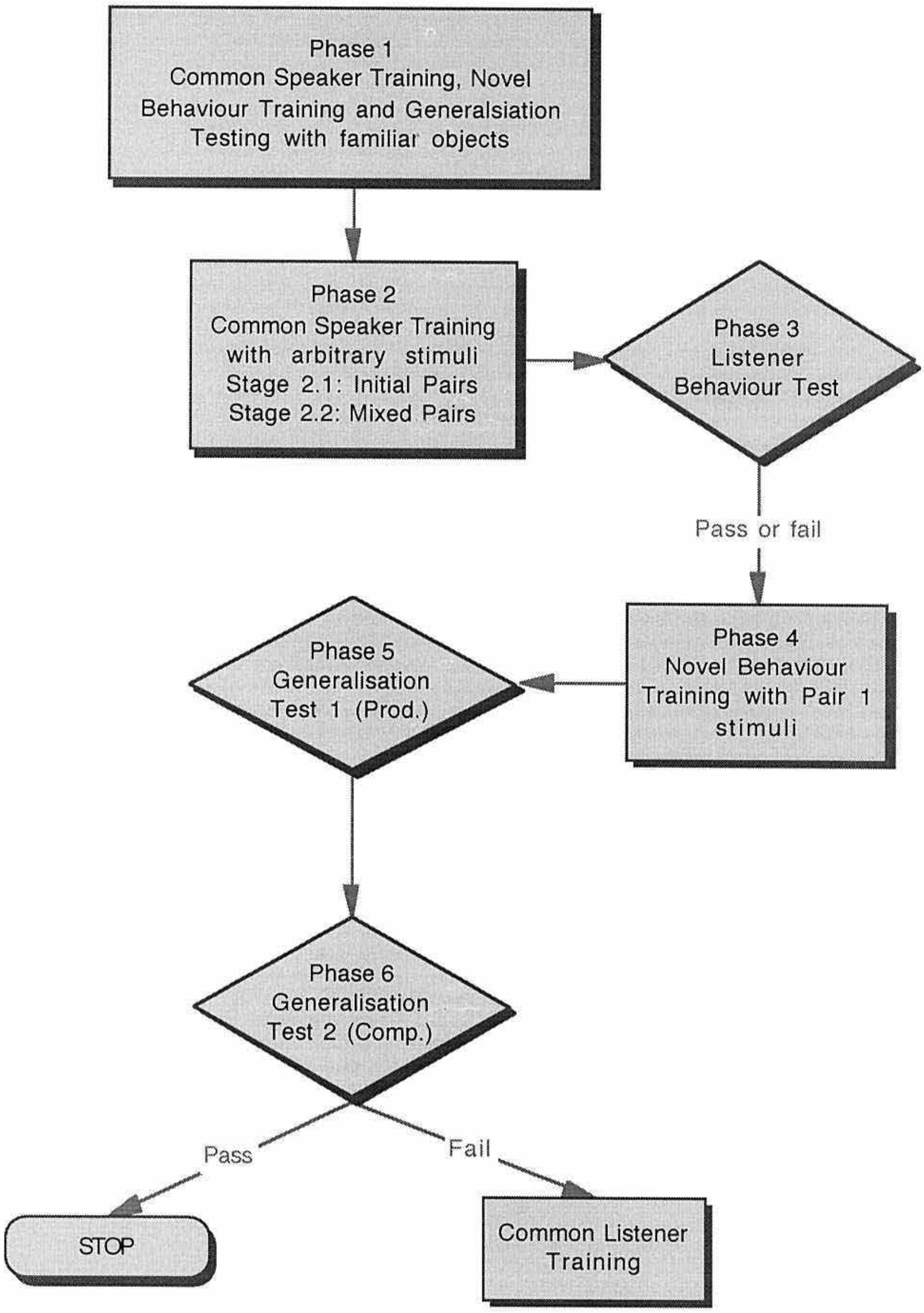


Figure 4.8: Flowchart representation of the procedure of Experiment 2

Stage 1.2: Training the "in-repertoire" behaviour to a subset of the stimuli. Stage 1.2 was identical to Stage 1.2 of Study 1a.

Stage 1.3: Testing for the occurrence of the trained behaviour to the untrained stimulus pairs. Stage 1.3 was identical to Stage 1.3 of Study 1a.

Phase 2: Common Speaker Training with Arbitrary Objects

Stage 2.1: Common speaker training with arbitrary objects: Initial pairs. The Stage 2.1 procedure was similar to Stage 2.1 of Study 1a. When the stimuli had been placed in their pre-specified random position in front of the child, the Experimenter pointed to the target stimulus and said, "Look at this, it's a zog/vek, can you say zog/vek?"

The experimenter responded with social praise if the child was correct, or if incorrect, provided corrective feedback by saying, "It's a zog/vek, can you say zog/vek?" If the child still did not respond correctly then these corrective feedback trials were continued until he or she produced a reliable approximation of both the "zog" and "vek" verbal utterance. Criterion was reached when the participant responded correctly on seven out of the eight trials within a block over two consecutive blocks. After criterion had been reached with the Initial Pair 1 stimuli (i.e., iZ1/iV1), the training procedure was repeated, first, with the Initial Pair 2 stimuli, and then with the Initial Pair 3 stimuli before progressing to the next training stage.

Stage 2.2: Common speaker training: Mixed pairs. As with Study 1a, the initial pairs stimuli were randomly mixed in Stage 2.2. In all other respects the training and learning criterion for each pair was identical to that of Stage 2.2 described above. The stimulus pairs remained in the new arrangement (i.e., mixed pairs) for the remainder of the procedure; after here they are denoted by Pair 1, 2, or 3, or individually as Z1/V1, Z2/V2, or Z3/V3.

Stage 2.3: Reduction to zero reinforcement. This stage was identical to that of Stage 2.2 above, except that the reinforcement was reduced to zero (see Study 1a: Stage 2.3 for details).

Phase 3: Listener Behaviour Test

After reaching criterion without reinforcement, the child was tested in order to determine whether he or she responded appropriately as a listener (i.e., select the stimuli on hearing the listener stimulus */zog/* or */vek/*) after being trained to emit the only vocal responses "zog" or "vek". Each pair was placed on the table separately and the experimenter said, "Can you give me the zog/vek?" The child was given approximately four seconds to respond, and, if he or she did not select one of the stimuli, the question was repeated and a further four seconds were given for him or her to respond.

Pair 1 stimuli were presented for four trials, each stimulus being targeted twice, once on the right and once on the left in a pre-specified random order. This was followed by four trials with Pair 2 and four trials with Pair 3. This procedure was repeated in order that each stimulus had been targeted four times in all. No reinforcement was given during this stage.

Phase 4: Training a Novel Behaviour to a Subset of the Stimuli

Stage 4.1: Novel behaviour training. Stage 4.1 was identical to that of Stage 4.1 of Study 1a.

Stage 4.2: Reduction to zero reinforcement. Trials continued as described in Stage 4.1 above, but reinforcement was reduced to zero (see Stage 2.3 of Study 1a).

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

To minimise the possibility of experimental cueing, a second experimenter (Experimenter 2) was introduced for all test sessions. Experimenter 2 was familiar with the participant and with the general experimental procedure but was not aware of either the assigned labels given to the experimental stimuli, or the novel behaviours assigned to the Pair 1 stimuli. Prior to each test session, Experimenter 2 was given a sheet of paper on which all the trials were listed; because of this she knew exactly which stimulus pair to use for each test trial, and which of the two stimuli to point to before instructing the child. Experimenter 1 sat behind the participant while Experimenter 2 conducted the test trials.

Stage 5.1: Maintenance of training. Prior to each of the test sessions, and to ensure all of the trained relations were intact, unreinforced speaker behaviour test trials (i.e., the experimenter asking, "What's this") were conducted with each of the three pairs of stimuli. This was followed by four test trials of the novel behaviour trained to Pair 1 (i.e., two trials with the Z1 stimulus and two with the V1 stimulus given the instruction, "Can you show me how this one goes?").

Stage 5.2: Testing for generalisation of the novel behaviour to the untrained stimuli. This stage, as with all subsequent test stages, was conducted by Experimenter 2 with the one-way screen in place. One of the two test pairs was placed on the table in front of the child in a pre-specified random order. Experimenter 2 ensured the participant was attending, and whilst pointing to the target stimuli said, "Look at this; can you show me how it goes?"

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 32 test trials, each stimulus was targeted eight times, four times on the left and four times on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4; see Stage 1.1 of Study 1a) appeared twice in each block and that the same trial type did not appear twice in succession. If the participant did not respond to the request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions. In each of the test sessions, the Phase 5 procedure was repeated in full; that is, both Stage 5.1 and Stage 5.2

For CH, Generalisation Test 2 was repeated. This was because, on her first exposure to Test 1, she responded by giving the functions for the stimuli used in the pre-training phases (i.e., when a zog stimulus was a target she put the stimulus on her head and when a vek stimulus was the target she placed the stimulus to her mouth). After this pattern of responding, she was exposed to an additional training block for the novel behaviour to the Pair 1 stimuli (as described in Phase 4). She was then given Generalisation Test 1 again and on the second exposure she responded with the two behaviours trained in Phase 4 to a subset of the stimuli.

Mastery criterion on Generalisation Test 1: This was as described in Study 1a.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

The procedure in this stage was similar to that of Phase 5 except that all three of the pairs were used to test for the emergence of listener behaviour (i.e., comprehension of the novel behaviour). Pair 1 was included in Phase 6 because only the production (i.e., a speaker behaviour) of the novel behaviour had been trained directly to the Pair 1 stimuli during Phase 4. As with Phase 5: Generalisation Test 1, prior to each of the test sessions, unreinforced speaker behaviour test trials were conducted; these were followed by four test trials of the novel behaviours trained to Pair 1 (see Stages 5.1 for detail).

One of the three pairs was placed on the table in front of the participant in a pre-specified random order. Experimenter 2 ensured the participant was attending and asked, "Can you give me the one that goes like this?" Experimenter 2 then modelled one of the behaviours (i.e., either clapping or waving).

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 24 test trials, each stimulus was a target 4 times, twice on the left and twice on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4; see Stage 1.1) appeared twice in each block and that the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond after four seconds, the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions. Participants were deemed to have passed the Generalisation Test 2 if they scored three out of four correct responses for each stimulus.

RESULTS

All four participants completed all phases of the study.

Phase 1: Common Speaker Training, "In-repertoire" Behaviour Training and Testing with Familiar Objects

Table 4.7 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common speaker training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 4.7 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

During Stage 1.1, TO, CH, and JA reached criterion performance in one block of training trials for each of the three stimulus pairs. Participant BH reached criterion in 2 blocks for the Pair 1 stimuli, 10 for the Pair 2 stimuli, and 1 block for the Pair 3 stimuli. All four participants learned the "in-repertoire" behaviour to criterion performance within one block, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 4.7

Results of Phase 1: Common Speaker Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, and H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common Speaker training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
TO	1	1	1	1	1	1
CH	1	1	1	1	1	1
BH	2	10	1	1	1	1
JA	1	1	1	1	1	1

Phase 2: Common Speaker Training with Arbitrary Objects

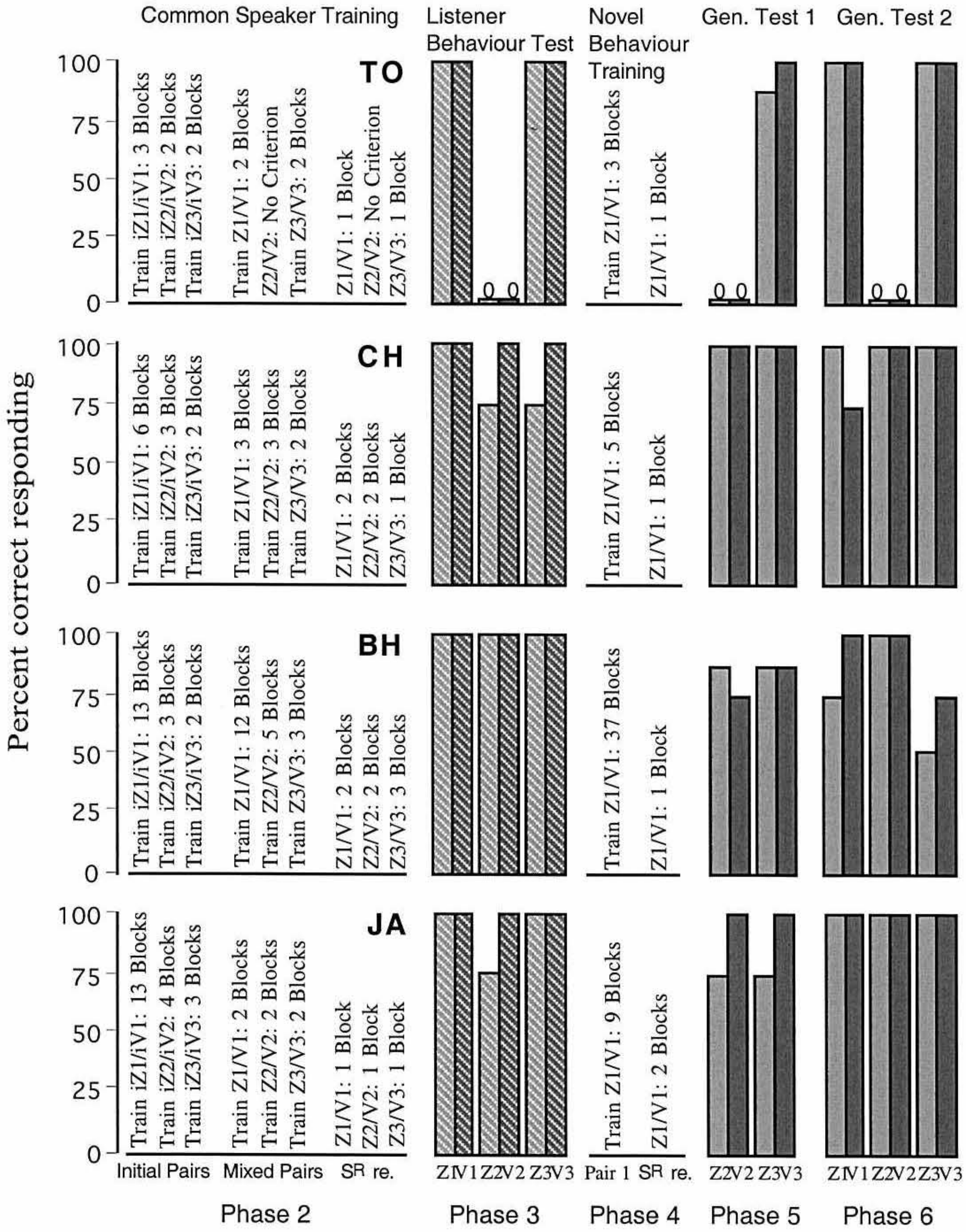
The results for Phase 2 through Phase 6 are represented in Figure 4.9. The data presented for Phase 2 are the number of blocks of training trials required to achieve criterion performance for the three stimulus pairs in each of the three stages.

Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Figure 4.9

Figure 4.9. Performance of participants TO, CH, BH, and JA on Phases 2 through 6. Phase 2: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Listener Behaviour Test, the percent correct responses, out of 24 trials, 4 trials for each stimulus. Phase 4: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 5: Generalisation Test 1, percent correct responses, out of 32 trials, 8 trials for each stimulus. Phase 6: Generalisation Test 2, percent correct responses, out of 24 trials, 4 trials for each stimulus.

Figure 4.9



Common Speaker Training
Listener Behaviour Test
Novel Behaviour Training
Gen. Test 1
Gen. Test 2
Percent correct responding
100
75
50
25
0
TO
Train iZ1/iV1: 3 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Z2/V2: No Criterion
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: No Criterion
Z3/V3: 1 Block
Train Z1/V1: 3 Blocks
Z1/V1: 1 Block
0 0
CH
Train iZ1/iV1: 6 Blocks
Train iZ2/iV2: 3 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 3 Blocks
Train Z2/V2: 3 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 2 Blocks
Z2/V2: 2 Blocks
Z3/V3: 1 Block
Train Z1/V1: 5 Blocks
Z1/V1: 1 Block
BH
Train iZ1/iV1: 13 Blocks
Train iZ2/iV2: 3 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 12 Blocks
Train Z2/V2: 5 Blocks
Train Z3/V3: 3 Blocks
Z1/V1: 2 Blocks
Z2/V2: 2 Blocks
Z3/V3: 3 Blocks
Train Z1/V1: 37 Blocks
Z1/V1: 1 Block
JA
Train iZ1/iV1: 13 Blocks
Train iZ2/iV2: 4 Blocks
Train iZ3/iV3: 3 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
Train Z1/V1: 9 Blocks
Z1/V1: 2 Blocks
Initial Pairs
Mixed Pairs
SR re.
Z1V1 Z2V2 Z3V3
Pair 1
SR re.
Z2V2 Z3V3
Z1V1 Z2V2 Z3V3
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. Participant TO required three blocks of training for the Initial Pairs 1, and two for both the Initial Pair 2 and the Initial Pair 3 stimuli. CH required six blocks of training for the Initial Pair 1 stimuli, three for the Initial Pair 2 stimuli, and two for the Initial Pair 3 stimuli. Participant BH required 13 blocks of training for Initial Pair 1, 3 for Initial Pair 2, and 2 for the Initial Pair 3. JA required 13 blocks for Initial Pair 1, 4 for Initial Pair 2, and 3 for Initial Pair 3.

Stage 2.2: Common speaker training: Mixed pairs. Participant CH required three blocks of training for both Pair 1 and Pair 2 and two blocks for Pair 3. BH required 12 blocks for Pair 1, 5 for Pair 2, and 3 for Pair 3. Participant JA required two blocks of training to reach criterion on all three pairs. Participant TO required two blocks of training for the Mixed Pairs 1 and the Mixed Pair 3 stimuli; he did not reach criterion performance on the Mixed Pairs 2 stimuli.

Stage 2.3: Reduction to zero reinforcement. The number of blocks required to achieve criterion performance (seven out of eight trials correct) under a zero reinforcement schedule is also shown in Figure 4.9. All the children maintained criterion performance under a zero reinforcement schedule and therefore none required a return to a 50 percent or 100 percent schedule during the reduction to zero reinforcement procedure (see Stage 2.3).

After reaching criterion for each stimulus pair during Stage 2.2, JA maintained criterion performance without reinforcement across one block of trials for each stimulus pair. Participant TO reached criterion for the Pair 1 and Pair 3 stimuli, but not for the Pair 2 stimuli. Participant CH required two blocks for the

Pair 1 and 2 stimuli, and one block for Pair 3. Participant BH required two blocks of trials without reinforcement to maintain criterion reinforcement for Pair 1 and Pair 2, and three blocks for Pair 3.

The mean number of blocks required for the five participants to meet the criteria for all three stages of Phase 2 was 34.5 (range 18 - 45). Participant CH required a total of 24 training blocks, BH 45 blocks, and JA 29 blocks. Participant TO required 18 training trials in all but did not reach criterion on the Pair 2 stimuli.

Phase 3: Listener Behaviour Test.

Performance on the Listener Behaviour Test (Phase 3) of each participant is shown in Figure 4.9 which presents percent correct responses over the 24 test trials, 4 trials for each of the individual stimuli. Criterion performance for listener responding was set at 75 percent, or three correct responses out of four for each stimulus, for both the zog and for the vek stimuli.

Participant BH made no errors on any of the 24 test trials. Participant CH scored 100 percent correct responding for all three vek stimuli and the Z1 stimulus, and 75 percent correct for both the Z2 and Z3 stimuli. Participant JA scored 100 percent correct responses for all stimuli except Z2, for which he scored 75 percent correct responses. These results show that, in the course of learning speaker behaviour, CH, BH, and JA also learned appropriately listener behaviour. All three participants could select the stimuli; thus by Horne and Lowe's (1996) definition, naming had been established.

Participant TO scored 100 percent correct with both Pair 1 and Pair 3 stimuli, but zero percent correct responding when the Pair 2 stimuli were targets.

Participant TO thus showed that he had also learned appropriate listener responding to the Pair 1 and Pair 3 stimuli, but not to the Pair 2 stimuli.

Phase 4: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figure 4.9 shows the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 4.1: Novel behaviour training. Participant TO reached criterion on the novel behaviour training in three blocks of eight trials, CH in five blocks, BH in 37, and JA in seven.

Stage 4.2: Reduction to zero reinforcement. Participants TO, CH, and BH each achieved criterion responding in the absence of reinforcement for the novel behaviour training in one block of trials, JA required two.

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figure 4.9 shows the percentage of correct responses over the 32 test trials of Phase 5, 8 trials with each stimulus. The criterion level for Generalisation Test 1 was set at 75 percent for each of the stimuli in a test pair.

Participant TO completed all 32 test trials in one session, and scored zero percent correct with the Pair 2 stimuli and 94 percent correct with the Pair 3 stimuli.

Participant CH made no errors throughout the Generalisation Test 1 (this was CH's second exposure to the Test 1). Participant BH completed all 32 test trials over two sessions, and scored 81 percent correct responses with the Pair 2 stimuli, and 87.5 percent correct responses with the Pair 3 stimuli; that is, 87.5 percent for the Z2, Z3, and V3 stimuli and 75 percent for the V2 stimulus. Participant JA scored 87.5 percent correct with both Pair 2 and Pair 3; that is, 100 percent for the vek stimuli and 75 for the zog stimuli. These results indicate that CH, BH, and JA showed evidence of generalisation of the novel behaviour. Participant TO showed generalisation only to the Pair 3 stimuli.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figure 4.9 shows for each child the percent of correct responses over the 24 test trials in Phase 6, 4 trials for each of the 6 test stimuli.

All 4 participants completed all 24 test trials in one session. Participant TO scored 100 percent correct responses to Pairs 1 and 3, and zero percent correct responses to Pair 2. Participant CH scored 100 percent to Pairs 2 and 3 and 87.5 percent correct to Pair 1. Participant BH scored 100 percent correct to Pair 2, 87.5 percent to Pair 1 and 62.5 percent to Pair 3. Participant JA made no errors on the Generalisation Test 2. The results for the test show again that CH, BH, and JA showed evidence of the generalisation of the comprehension, although BH failed to reach criterion on the Pair 3 stimuli and To failed to do so on the Pair 2 stimuli. Participant TO showed such generalisation only to the Pair 1 and Pair 3 stimuli.

Spontaneous verbal behaviour

Participants CH, TO, and JA did not make any idiosyncratic verbalisations during the procedure other than the experimentally defined verbalisations (i.e., "zog" and "vek").

Participant BH said, "circle", and "Look, it's a ring" () and "It's a headband" (). During the training of the novel behaviour, BH said, "Is it going to wave?", "It's wave, yes?", "Is it going to clap?", and "It's not a waves, no?" During the Generalisation Test 1, she said, "It's not going clap, no?" five times when the Z2 stimulus was a target.

DISCUSSION

The aim of Study 2 was to show categorisation by generalisation after training common speaker training alone (i.e., in the absence of appropriate listener relations, and therefore naming). After learning a common speaker relation, three of the participants CH, BH, and JA, showed appropriate untrained listener relations with respect to the experimental stimuli; thus all three showed evidence of naming. Subsequently, all three participants showed clear evidence of generalisation of the novel behaviour to untrained stimuli during both tests of generalisation; and, as predicted by the naming account (Horne and Lowe, 1996), showed they had formed two classes with the arbitrary stimuli. Participant TO's performance on the tests is discussed below.

During the training in Stage 2.2, TO reversed the experimental allocations of the Pair 2 stimuli; he consistently responded to the Z2 stimulus with the tact "vek", and to the V2 stimulus with the tact "zog". In response to this, the experimenter initially attempted to revert TO's responding to the original experimentally defined classes. However, despite 12 blocks of trials he continued to respond with his reversed tacting; thus his reversal of the tact responses remained resistant to the contingencies of reinforcement. This extended training with Pair 2 caused concern; it was therefore decided that the procedure proceed to Pair 3 training. One of the reasons for this was that extensive re-training of the Pair 2 stimuli may have endangered TO's participation in the study; TO found it difficult to concentrate and was showing signs of boredom at this stage in the training. There was also the question of which would prove to exert the stronger control during test trials: control exerted by his naming behaviour (i.e., verbally controlled behaviour), or control exerted by the contingencies supplied by the directly training history with those stimuli (i.e., contingency shaped behaviour).

The problems that Pair 2 caused TO are worth investigation. The other pairs were learned quickly and easily, yet training for Pair 2 was laborious. The fact that he made a reversal offers an explanation of why the training for Pair 2 took as long as it did: his responding was in direct conflict with the experimentally defined contingencies, and therefore he was being marked as "incorrect" (and not being reinforced) when in fact he was responding consistently to each of the Pair 2 stimuli. This is interesting in that it relates to the issue of the insensitivity of verbally controlled behaviour to the scheduled contingencies (Catania, 1998; Lowe, 1980; Matthews, Shimoff, Catania, & Sagvolden, 1977).

One may also speculate why TO reversed the names of the Pair 2 stimuli. As discussed in Chapter 2, there is a body of psycholinguistic research that points to the salience of object shape in the naming of novel objects (e.g., Gathercole & Min, 1997). This is commonly known as the shape bias. Table 4.8 shows the stimulus allocations for TO in the Stage 2.2 of training.

Table 4.8. Participant TO's stimulus allocations for Stage 2.2.

	Pair One		Pair Two		Pair Three	
Participant	Zog 1	Vek 1	Zog 2	Vek 2	Zog 3	Vek 3
Mixed pairs						

The stimuli that TO called a "zog" (Z1, V2, & Z3) were "solid", that is, they had no obvious appendages. Conversely, all the stimuli he called "vek" (V1, Z2, & V3) were "open" and had obvious appendages. The "arms" of the V1 and Z2 stimuli are very similar; this may have caused the reversal of the Pair 2 stimuli in line with a shape bias. Although this is speculative, it is backed by a consistent literature, one that highlights the salience of the shape over other cues in naming contexts (Gathercole et al., 1999; Markman, 1992). The rationale for using arbitrary stimuli in this kind of research was to prevent this type of stimulus associations from forming. However, what is apparent is the difficulty of preventing participants' existing training histories, particularly their verbal histories, from entering into the experimental context.

To summarise TO's test performance: On the categorisation tests, TO clapped to any object that he called a "vek" and waved to any object he called a "zog". Thus his responses on the generalisation tests directly correlated with his verbal responses. Strictly speaking, TO did not show the appropriate generalisation for Pair 2; this is because he clapped and waved to the wrong stimuli as defined by the original experimental allocations. Nonetheless, he consistently responded correctly with respect to his own names for those objects. It appears that, at least in this case, verbal control was more robust than control exerted by the scheduled contingencies of reinforcement. Similar findings regarding the insensitivity of verbal behaviour are well documented in the literature (see e.g., Catania, 1998;

Dickens, Bentall & Smith, 1993; Lowe, 1980; Matthews et al., 1977; Randell & Remington, 1999).

During Generalisation Test 1, CH showed an interesting pattern of responding. When the second experimenter placed the two arbitrary objects in front of her and said, "Can you show me how this goes?", CH placed the stimulus on her head if the target stimulus was a zog, and placed it to her mouth if it was a vek. That is, she responded with the in-repertoire behaviours and not the novel behaviours. She subsequently responded consistently in this way to all the test trials; all zogs took on the "hat function" and all veks took on the "cup function".

After this first test session, the novel behaviour training (Phase 4) was resumed for one block of trials and Generalisation Test 1 was repeated. On the second exposure to Generalisation Test 1, CH showed 100 percent correct responses to all of the four experimental stimuli; that is, she responded by clapping and waving to the appropriate stimuli. Her second exposure to the Test 1 is reported in Figure 4.9.

As mentioned in Chapter 2, Harris et al. (2000), taught common speaker behaviour and then tested for categorisation. However, there was never a direct test of listener behaviour in the Harris et al. procedure. Listener behaviour was inferred because the categorisation test was a selection based test (and therefore, an indirect test of listener responding). In the present research, all four children showed appropriate listener behaviour when tested. Although this is not conclusive evidence, due to the small number of participants, this lends support to the claim that, in many cases, listener responding may be trained indirectly as a result of speaker training. Horne and Lowe (1996) maintain that once a child has been taught to make a verbal response to a particular object (i.e., a tact), they invariably show appropriate listener behaviour to that object (and see Huttenlocher & Smiley, 1987).

* * *

In the present studies, just as there was a distinction made between the listener behaviour and speaker behaviour during the basic discrimination training, there was a distinction made between comprehension and production of discrimination training of the novel behaviour during Phase 4. During Studies 1a, 1b, and 2, the Phase 4 training of the novel behaviour involved training the child to produce the behaviour; that is, to respond as a speaker. Therefore, regarding the Horne and Lowe (1996) account, two questions remained. First, would categorisation still occur if the child was taught only to respond as a listener to the novel behaviour? Second, given this comprehension training, would the child go on to show appropriate production of the novel behaviour to the untrained stimuli?

These were the questions that Study 3 addressed.

Study 3: How Does Training Comprehension of the Novel Behaviour Affect Generalisation?

Study 3 was an exploratory study based upon Studies 1a and 2, in which importance was placed on whether (following speaker and listener training respectively) training novel behaviour via comprehension rather than, as before, via production, would give rise to generalisation of the novel behaviour. Just one child was assigned to each of the two conditions: *Condition A: common listener training*; and *Condition B: common speaker training*.

For Condition A: common listener training, Phases 1, 2, and 3 were as described in Study 1a. For, Condition B: common speaker training, Phases 1, 2, and 3 were as described in Study 2. Phases 4, 5, and 6 were identical for both conditions. Unlike Studies 1a and 2, however, during the Phase 4 novel behaviour training, the child was taught to select the correct object *upon seeing the experimenter* produce one of the two novel behaviours; that is, the participants received training in comprehension. During Phase 5 generalisation of the comprehension of the novel behaviour to the untrained stimuli was tested, and during Phase 6 generalisation of the production of the novel behaviour to the untrained stimuli was tested.

METHOD

Participants

Two participants took part in Study 3: HT in Condition A: common listener training; and JT in Condition B: common speaker training. Their ages were 32 and 42 months at the start of the procedure (see Table 4.9).

Table 4.9 Participants' sex, age at start of procedure, age at first test, and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
HT	M	32; 01	35; 04
JT	F	42; 06	43; 02

F = Female; M = Male

Apparatus and Setting

These were identical to those described in Study 1a.

Stimuli

These were identical to those described in Study 1a (see Figure 4.3).

CONDITION A: COMMON LISTENER TRAINING

Procedure

Common listener training of Study 3 was similar to that of Study 1a in terms of general experimental design and format. The differences between the two procedures are noted below for each of the separate stages (see Figure 4.10)

Phase 1, *Phase 2*, and *Phase 3* were as described in Study 1a.

Phase 4: Training a Novel Behaviour to a Subset of the Stimuli.

Stage 4.1: Novel behaviour training. As described in Study 1a, clapping and waving were selected as the novel behaviours to be trained. One of the behaviours (either clapping or waving) was randomly assigned to the zog class and one to the vek class; the novel relations were thus trained only to the Pair 1 stimuli.

The two stimuli were placed in front of the participant. The Experimenter ensured the child was attending and said, "Can you give me the one that goes like this?" The Experimenter then modelled one of the behaviours (i.e., either clapping or waving).

If the child selected the correct stimulus, the experimenter responded with social praise; if the child failed to select the correct stimulus, the experimenter provided corrective feedback. Block structure and criterion levels were as described in Study 1a.

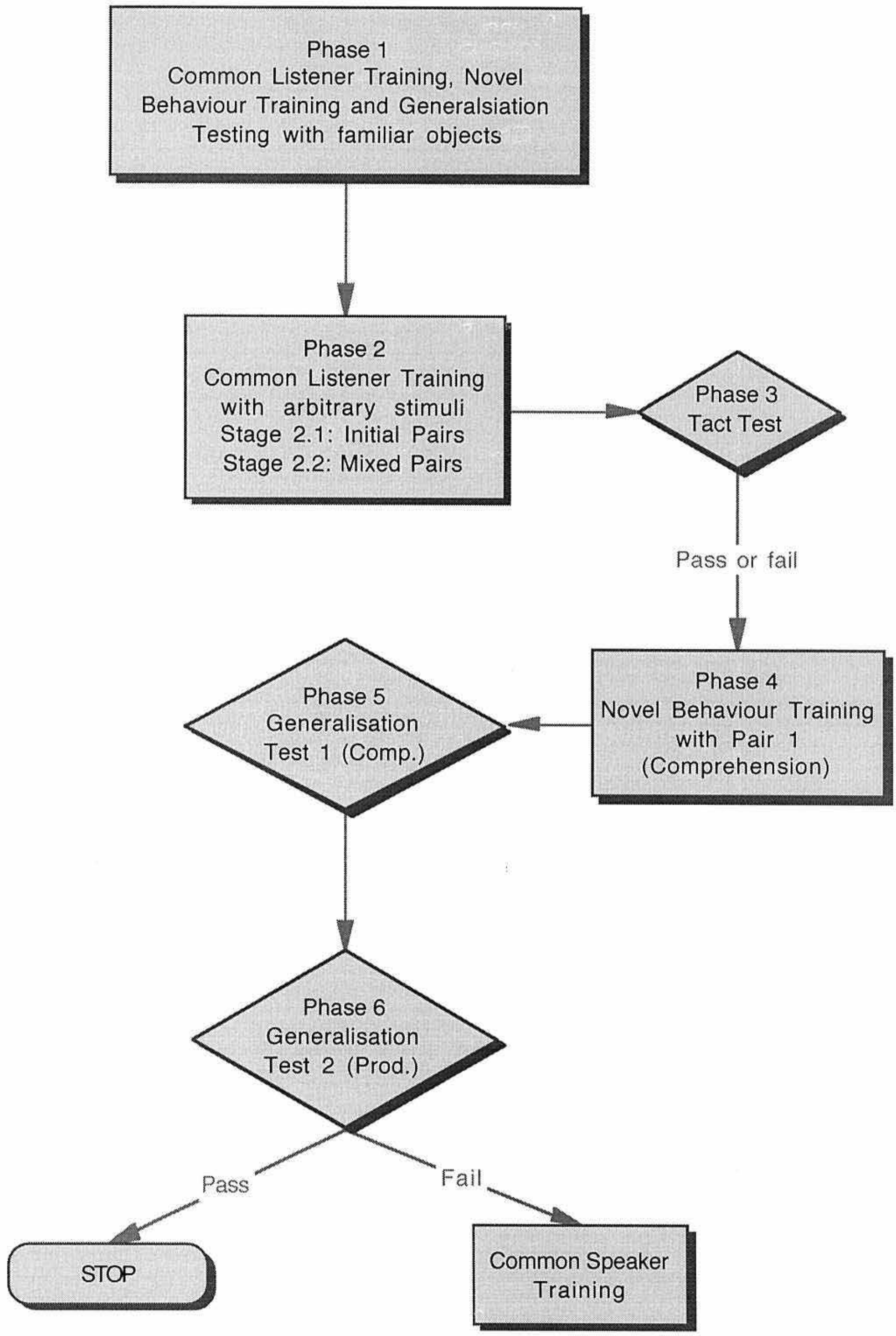


Figure 4.10: Flowchart representation of the procedure of Condition A of Experiment 3 (common listener training)

Stage 4.2: Reduction to zero reinforcement. Trials continued as described in Stage 4.1, but reinforcement was reduced to zero (see Stage 2.3 of Study 1a).

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Comprehension)

To minimise the possibility of experimental cueing, a second experimenter (Experimenter 2) was introduced for all test sessions. Experimenter 2 was familiar with the participant and with the general experimental procedure but was aware neither of the assigned labels given to the experimental stimuli, nor of the novel behaviours assigned to the Pair 1 stimuli. Prior to each test session, Experimenter 2 was given a sheet of paper on which all the trials were listed; because of this she knew exactly which stimulus pair to use for each test trial, and which of the two stimuli to which to point before instructing the child. Experimenter 1 sat behind the participant while Experimenter 2 conducted the test trials.

Stage 5.1: Maintenance of training. Prior to each of the test sessions, to ensure all of the trained relations were intact, unreinforced listener behaviour test trials (i.e., those that utilised the request, "Can you give me the zog/vek") were conducted with each of the three pairs of stimuli. This was followed by four test trials of the novel behaviour trained to Pair 1 (i.e., two trials with the Z1 stimulus and two with the V1 stimulus given the instruction, "Can you give me the one that goes like this?").

Stage 5.2: Testing for generalisation of the novel behaviour to the untrained stimuli. This stage, as with all subsequent test stages, was conducted by

Experimenter 2 with the one-way screen in place. One of the two test pairs was placed on the table in front of the child in a pre-specified random order. Experimenter 2 ensured the participant was attending, and said, “Can you give me the one that goes like this?" Experimenter 2 then modelled one of the behaviours (i.e., either clapping or waving).

Experimenter 2 waited for the participant to respond, and, when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. In the course of 32 test trials, each stimulus was targeted 8 times, 4 times on the left and 4 times on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4) appeared twice in each block; also, the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond within four seconds, the trial was marked as incorrect. No reinforcement was given during test sessions.

In each of test session, the Phase 5 procedure was repeated in full; that is, both Stage 5.1 and Stage 5.2.

Mastery criterion on Generalisation Test 1: This was as described in Study 1a.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Speaker Behaviour (Production).

The procedure in this stage was similar to that of Phase 5 except that all three of the pairs were used to test for the emergence of speaker behaviour (i.e., production of the novel behaviour). Pair 1 was included in Phase 6 because only the comprehension (i.e., a listener behaviour) of the novel behaviour had been trained directly to the Pair 1 stimuli during Phase 4. As with Phase 5: Generalisation Test 1, prior to each of the test sessions, four unreinforced listener behaviour test trials were conducted with the three pairs followed by four test trials of the novel behaviours trained to Pair 1 (see Stage 5.1).

One of the three pairs was placed on the table in front of the participant in a pre-specified random order. Experimenter 2 ensured the participant was attending and asked, "Look at this; can you show me how it goes?" Experimenter 2 then modelled one of the behaviours (i.e., either clapping or waving depending on which was the target behaviour).

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 24 test trials, each stimulus was a target four times, twice on the left and twice on the right. Trials were organised into blocks of eight and were counterbalanced within each block such that each trial type (i.e., Trial Type 1, 2, 3, or 4; see Stage 1.1) appeared twice in each block; also, the same trial type did not appear twice in succession. If the participant did not respond to the first request within four seconds, Experimenter 2 repeated the instruction. If the participant still did not respond the trial was marked as incorrect. All trials were marked as either correct or incorrect. No reinforcement was given during test sessions. Participants were deemed to have passed the Generalisation Test 2 if they scored three out of four correct responses for each stimulus.

A deviation from the standard procedure described for Phase 6 occurred with HT. This was because, on the initial test trials of Phase 5 (as described below), HT failed to make any responses. However, as with other situations when the child did not respond, it was unclear whether this was because he lacked the appropriate behavioural repertoire or because of some other reason (such as a failure to understand the experimental instruction). In order to test for the latter of these explanations, one block of eight training trials was conducted with the Pair 1 stimuli for the *production* of the novel behaviour. The Pair 2 and Pair 3 stimuli were used to test for generalisation.

CONDITION B: COMMON SPEAKER BEHAVIOUR

Procedure

Common speaker training of Study 3 was similar to that of Study 2 in terms of general experimental design and format. The differences are noted below for each of the separate stages (see Figure 4.11).

Phase 1, *Phase 2*, and *Phase 3*

These were as described in Study 2.

Phase 4: Training a Novel Behaviours to a Subset of the Stimuli

This was as described in Study 2.

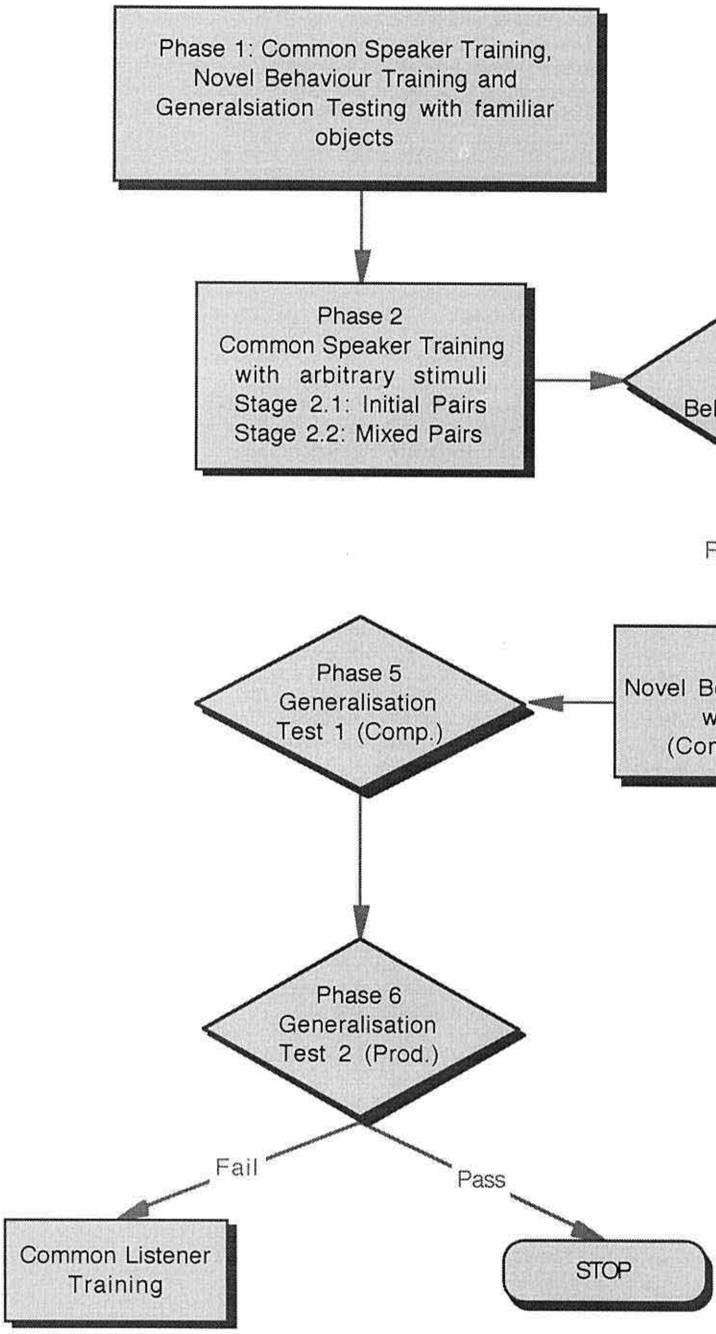


Figure 4.11: Flowchart representation of the procedure of Condition B of Experiment 3 (common speaker training)

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Comprehension)

This was as described in Phase 5 of Condition A above

Phase 6: Generalisation Test 2 - Testing for the Emergence of Speaker Behaviour (Production).

This was as described in Phase 5 of Condition A above.

RESULTS

Both HT and JT completed all phases of the study. The results are reported first for Condition A, then for Condition B.

CONDITION A: COMMON LISTENER TRAINING - Participant HT

Phase 1: Common Listener Training, "In-repertoire" Behaviour Training and Testing with Familiar Objects

Table 4.10 shows the number of blocks of eight trials taken by participant HT to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common listener training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 4.10 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

Participant HT required one block of training for the Pair 1 stimuli (i.e., H1/C1), two blocks for the Pair 2 stimuli (i.e., H2/C2), and one block for the Pair 3 stimuli (i.e., H3/C3). HT learned the in-repertoire behaviour to criterion within one block, and passed the test for the occurrence of the in-repertoire behaviour to both Pair 2 and Pair 3 stimuli within one block (to the instruction, "Look at this; can you show me how this goes?").

Table 4.10

Results of Phase 1 for HT: Common listener training with familiar objects for Condition A. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1 number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, and H3/C3). Stage 1.2 number of blocks of training to criterion for the production of the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3 number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common listener training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
HT	1	2	1	1	1	1

Phase 2: Common Listener Training with Arbitrary Objects

The results for Phase 2 through Phase 6 are represented in Figure 4.12 for HT. The data for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. Participant HT required three blocks of training for Initial Pair 1, and two blocks for both the Initial Pair 2 and Initial Pair 3 stimuli.

Figure 4.12

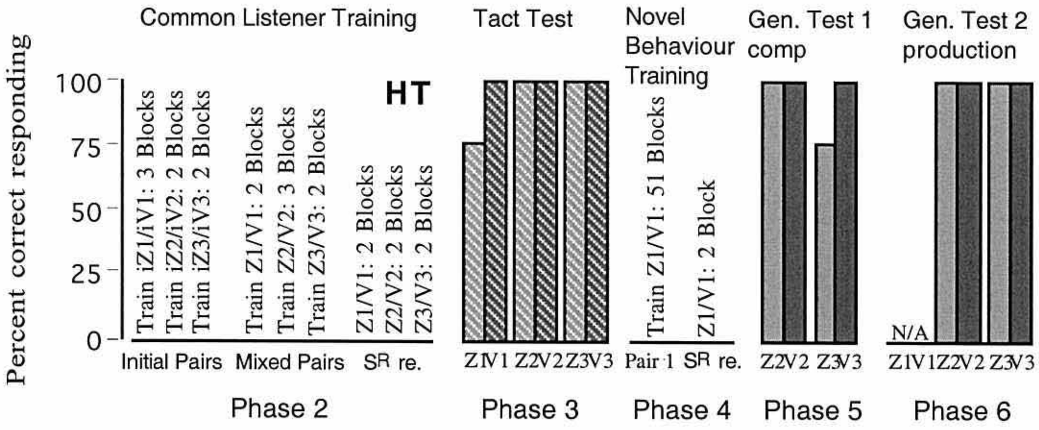


Figure 4.12. Performance of participant HT on Phases 2 through 6 of Condition A. Phase 2: Common Listener Training, number of training blocks to criterion (seven our of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 3: Tact Test, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Novel Behaviour Training, number of trial blocks to criterion on comprehension training for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 5: Generalisation Test 1 - Comprehension, percent correct responses, out of 32 trials, 8 for each stimulus. Phase 6: Generalisation Test 2 - Production, percent correct responses, out of 24 trials, 4 for each stimulus.

Stage 2.2: Common listener training: Mixed pairs. Participant HT reached criterion in three blocks or less for all three pairs.

Stage 2.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 2.2, HT maintained criterion performance without reinforcement across two blocks of trials for each stimulus pair.

Participant HT required a total of 20 training blocks to meet the criteria for all three stages of Phase 2

Phase 3: Tact Test.

Performance on the tact test (Phase 3) for HT is shown in Figure 4.12; this presents percent correct responses over the 24 test trials, four trials for each of the six stimuli. The criterion for successful tacting was set at 75 percent correct responses, or three out of four for each stimulus, for the zog and for the vek stimuli.

HT scored 100 percent correct responses with the Z2, Z3, and all three of the vek stimuli, and 75 percent correct with the Z1 stimulus. These results show that HT had also learned appropriate speaker behaviour; by Horne and Lowe's (1996) definition, naming had been established.

Phase 4: Training the Comprehension of the Novel Behaviours to a Subset of the Stimuli.

Figure 4.12 shows the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 4.1: Novel behaviour training. Participant HT reached criterion on the novel behaviour training in 51 blocks of eight trials.

Stage 4.2: Reduction to zero reinforcement. Once criterion performance had been established, HT maintained criterion responses in the absence of reinforcement for the novel behaviour training over one block of trials.

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Comprehension)

Figure 4.12 shows the percentage of correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted 8 times. The criterion level for Generalisation Test 1 was set at 75 percent for each stimulus in a test pair.

Participant HT completed all 32 test trials in one session and scored 100 percent correct with Pair 2 and 87.5 percent correct responses with Pair 3. HT therefore showed criterion performance on the test of generalisation.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Speaker Behaviour (Production).

Figure 4.12 shows the percent correct responses, for the Pair 2 and Pair 3 stimuli only, over the 16 test trials, 4 trials for each of the 4 test stimuli.

After HT's initial failure to respond to the experimental instruction, the Pair 1 stimuli were trained on the production of the novel behaviour. On the generalisation test trials, HT completed all 16 test trials in one session and scored 100 percent correct responses for both Pair 2 and Pair 3; thus he met the criterion level for success of 75 percent correct responses for each of the stimuli in a test pair.

Spontaneous verbal behaviour

Participant HT made no verbalisations during the procedure other than those required by the study (i.e., when he named the stimuli on the tact test).

CONDITION B: COMMON SPEAKER TRAINING - Participant JT

Phase 1: Common Speaker Training, "In-repertoire" Behaviour Training and Testing with Familiar Objects

Table 4.11 shows the data for all three stages of Phase 1.

Table 4.11

Results of Phase 1 for JT: Common speaker training with familiar objects for Condition B. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1 number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, and H3/C3). Stage 1.2 number of blocks of training to criterion for the production of the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3 number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common listener training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
JT	1	2	1	1	1	1

Phase 2: Common Listener Training with Arbitrary Objects

The results for Phase 2 through Phase 6 are represented in Figure 4.13 for Participant JT.

Stage 2.1: Common speaker training with arbitrary objects: Initial pairs. JT required two blocks of training for all three pairs of the Initial Pair stimuli.

Stage 2.2: Common speaker training: Mixed pairs. JT required two blocks of training to attain criterion performance on the Pair 1 stimuli, three blocks for the Pair 2 stimuli, and eight blocks for the Pair 3 stimuli.

Stage 2.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 2.2, JT maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

Participant JT required a total of 22 training blocks to meet the criteria for all 3 stages of Phase 2

Phase 3: Listener Behaviour Test.

JT made no errors across the 24 test trials. These results show that JT had also learned appropriate listener behaviour; by Horne and Lowe's (1996) definition, naming had been established.

Figure 4.13

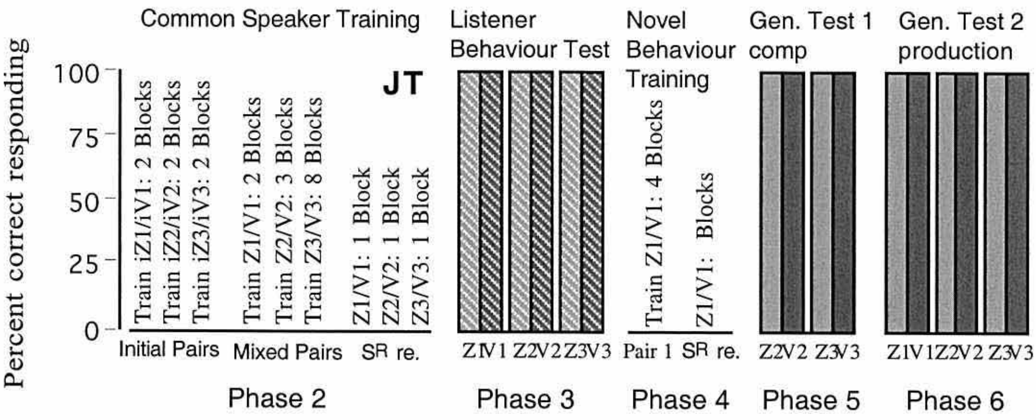


Figure 4.13. Performance of participant JT on Phases 2 through 6 of Condition B. Phase 2: Common Speaker Training, number of training blocks to criterion (seven our of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 3: Listener Behaviour Test, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Novel Behaviour Training, number of trial blocks to criterion on comprehension training for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 5: Generalisation Test 1 - Comprehension, percent correct responses, percent correct responses, out of 32 trials, 8 for each stimulus. Phase 6: Generalisation Test 2 - Production, percent correct responses, out of 24 trials, 4 for each stimulus.

Phase 4: Training the Comprehension of the Novel Behaviours to a Subset of the Stimuli.

Stage 4.1: Novel behaviour training. Participant JT reached criterion on the novel behaviour training in four blocks of eight trials.

Stage 4.2: Reduction to zero reinforcement. Once criterion performance had been established, JT maintained criterion responding in the absence of reinforcement for the novel behaviour training over one block of trials.

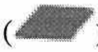
Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Comprehension of the Novel Behaviour to the Untrained Stimuli.

Participant JT completed all 32 test trials in one session and made no errors (see Figure 4.13).

Phase 6: Generalisation Test 2 - Testing for the Emergence of Speaker Behaviour (Production).

Participant JT completed all 24 test trials in one session and again made no errors (see Figure 4.13).

Spontaneous verbal behaviour

Participants JT made very few verbalisation during the study other than the experimentally defined ones (i.e., "zog" and "vek"). On the first presentation of the V3 stimulus she commented "that's a diamond" (). This name may have made it more difficult for her to learn the experimentally defined response of "vek" for that stimulus, and may explain why she took eight blocks of training to reach criteria on the Pair 3 stimuli.

DISCUSSION

The aim of Study 3 was exploratory in nature. The distinction between listener behaviour, or comprehension, and speaker behaviour, or production, is important in the naming account; thus what distinguished this study from others reported in this chapter is that the participants were trained only to comprehend the novel behaviour with respect to the Pair 1 stimuli in Phase 4. After being trained to respond as a listener to the arbitrary stimuli, HT showed appropriate speaker behaviour to those objects. Similarly, JT, after being trained as a speaker to the arbitrary stimuli, showed appropriate listener responding to those objects. Both children had shown naming; HT went on to show a generalisation of the comprehension to the untrained stimuli on Test 1; and JT went on to show a generalisation of the comprehension to the untrained stimuli on Test 1, plus a generalisation of the production of the novel behaviour on Test 2. Both sets of results accord with the predictions of the naming account, and indicated that when children are naming arbitrary stimuli they also generalise novel behaviour to untrained objects, and that this is the case even if the novel behaviour was trained through comprehension.

HT failed to respond on the initial trials of Generalisation Test 2, which was a test for the generalisation of the *production* of the novel behaviour. There was a problem if the child did not respond with either of the required behaviours during the test situation. This will be called *non-responding*. Because of this, it was difficult to conclude that he lacked the necessary behavioural repertoire, and hence did not respond, or that, owing to other contextual features of the test situation, he was simply distracted. An example of contextual features that could have affected the responding on the test situation was the introduction of the second experimenter.

It should also be noted that, in each of these studies, the Phase 1 training and testing with familiar objects was introduced into the procedure for the purpose of identifying whether the child would respond appropriately to the experimental instructions. Although the participants had been tested on the generalisation of comprehension during Stage 3 of Phase 1 (familiar objects), they had not been tested in the generalisation of production — that is, the equivalent of Generalisation Test 2 with the familiar stimuli.

As mentioned, there are two possible explanations for HT's non-responding during the second test. First, he may have not understood what was required of him and thus failed to respond. Second, his failure to respond may have been a demonstration of the independence of listener and speaker functions. He was trained to respond to the novel behaviour as a listener, that is, to select the correct stimuli on seeing the experimenter perform the behaviour. However, Generalisation Test 2 require that he produce the novel behaviour, that is, respond as a speaker. Although he had demonstrated a generalisation of the comprehension (listener responding) during the Generalisation Test 1, this had been directly trained during the Phase 4 training. This did not result in him generalising the production of that same behaviour. Thus his failure could be a demonstration of listener responding in the absence of appropriate speaker responding, and more importantly, a demonstration of the fact that listener responding does not always entail speaker responding.

Following this failure, production of the behaviour was trained directly to the Pair 1 stimuli; this was followed by a generalisation test that included only the Pair 2 and Pair 3 stimuli; he subsequent demonstrated generalisation to the untrained Pair 2 and Pair 3 stimuli.

GENERAL DISCUSSION

The naming account predicts that naming is necessary for the categorisation of arbitrary, or formally unrelated, objects. The studies that are reported in this chapter were designed to test this prediction. Naming is a fusion of speaker and listener relations; therefore, in testing the prediction, and in the search for falsification, attempts were made to provide evidence of categorisation in the absence of naming.

During Study 1a, an attempt was made to train the children to respond only as listeners to the arbitrary stimuli; all four participants showed both listener (trained) and speaker (untrained) relations, and thus evidence of full naming; as predicted by the naming account, all four went on to shown categorisation. During Study 2, an attempt was made to train the children to respond only as speakers to the arbitrary stimuli; again all participants showed both speaker (trained) and listener (untrained) relations, and therefore naming; and once again, all four went on to show categorisation.

These results provide evidence in favour of the naming account, but they do not provide the critical test of showing categorisation in the absence of naming behaviours. This is because all of the children in Studies 1a, lb, 2, and 3 showed both listener and speaker relations prior to the generalisation tests. Thus the goal of attempting to train listener relations in the absence of speaker relations, and speaker relations in the absence of listener relations was not achieved.

Two questions emerge from these results: why did the children show appropriate listener behaviour after common speaker training? and why did the children show appropriate speaker behaviour after common listener training? These are discussed in turn below:

Why did the children show appropriate listener behaviour after receiving only common speaker training? Several studies that have taught only the speaker relations have found that appropriate listener behaviour is almost invariably present, and that children, on the whole, categorise arbitrary objects following common speaker training (e.g., Harris et al., 2000; Huttenlocher & Smiley, 1987). How does this occur?

As discussed, listener responding may, in many circumstances, be brought about in the course of teaching speaker relations. This is because both the object and the listener stimulus are present during speaker training. During common speaker training, the child is required to vocalise the tact response to a specific stimulus. Thus, even if the child was not previously capable of responding as a listener to that particular stimulus, this behaviour may develop during speaker training for the simple reason that the sight of the stimulus may be reliably preceded by the child hearing his or her own utterance of the word; in such circumstances, and if this relation is reinforced (Bell, Horne, & Lowe, 2000), the conditions are present whereby the self-listener stimulus can become discriminative for orienting to the object. This, of course, is a listener response. The above should be especially true if the child had an existing generalised listener repertoire, such as generalised responding to "Where is the ...", "Point to the ...", et cetera. (see Horne & Lowe, 1996, 1997, p. 290).

As Horne and Lowe (1996) suggest, the teaching of what is generally regarded as a tact relation — a unidirectional object-word relation — often also entails appropriate listener behaviour. Thus, in most natural language learning contexts, teaching a tact relation is teaching a name relation. However, the extent to which this is the case in all situations is an empirical matter.

Why did the children show appropriate speaker behaviour after receiving only common listener training? The Randle (1999) study reported evidence of children not showing appropriate speaker behaviour, or categorisation, after they had received common listener training. The fact that children as old as four years were failing to show appropriate speaker behaviour after common listener training in Randle's study appears puzzling. It is expected, once a certain level of verbal sophistication is achieved, that teaching either listener or speaker behaviour would entail the presence of the other relation; this is explained by the higher order nature of the name relation (Horne & Lowe, 1996, p. 200). For instance, children with an existing echoic repertoire, who can reliably select a zog or vek stimulus on hearing /zog/ or /vek/, should also name those stimuli as "zog" or "vek" when required; this would be the case if they had echoed in the presence of the object under reinforcing conditions. This is known as an *echo-tact* (Bell et al., 2000), and is one way in which Horne and Lowe maintain that naming occurs in natural language learning contexts. However, this naming context may be expected to occur less with younger children because, according to the theory, higher order naming would be less well established with younger children and thus the independence of the listener and speaker relations would be greater.

During the common listener training in the Randle (1999) study, the children may have shown some tacting behaviour, but, because tacting was never reinforced explicitly, this relation may have been weak. During the intervening test trials, any weak relation between the object and the verbal response (tact) could have been extinguished; this may explain why the children failed both the categorisation test and the subsequent test for speaker behaviour: during the sessions the children may not have engaged in speaker behaviour because such behaviour was not reinforced.

As Horne and Lowe (1996) note, although speaker behaviour may occur independently of listener relations, the most likely manner in which a tact (speaker) relation arises is via already existing listener and echoic relations. This development has already been described (see Chapter 3). Thus the fact that some children taught common listener relations show appropriate speaker relations is explained by the higher order nature of the name relation. As stated, assuming a child has an existing echoic repertoire, during listener training she may echo (covertly or overtly) that listener stimulus. By the nature of listener training, the child would be attending to the object (and of course being reinforced for such attending) while echoing the verbal response; thus the conditions are present for the object to gain discriminative control over the tact response. Tacting plus corresponding listener behaviour is naming (Horne & Lowe, 1996, 1997, in press).

According to the naming account, therefore, if a child does not echo in the presence of an object, the conditions are not present whereby the object can gain discriminative control over the verbal response; thus, in these conditions, and even though the child may be responding reliably as a listener, he or she is not naming, and hence he or she should not categorise. However, this does not explain why there was a disparity between the Randle (1999) research and the results of Study 1a.

Although the research in Studies 1a and 2 provides strong evidence in favour of the naming account, it failed in the principal aim of training only speaker relations and only listener relations. The children in these studies were aged between 2.5 and

4 years. As stated, higher order naming may be expected to be relatively established in children of this age group. Thus in Studies 4 and 5, reported in Chapter 5, children around 2 years of age participated in either a common listener training procedure or a common speaker training procedure. This again was an attempt to train common listener behaviour in the absence of appropriate speaker behaviour (Study 4), and analogously, train common speaker behaviour in the absence of appropriate listener behaviour (Study 5). Additionally, a categorisation by selection procedure was incorporated for some of the participants in Studies 4 and 5 after they had completed Generalisation Test 1 and 2.

CHAPTER 5

Study 4: Categorisation Following Common Listener Training in Children under 2.5 years

In Study 1a four children taught a common listener response to a set of arbitrary objects went on to show appropriate speaker behaviour on a tact test. All four subsequently showed generalisation of a novel behaviour that was trained only to a subset of the stimuli, to other untrained arbitrary stimuli. Such generalisation indicates categorisation behaviour as predicted by naming theory.

Horne and Lowe (1996) state that, once higher order naming is in place, it may be necessary to train only the speaker or only the listener components of the name relation in order for the whole name relation to be established. This is because naming is a higher order relation (Horne & Lowe, 1996, p. 199). One of the reasons why all four of the participants in Study 1a named after receiving only listener training may have been due to their relative verbal sophistication; the children participating in the study were aged between 2.5 and 4 years. Thus, in Study 4, participants under the age of 2.5 years were exposed to the same procedure as that of Study 1a. This was an attempt to test for generalisation after training listener relations but in the absence of naming.

Both the Harris et al. (2000) and Randle's (1999) studies used the categorisation by selection method to test for the presence of classifying behaviour. This additional categorisation test was incorporated for some of the participants of Study 4 (i.e., Participants RH, CM, FJ, BB, & MH) after they had completed both Generalisation Test 1 and Test 2.

METHOD

Participants

Six Participants, SH, RH, CM, FJ, CP, BB, and MH took part in Study 4. Their ages ranged from 22 to 26 months at the start of the procedure (see Table 5.1 for details).

Table 5.1. Participants' sex, age at start of procedure, age at first test and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days	Griffiths GQ score
SH	F	26;22	29;01	138
RH	M	22;14	29;18	113
CM	F	24;10	30;11	121
FJ	F	25;14	26;22	-
BB	F	22;15	23;30	-
MH	F	25;18	27;15	-

F = Female; M = Male; (-) = Data not available

Apparatus and Setting

These were identical to those of Study 1a (Chapter 3).

Stimuli

These were identical to those of Study 1a.

Procedure

All phases of the study are represented in Figure 5.1 and Figure 5.2.

Phases 1 to 6

In general, the procedure for Phases 1 through to 6 was identical to that described in Study 1a. However, in Phase 5: Generalisation Test 1, the procedure was altered for Participant CM. This was because CM did not respond to the test stimuli. As with all situations of non-responding (see the discussion section of Study 3), there were two possible explanations available: either (a) CM did not respond because she did not have the appropriate response in her behavioural repertoire, or (b) she failed to respond because of other contextual features of the test situation—for example, because she did not understand the experimental instructions. To shed light on this issue, the test trials on Pair 2 and Pair 3 stimuli were run intermittently with unreinforced trials with the trained Pair 1 stimuli. Over the six test sessions, four random test trials with Pair 2 and 3 were followed by four random unreinforced trials with the Pair 1 stimuli. Thus, with CM, the test sessions were conducted as follows.

The first test session consisted of four parts: (a) four random test trials with Pair 2 and Pair 3; (b) four random unreinforced trials with Pair 1; (c) four random test trials with Pair 2 and Pair 3; and (d) two random unreinforced trials with Pair 1. For all subsequent test sessions (i.e., the second test session through to the sixth) four random test trials with the Pair 2 and Pair 3 stimuli were followed by four random unreinforced trials with Pair 1.

Phase 7: Categorisation by Selection Test with all Six Experimental Stimuli

Phase 1 through to Phase 7 are represented in Figure 5.1. Participants FJ, MH, BB, CM, and RH participated in Phase 7. Prior to the test trials with the arbitrary stimuli, it was necessary, as with other test phases, to ensure that each child could respond appropriately to the experimental instructions. For this reason, a categorisation test was first conducted with the familiar objects used in Phase 1.

Stage 7.1: Categorisation by selection test with familiar objects. As with all other test phases, the categorisation by selection test was conducted by Experimenter 2 from behind the one-way screen. All six familiar objects (the three hats and the three cups) used in Phase 1 of the study were reintroduced to the child at this stage. All six objects were placed in a random order on the table from behind the screen. Experimenter 2 then selected one of the objects and said, "Look at this; can you give me the others like this one?" The experimenter then waited for the response, and after the child had made his or her selection, all six stimuli were removed form the table and re-positioned for the subsequent trial.

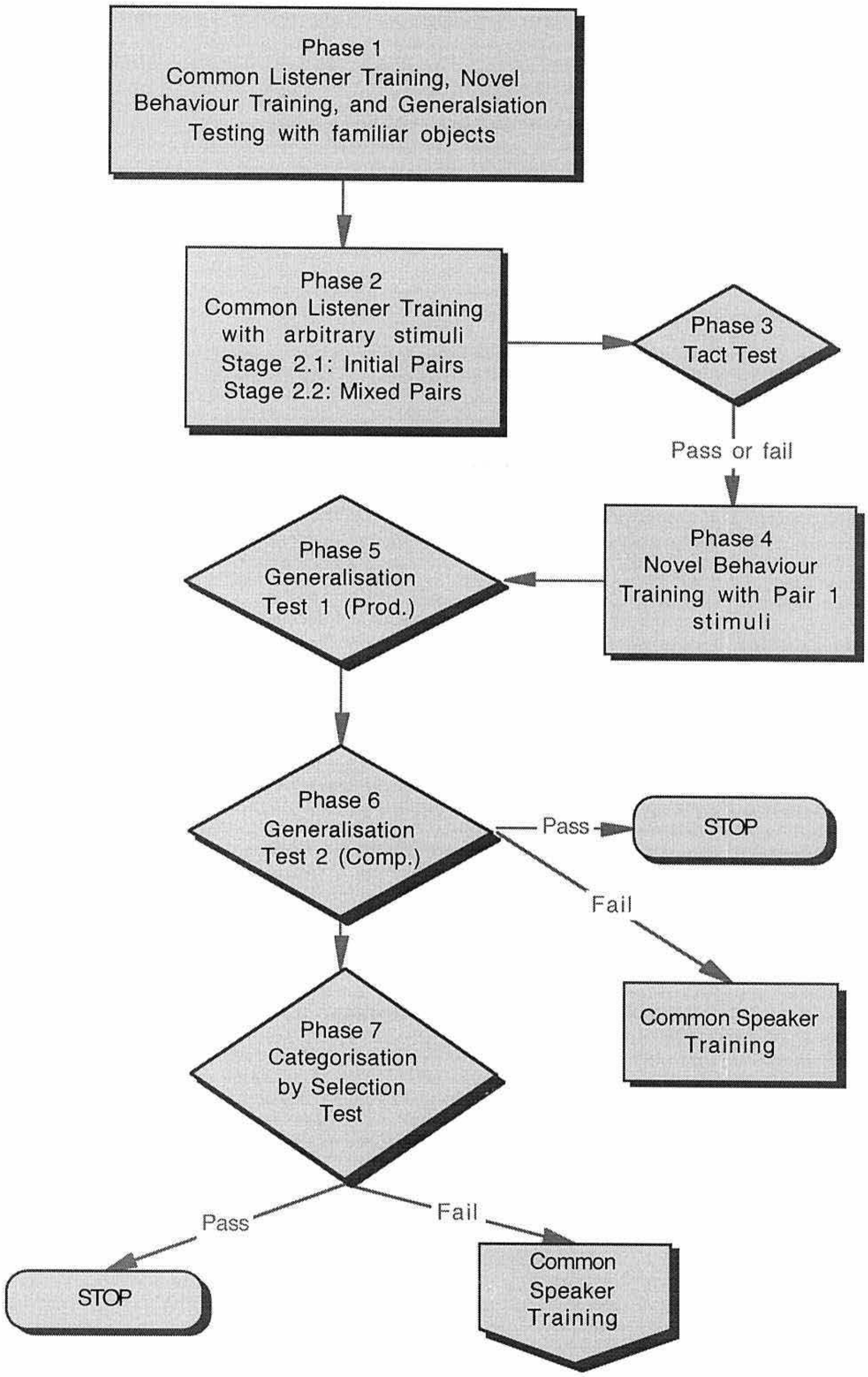


Figure 5.1: Flowchart representation of the procedure of Experiment 4 (Phases 1 - 7).

All the children responded correctly, by giving the other two hats when a hat was target, or the other two cups when a cup was target, and therefore the test trials continued until each of the six stimuli had been a target once. There was no reinforcement given during these trials.

Stage 7.2: Categorisation by selection test with arbitrary objects. Experimenter 2 placed the six arbitrary stimuli in a random pre-specified order on the table in front of the child. Experimenter 2 then picked up the target stimulus and said, "Look at this; can you give me the others like this one?" As with Stage 7.1, the experimenter then waited for the child to respond, and, after the child had done so, removed all the stimuli from the table and repositioned them for the next trial. Eighteen trials were conducted in order that each of the six stimuli were targeted randomly three times in a different position.

If the child responded by giving two of the stimuli, the trial was marked as valid. If the child gave more than two stimuli, the trial was deemed invalid and the experimenter replaced the stimuli in their position and said, "No, I don't want all of them; just give me the others like this one." Therefore only trials in which the child selected two of the stimuli were recorded.

As with other test phases, the number of trials performed in a session varied and depended on the individual child. If the 18 trials were split into a number of sessions, each of the sessions commenced with two trials with the familiar objects, one with a hat as target and one with a cup, as described in Stage 7.1 above.

Categorisation by Selection Test 2. With two of the participants, FJ and BB, after failure to respond correctly on the standard categorisation by selection test as described above, a repeat of the test was given, but this time the instruction, "What's this? Can you give me the others like this one?" was used. This was an attempt to prompt the *overt* vocalisation of the target stimulus name prior to selection.

On the second categorisation by selection test, six trials were conducted, one with each of the experimental stimuli. In all other respects the test was identical to that described above. For both FJ and BB, following the second categorisation by selection test, a repeat of the first categorisation by selection test was conducted using the "Look at this. Can you give me the others like this one?" instruction. Thus these two children each participated in three categorisation by selection tests in total.

Mastery criterion on the categorisation by selection test: As with Generalisation Test 1 (see Study 1a), Binomial probability distributions statistics were calculated to determine the probability of scoring a specific number of correct trials by chance (see Howell, 1992). The Binomial probability distributions statistic is mathematically defined as:

$$p(X) = \frac{N!}{X!\,(N - X)!}\, p^{X}\, q^{(N-X)}$$

where:

$p(X)$ = The probability of X successes.

N = The number of trials. The standard number of test trials was 18.

p = The probability of success on any one trial. That is, the probability of giving the two correct stimuli on any one trial. On any one trial there was a possibility of selecting 10 possible two-stimuli configurations, only one of which would be correct. Thus the constant p was set at 0.1.

q = $(1 - p)$ The probability of a failure on any one trial, that is, of selecting one of the nine incorrect stimulus pair configurations.

Applying the Binomial distribution probabilities indicates a significant generalisation score of 33 percent correct responses, or 6 out of 18 ($N = 18, p = 0.1$; $P(6) = 0.0052 < 0.01$). Criterion performance on the categorisation test was therefore deemed to have occurred when participants scored at least 33 percent correct responses, or three correct from nine, for the zog stimuli and for the vek stimuli.

Continuation in the procedure after Phase 7 depended on the outcome in the generalisation and categorisation tests (Phase 5, Phase 6, & Phase 7). If the participant showed evidence of generalisation in the three test phases, as did Participants FJ, MH, and BB, the child's participation in the procedure finished at Phase 7.

If the participant failed the generalisation and categorisation tests, as did participants CM and RH, progression to the next phase depended on whether the child had passed the Phase 3: Tact Test. If the child had passed the tact test—and thus showed evidence of naming—the participation of the child in the procedure ended at Phase 7. If, on the other hand, the participant had not passed the tact test—

and thus had not shown evidence of naming—as was the case with both CM and RH, the procedure moved to *Phase 8: Common Speaker Training*. Figure 5.2 shows the procedure for Phase 8 through to Phase 11 of Study 4 for CM and RH.

Common speaker training was similar to the common speaker training as described in Study 2; the differences are noted below for the separate phases. There was no training with the familiar objects during the common speaker training; therefore training began with the arbitrary objects and the stimuli remained in their designated mixed pairs categories as determined in Stage 2.2.

Phase 8: Common Speaker Training with Arbitrary Objects

The training in this phase was similar to that of in Phase 2 of Study 2. The only difference was that the stimuli remained in their designated pair arrangement as described above; therefore there was no initial pairs training stage.

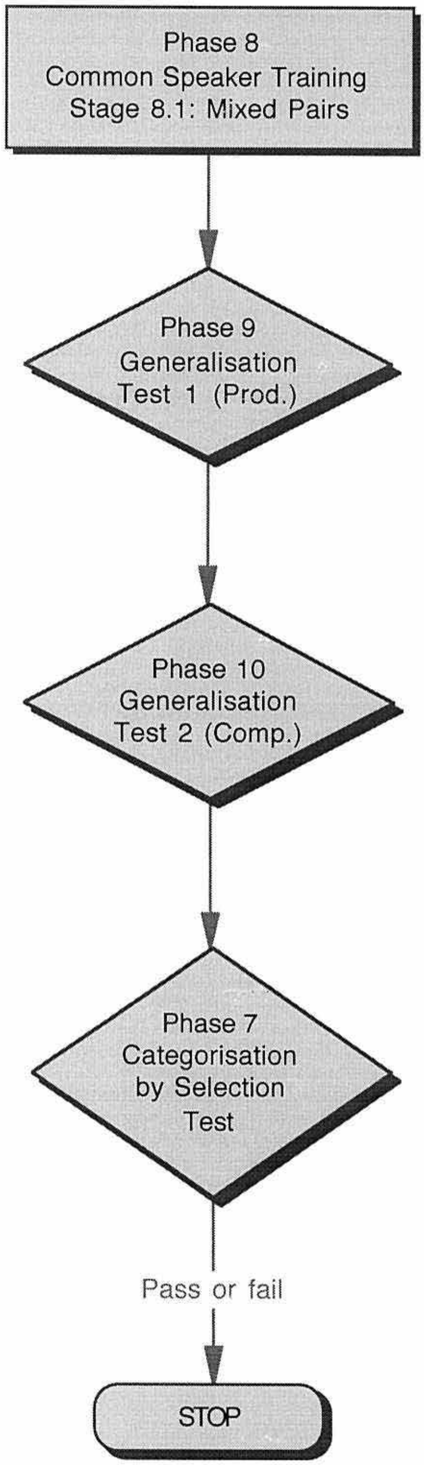


Figure 5.2: Flowchart representation of the procedure of Experiment 4 (Phases 8 - 11).

Phase 9: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

This phase was identical to that of Phase 5: Generalisation Test 1 of Study 2.

Phase 10: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

This phase was identical to that of Phase 6: Generalisation Test 2 of Study 2. CM's participation in the research ended after this phase.

Phase 11: Categorisation by Selection Test with all 6 Experimental Stimuli

This phase was identical to that of Phase 7: Categorisation by Selection Test below. RH's participation in the research ended after this phase.

RESULTS

SH completed Phase 1 through Phase 6; FJ, MH, and BB completed Phase 1 through Phase 7; CM competed Phase 1 through Phase 10; and, RH competed Phase 1 through Phase 11.

Phase 1: Common Listener Training, "In-repertoire" Behaviour Training, and Testing with Familiar Objects

Table 5.2 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1:*

Common listener training, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 5.2 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

During Stage 1.1, all participants reached criterion performance in one block of training for each of the three stimulus pairs. All four children learned the "in-repertoire" behaviour to criterion performance within four blocks, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 5.2

Results of Phase 1: Common Listener Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, and H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common listener training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
SH	1	1	1	2	1	1
RH	1	1	1	1	1	1
CM	1	1	1	1	1	1
FJ	1	1	1	4	1	1
BB	1	1	1	1	1	1
MT	1	1	1	2	1	1

Figures 5.3 and 5.4 show the results for all six participants of Study 4. Figure 5.3 shows the results for Phase 2 through Phase 6 for SH, and for Phase 2 through Phase 7 for FJ, MH, and BB. Figure 5.4 shows the results for Phase 2 through Phase 10 for CM, and for Phase 2 through Phase 11 for RH.

Phase 2: Common Listener Training with Arbitrary Objects

The data presented for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. Participants SH, FJ, MH, and BB reached criterion performance on all three pairs of stimuli in four blocks or less (see Figure 5.3).

Figure 5.4 shows that CM required 19 blocks of training trials for the Initial Pair 1 stimuli, 12 for the Initial Pair 2 stimuli, and 26 blocks for the Initial Pair 3 stimuli. Participant RH required 10 blocks of training for the Initial Pair 1 stimuli, five blocks for the Initial Pair 2 stimuli, and six blocks for the Initial Pair 3 stimuli.

Figure 5.3

Figure 5.3. Performance of SH on Phases 2 through 6, and FJ, MH, and BB on Phases 2 through 7. Phase 2: Common Listener Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (SR re.) stages. Phase 3: Tact Test, percent correct responses, out of 24 trials, 4 trials for each stimulus. Phase 4: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 5: Generalisation Test 1, percent correct responses, out of 32 trials, 8 trials for each stimulus. Phase 6: Generalisation Test 2, percent correct responses, out of 24 trials, 4 trials for each stimulus. Phase 7: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the zog stimuli and 9 for the vek stimuli. (For FJ, MH, & BB, Phase 7 consisted of three tests: Category Test 1 using the "Look at this" instruction; Test 2 using the "What's this?" instruction; and Test 3 the "Look at this" instruction).

Figure 5.4

Figure 5.4. Performance of CM on Phases 2 through 10, and RH on Phases 2 through 11: Phases 2 through 7 were as described in the above in the caption for Figure 5.3 above; Phase 8: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs; Phase 9: Generalisation Test 1, as described in Phase 5 above; Phase 10: Generalisation Test 2, as described in Phase 6 above; and, Phase 11: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 for the zog and 9 for the vek stimuli.

Figure 5.3

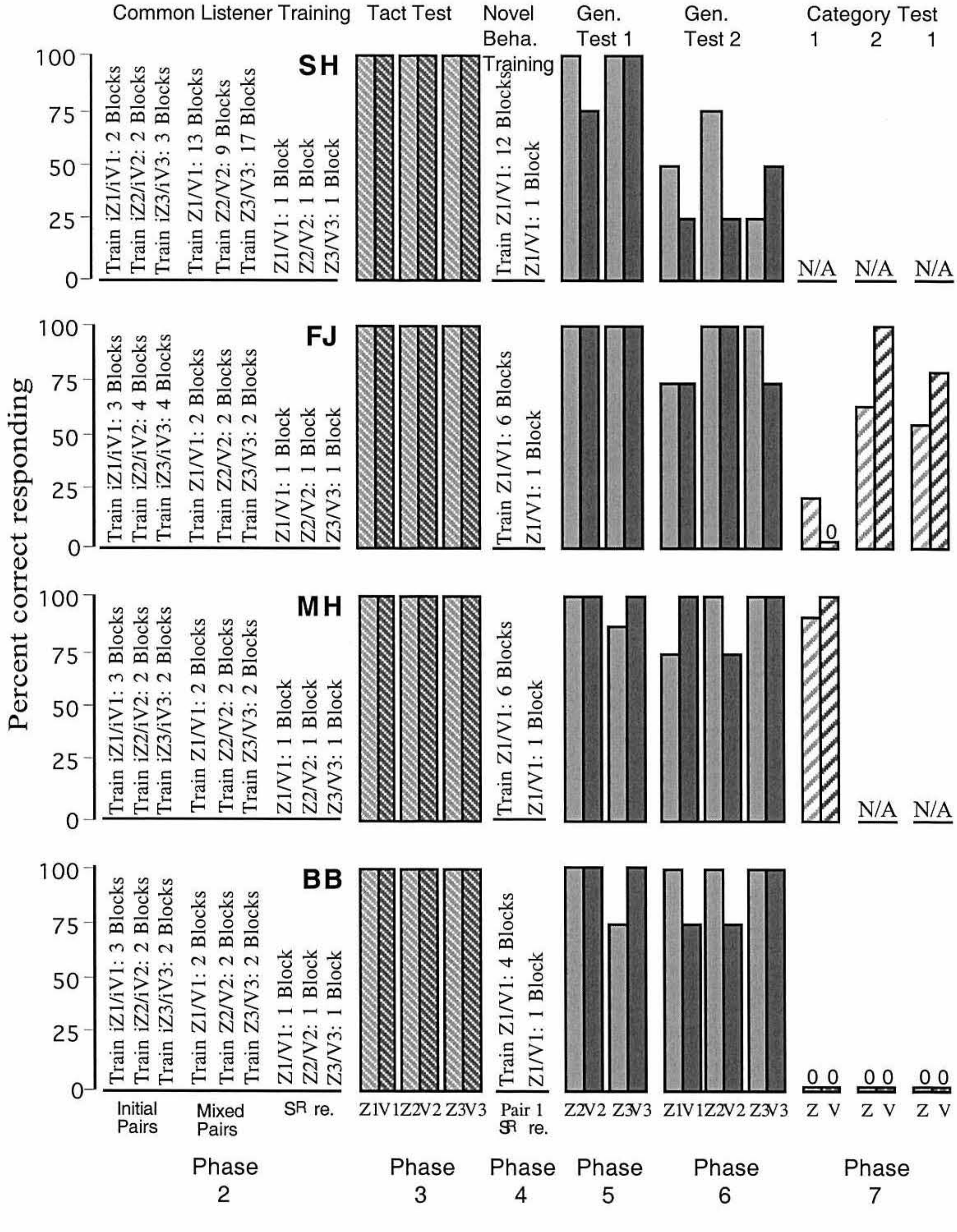
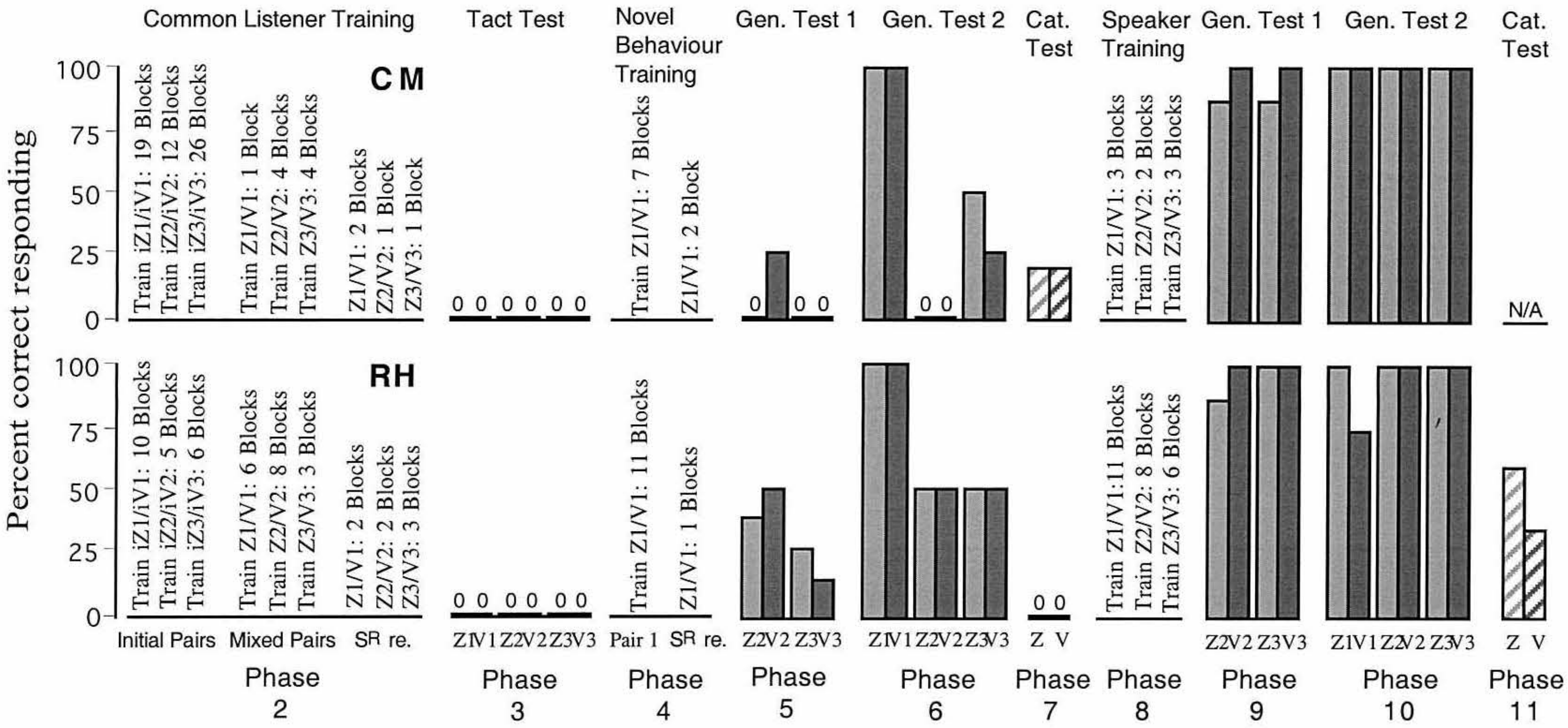

Common Listener Training
Tact Test
Novel Beha. Training
Gen. Test 1
Gen. Test 2
Category Test
1 2 1
SH
FJ
MH
BB
Percent correct responding
0
25
50
75
100
Train iZ1/iV1: 2 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 3 Blocks
Train Z1/V1: 13 Blocks
Train Z2/V2: 9 Blocks
Train Z3/V3: 17 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
Train Z1/V1: 12 Blocks
Z1/V1: 1 Block
N/A
Train iZ1/iV1: 3 Blocks
Train iZ2/iV2: 4 Blocks
Train iZ3/iV3: 4 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Train Z1/V1: 6 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 4 Blocks
0
Initial Pairs
Mixed Pairs
SR re.
Z1V1 Z2V2 Z3V3
Pair 1 SR re.
Z2V2 Z3V3
Z1V1 Z2V2 Z3V3
Z V
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7

Figure 5.4


Common Listener Training
Tact Test
Novel Behaviour Training
Gen. Test 1
Gen. Test 2
Cat. Test
Speaker Training
Gen. Test 1
Gen. Test 2
Cat. Test
Percent correct responding
100
75
50
25
0
CM
Train iZ1/iV1: 19 Blocks
Train iZ2/iV2: 12 Blocks
Train iZ3/iV3: 26 Blocks
Train Z1/V1: 1 Block
Train Z2/V2: 4 Blocks
Train Z3/V3: 4 Blocks
Z1/V1: 2 Blocks
Z2/V2: 1 Block
Z3/V3: 1 Block
Train Z1/V1: 7 Blocks
Z1/V1: 2 Block
Train Z1/V1: 3 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 3 Blocks
N/A
RH
Train iZ1/iV1: 10 Blocks
Train iZ2/iV2: 5 Blocks
Train iZ3/iV3: 6 Blocks
Train Z1/V1: 6 Blocks
Train Z2/V2: 8 Blocks
Train Z3/V3: 3 Blocks
Z1/V1: 2 Blocks
Z2/V2: 2 Blocks
Z3/V3: 3 Blocks
Train Z1/V1: 11 Blocks
Z1/V1: 1 Blocks
Train Z1/V1:11 Blocks
Train Z2/V2: 8 Blocks
Train Z3/V3: 6 Blocks
Initial Pairs
Mixed Pairs
SR re.
Z1V1 Z2V2 Z3V3
Pair 1
SR re.
Z2V2 Z3V3
Z1V1 Z2V2 Z3V3
Z V
Z2V2 Z3V3
Z1V1 Z2V2 Z3V3
Z V
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11

Stage 2.2: Common listener training: Mixed pairs. Participants SH required 13 blocks to reach criterion for Mixed Pair 1, 9 for Mixed Pair 2, and 17 for Mixed Pair 3. Participants FJ, MH, and BB each required only two blocks to attain criterion performance for all three of the mixed pairs stimuli (i.e., Z1/V1, Z2/V2, and Z3/V3) (see Figure 5.3).

Participant CM reached criterion for Mixed Pair 1 in one block, and both Mixed Pair 2 and 3 in four blocks. Participant RH reached criterion for Mixed Pair 1 in six blocks, Mixed Pair 2 in eight blocks and Mixed Pairs 3 in three blocks (see Figure 5.4).

Stage 2.3: Reduction to zero reinforcement. The number of blocks required to achieve criterion performance (seven out of eight trials correct) under a zero reinforcement schedule is shown in Figures 5.3 and 5.4. All the children maintained criterion performance under a zero reinforcement schedule.

After reaching criterion with each stimulus pair during Stage 2.2, participants SH, FJ, MH, and BB required only one block of trials for each stimulus pair.

Participant CM required two blocks for Pair 1 and one block for both Pair 2 and Pair 3. RH required two blocks for both Pair 1 and Pair 2, and three blocks for Pair 3.

The mean number of blocks required for the six participants to meet the criteria for all three stages of Phase 2 was 36.5 (range 16 - 73). Participant SH required a total of 50 training blocks, FJ 20 blocks, both MH and BB 16 blocks, RH 45 blocks, and CM 73 blocks.

Phase 3: Tact Test.

The performance of each participant on the Tact Test (Phase 3) is shown in Figures 5.3 and 5.4. This presents percent correct responses over the 24 test trials, four trials for each of the individual stimuli. Significant performance for tacting was set at 75 percent, or three correct responses out of four, for each of the zog and the vek stimuli.

Participants SH, FJ, MH, and BB made no errors on any of the 24 test trials; these results show, that in the course of procedure, they had also learned appropriate speaker behaviour; thus by Horne and Lowe's (1996) definition, naming had been established.

In contrast, out of the 24 test trials, neither CM nor RH passed the tact test: thus naming had not been established with these two participants.

Phase 4: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figures 5.3 and 5.4 show the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 4.1: Novel behaviour training. Participant SH reached criterion on the novel behaviour training in 12 blocks of 8 trials, FJ and MH in 6 blocks, BB in 4, RH in 11, and CM in 7.

Stage 4.2: Reduction to zero reinforcement. All participants achieved criterion responding in the absence of reinforcement for the novel behaviour training in one block of trials.

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figures 5.3 and 5.4 show the percent correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted 8 times. The criterion level for Generalisation Test 1 was set at 75 percent for each of the stimuli in a test pair.

Participants SH scored 87.5 with the Pair 2 stimuli and 100 percent with the Pair 3 stimuli. Participant FJ made no errors on the test. Participant MH scored 100 percent for the Pair 2 stimuli and 94 percent for the Pair 3 stimuli. Participant BB scored 100 percent correct with the Pair 2 stimuli and 87.5 percent correct with the Pair 3 stimuli

Participant CM completed the 32 test trials over six test sessions, but did not respond on any of the trials. Thus CM scored a total of 6.25 percent correct responses (2 of 32) over the 32 test trials. For the individual stimuli, CM scored 25 percent correct for the V2 stimulus. She did not respond correctly to any of the other three test stimuli (Z2, Z3, & V3). During the six test sessions, a total of 26 unreinforced trials were conducted with the trained Pair 1 stimuli and CM scored a total of 24 out of 26 correct with that pair.

Participant RH completed the 32 test trials over three test sessions and scored 44 percent correct for the Pair 2 stimuli, and 19 percent correct for the Pair 3 stimuli. He showed no evidence of reaching criterion performance with any of the experimental stimuli.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figures 5.3 and 5.4 show for each child the percent correct responses over the 24 test trials in Phase 6, four trials for each of the six test stimuli.

Participant SH scored 37.5 percent correct for Pairs 1 and 3, and 50 percent correct for the Pair 2 stimuli. Thus, SH did not show evidence of generalisation in Test 2. FJ scored 75 percent, 100 percent and 87.5 percent correct for Pairs 1, 2, and 3 respectively. Both MH and BB scored 87.5 percent correct for Pairs 1 and 2, and 100 percent correct for Pair 3.

Participant CM scored 100 percent correct responses for the Pair 1 stimuli, 0 percent for the Pair 2 stimuli, and 37.5 percent for the Pair 3 stimuli. The results indicate that CM reached criterion performance for the Pair 1 stimuli, but failed to show generalisation for both the Pair 2 and Pair 3 stimuli.

Participant RH scored 100 percent correct responses for the Pair 1 stimuli and 50 percent for both the Pair 2 and Pair 3 stimuli. The results indicate that RH had reached criterion performance for the Pair 1 stimuli, but not the Pair 2 and Pair 3 stimuli.

Phase 7: Categorisation by Selection Test.

Figures 5.3 and 5.4 show for each child (FJ, MH, BB, CM, & RH) the percent correct responses over the 18 test trials in Phase 7, 9 for the zog and 9 for the vek stimuli. Criterion level for success on the test was set at 33 percent correct responses (or three from nine) for the zog stimuli and for the vek stimuli.

Participant MH scored 89 percent correct responses for the zog stimuli, and 100 percent correct for the vek stimuli, and thus she showed categorisation (see Figure 5.3).

Participant RH made no correct responses on the test. Participant CM scored 22 percent correct responses (two from nine) for the zog stimuli and for the vek stimuli. Therefore, neither CM nor RH showed criterion performance on the test (see Figure 5.4).

Both FJ and BB participated in three categorisation by selection tests. Participant BB made no correct responses on any of the three separate categorisation tests. Participant FJ's results are described for the separate tests below.

Categorisation by Selection Test 1: This test used the instruction, "Look at this, can you give me the others like this one?" (as described above). Participant FJ scored 22 percent correct (two from nine) for the zog stimuli, and zero percent correct for the vek stimuli. Thus FJ failed to reach criterion on the test.

Categorisation by Selection Test 2: This test used the instruction, "What is this, can you give me the others like this one?" Participant FJ scored 66 percent correct responses (six from nine) for the zog stimuli, and 100 percent correct for the vek stimuli. Thus FJ reached criterion performance on the second test of categorisation by selection.

Categorisation by Selection Test 1 (repeat): This was identical to the Categorisation by Selection Test 1 described above. Participant FJ scored 56 percent correct responses (five of nine) for the zog stimuli and 77 percent correct for the vek stimuli. Thus FJ reached criterion performance on the repeat of the first test of categorisation by selection.

Phase 8: Common Speaker Training with Arbitrary Objects

Participant CM reached criterion for all three pairs in three blocks or less. Participant RH took 11 blocks for Pair 1, 8 for Pair 2, and 6 for Pair 3.

Phase 9: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

On the repeat of Generalisation Test 1, CM scored 94 percent correct responding for both pairs. Participant RH scored 100 percent for Pair 3 and 94 percent for Pair 2. Both participants therefore reached criteria performance on the test.

Phase 10: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension)

Again, on the repeat of Generalisation Test 2, both participants reached criterion responding: CM scored 100 percent for all three pairs and RH scored 100 percent for Pairs 2 and 3, and 94 percent correct for Pair 1.

Phase 11: Categorisation by Selection Test with all 6 Experimental Stimuli

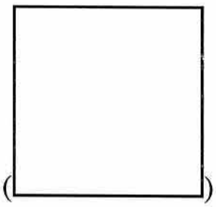
Only RH completed Phase 11. He scored 55 percent correct responses (five from nine) for the zog stimuli and 33 percent correct responses (three from nine) for the vek stimuli. He thus achieved criterion performance on the test for both the zog and the vek stimuli.

Spontaneous verbal behaviour

All participants' verbalisations made during common listener training (Phase 2) are indicated in Table 5.3, including the verbal prompt that preceded the vocalisation and the stimuli present at the moment the verbalisation was made.

Participant SH said both "vek" and "zog" on three occasions, all on trials when the relevant stimulus was the target. She did not make any vocalisation during the rest of the procedure, however, she demonstrated naming on the tact test.

Participant RH said "zog" on two occasions, and he called one of the stimuli "ears", and responded to another with "That's a hole". There was no evidence that he had named the stimuli from his verbalisations and he did not demonstrate appropriate tacting on the test.

Participant CM's verbalisations during the common listener training are indicated in Figure 5.3. During the tact test she said "Be' ydy hyn", which is Welsh for "What's this?", but she did not respond with any of the stimulus names. During the function training with the Z1 and V1 stimuli, CM said, "can fly" and she made noises to zog stimulus () imitating an aircraft. She also said, "that's not egg" to the V1 stimulus (). Participant CM provided no evidence that she had named the stimuli from her verbalisations and she did not demonstrate appropriate tacting on the test.

Participant FJ said "zog" or "zoggy" on 24 occasions and "vek" or "vekky" on 25 occasions during the training. This suggests that she had learned to name the stimuli; this was confirmed by her tact test results. She did not make any further verbalisation during the procedure.

Participant MH said "zog" on four occasions and "vek on two. There was no strong evidence that she had learned to name the stimuli during the training but she did demonstrate tacting on the test.

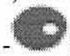
Participant BB said "zog" or "zoggy" on five occasions and "vek" on three. During the tact test BB said "round " to both the V1 () and the V2 () stimuli, and she said "me" to the V3 () stimulus in addition to tacting the correct stimuli responses. During the Generalisation Test 2, she said "zoggy" to all of the zog stimuli.

Spontaneous verbalisations during common speaker training.

During the common speaker training that followed failure on the categorisation tests, RH did not make any verbalisations other than those required by the study (i.e., "zog" and "vek").

During common speaker training, CM said, "ponytail" five times to the Z2 stimulus ().

Table 5.3: Children's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
SH	Z1/V1	Can you give me the zog?	vek
	Z3/V3	Can you give me the zog?	zog x 3; That's a zog (pointing to the stimulus)
		Can you give me the vek?	vek x 2
RH	iZ1/iV1	Can you give me the zog?	zog; zz
	iZ2/iV2	Can you give me the zog?	ears (pointing to the stimulus - )
	iZ3/iV3	Can you give me the zog?	zog; zig-zog
	Z3/V3	Can you give me the zog?	It's a hole; That's a hole x 2 (pointing to the stimulus - )
CM	iZ1/iV1	Can you give me the zog?	iog x 4; clog-clog-clog; stands eto (Welsh for "again"); stand (holding the stimulus)
		Can you give me the vek?	bek x 4; This is the one (pointing to the stimulus); Stand x 2
	iZ3/iV3	Can you give me the zog?	Fall down x 2 (holding the stimulus); peepo-peepo
	Z3/V3	Can you give me the vek?	That's not the vek
FJ	iZ1/iV1	Can you give me the zog?	zog x 2; zoggy x 7
		Can you give me the vek?	vek x 5
	iZ2/iV2	Can you give me the zog?	zoggy x 11
		Can you give me the vek?	vek x 10; vekky x 2
	iZ3/iV3	Can you give me the zog?	zoggy x 3
		Can you give me the vek?	vek x 5
	Z2/V2	Can you give me the vek?	vek
	Z3/V3	Can you give me the zog?	zoggy
		Can you give me the vek?	vek
MH	iZ1/iV1	Can you give me the zog?	zog
		Can you give me the vek?	vek
	iZ2/iV2	Can you give me the zog?	zog
		Can you give me the vek?	vek
	iZ3/iV3	Can you give me the zog?	zog x 2
BB	iZ1/iV1	Can you give me the zog?	zog x 2
		Can you give me the vek?	vek
	iZ2/iV2	Can you give me the zog?	zog
	Z3/V3	Can you give me the zog?	zoggy x 2
		Can you give me the vek?	vek x 2

DISCUSSION

The aim of Study 4 was to test for categorisation of formally unrelated stimuli in children aged less that 2.5 years teaching only common listener behaviour and in the absence of appropriate speaker behaviour. Of the six children who completed Study 4, four showed they had named the stimuli after receiving only common listener training; these children demonstrated generalisation of a trained novel behaviour to other untrained objects; and that for three of these children, when presented with a categorisation by selection test, two passed (FJ & MH) that test also and one (BB) failed. The remaining two participants, CM and RH, did not learn to name the stimuli after common listener training. They did not demonstrate generalisation of the trained novel behaviour to other untrained objects, and neither did they categorise those stimuli on the categorisation by selection test. When given common speaker training, and thus training to name, these two children subsequently demonstrated generalisation of the novel behaviour to the other untrained objects. Participant RH also categorised those stimuli on the categorisation by selection test.

In the search for falsification of Horne and Lowe's (1996) account, this study tested for categorisation *in the absence of naming* by attempting to train only common listener relations. Two lines of evidence surfaced from Study 4.

First, neither CM and RH named (if the had passed the categorisation tests it would have been counter to Horne and Lowe's predictions), and neither did they pass the categorisation tests until they were trained to name the stimuli. These results are consistent with the findings of the Randle (1999) study (discussed in Chapters 3 & 4), which showed children of a similar age group to those being studied here failed to show categorisation after being taught only listener relations.

Second, all the children that showed naming also showed categorisation. Again, this provides support for the naming account and is consistent with the studies conducted by Harris et al. (2000) and Randle (1999).

Participant CM was deemed to have failed Generalisation Test 1 because she responded very little. As discussed, non-responding during the test is open to competing explanations. This fact was the reason for including trials with the trained Pair 1 stimuli intermittently with the test Pairs 2 and 3 for CM. Her failure to respond to the Pair 2 and Pair 3 test stimuli while at the same time responding to the Pair 1 stimuli indicates she had failed to generalise appropriate responding to the test pairs.

Comparing the categorisation by generalisation and categorisation by selections tests. As can be seen from Figure 5.3, both FJ and BB failed the first categorisation by selection test. This was after they had shown similar categorisation behaviour on the pre-training phase with familiar objects, and after they had both shown categorisation by generalisation on Generalisation Test 1 and 2.

Participant FJ failed to respond on the first categorisation by selection test. On the second categorisation by selection test, however, she reached criterion responding with the "What's this?" instruction. Subsequently, given this experience, she passed the repeat of the first categorisation by selection test (i.e., to the "Look at this" instruction) that she had initially failed. Thus, it appears, her failure on the initial test was due to her not understanding the experimental situation, because the prompt to overtly name the target stimulus enabled her to pass the test.

Participant BB failed all three of the categorisation by selection tests even when the instruction included the prefix "What's this?" With BB the prompt to name overtly did not result in her passing the selection test. On the repeat of the first categorisation test she again did not show any correct responses and thus she showed a clear disparity between the performances on the two types of categorisation test.

Participant RH's performance on the two generalisation tests (Phase 9 & 10) and his second exposure to the Categorisation by Selection Test (Phase 11, see Figure 5.4) provides further evidence suggesting that the categorisation by selection is more difficult than categorisation by generalisation. After receiving common speaker training, RH showed generalisation on both Test 1 and Test 2. However, although RH attained criterion performance on both the zog and the vek stimuli on the categorisation by selection test, his performance was less convincing than on the tests of generalisation, particularly for the vek stimuli. Similarly, BB failed all the trials of the categorisation by selection test. This was the case even when the instruction was prefixed by "What's this?" in order to evoke her overt vocalisation of the class names. Further, this was despite her passing a similar test with the familiar stimuli, and showing categorisation by generalisation on both Test 1 and Test 2. These results raise the question of why participants should pass the categorisation by generalisation test but not the categorisation by selection test?

One possible answer is that, during the categorisation by selection test the child has to respond to a complex instruction, that, although part of the pre-training phase with the familiar stimuli, was not part of the training phases with arbitrary stimuli. Conversely, the instruction used in the categorisation by generalisation test was an integral (and reinforced) part of the training procedure. This is because, during the Phase 4 training of the novel behaviour, the children were trained to respond to the instruction, "Can you show me how this goes?" This was the same instruction that was used in the test situation, the only difference being that the stimuli used in the test sessions were untrained in that particular context. Therefore the categorisation by generalisation test was more similar to the training (Phase 4) than was the categorisation by selection test. This is one reason why the categorisation by generalisation may be regarded as a more sensitive test for categorisation (Dougher & Markham, 1996). This may have implications for Randle's (1999) findings. In Randle (1999) studies seven of nine children taught only listener behaviour failed a categorisation by selection test. Thus, given the data found in the present research, it may be argued that the children failed the test because it was particularly difficult — not because they hadn't named the stimuli. It may be the case, that if the children had been given the categorisation by generalisation test, they may have demonstrated categorisation. However, this seems unlikely given the data from RH and CM from Study 4. Both these children failed to show naming after only common listener training and they also failed to show both categorisation by generalisation and categorisation by selection. It thus seems plausible that the children in the Randle study failed to categorise because they did not name the stimuli.

These results that show categorisation by selection in the pre-training phase but not in the experimental phase raise questions regarding the validity of the pre-training phase. Although the pre-training phase gave the participants broad experience of the experimental phases, there was an important difference between the two phases: the pre-training phases used stimuli that were *formally related* (i.e., three hats and three cups), conversely, the training and testing phases used stimuli that were *formally unrelated* — thus additional stimulus similarity cues were available in the pre-training phase. In other words, the stimuli used in the pre-training phase were of the basic category type similar to those used in the developmental studies into early categorisation discussed in Chapter 2 (e.g., Gopnik & Meltzoff, 1992). This may explain why the training received in the pre-training phase may not have fully generalised to the context of the testing phases with the arbitrary stimuli. This could account for why, for example, FJ responded correctly to the categorisation by selection test with the hats and cups, but not with the arbitrary stimuli, until, that is, she was prompted for the overt name response prior to making her selection: the overt naming response would have provided her with the listener stimulus to select the stimuli in that class.

Independence of listener and speaker relations. The Horne and Lowe (1996) account maintains that when teaching speaker behaviour, or what Skinner (1957) termed a tact, what is often taught is full naming. If this is correct, on Generalisation Test 2 one would have expected the children to have responded correctly to the Pair 1 stimuli as a listener. This is because they had been trained directly to produce the behaviour with the Pair 1 stimuli during Phase 4 training of the novel behaviour (i.e., to respond as a speaker). Therefore, apropos the Pair 1 stimuli, Generalisation Test 2 was a test for the presence or absence of appropriate listener responding following speaker training: it was not a test of generalisation per se. As can be seen from Figure 5.4, both CM and RH scored 100 percent correct responses for the Pair 1 stimuli during Generalisation Test 2, but they did not show generalisation to the untrained Pair 2 and Pair 3 stimuli.

These results suggests that even when participants have shown reliable listener responding, they do not generalise this responding to other stimuli (or events) if these stimuli (or events) are not part of an existing verbal repertoire. (This of course is referring to objects and events that are formally unrelated, or have no direct training history that would allow such generalisation.)

This inability to generalise has implications for applied behaviour analysis. Children with whom it is difficult to engineer generalisations outside of directly trained contexts — children who display autistic behaviours, for instance — may benefit from language training that involves first establishing listener, then echoic, and finally object (or event) related speaker behaviour. The evidence suggests that children who name a class of objects or events show generalisation of trained behaviours within that class, and that children who do not name objects or events do not show such generalisation.

The training of the comprehension of the novel behaviour provides evidence that when a child is behaving as both a speaker and a listener, even if the child is taught a novel behaviour only as a listener, this listener responding will generalise to untrained stimuli. Conversely, if the child is trained only as a listener to the experimental stimuli, as was the case with CM and RH, even if he or she is trained to produce the novel behaviour (and it is assumed that therefore they can respond as a listener to that novel behaviour) the novel behaviour does not generalise to other listener class stimuli. Thus the evidence suggests that the child has to be taught to behave as both a listener and a speaker to *each stimulus within a class*. From the naming perspective, this does not imply explicit training in both listener and speaker relations for every exemplar of a class of objects or events (although this may be the case very early in the development of language). There are two processes that account for how this may occur in natural settings.

First, many objects and events are formally related, that is, they share some stimulus similarity that allows novel objects and events to enter into an existing class and to "acquire" a training history that goes with that class; this refers to what is termed the shape bias in developmental psycholinguistics (see Chapter 2). Second, as regards formally unrelated objects and events, because of the higher order nature of the name relation, experience of either listener or speaker relations may be sufficient for novel objects and events to enter into an existing name relation, and to acquire the past history of responding that comes with that name relation. This latter point describes verbal generativity.

* * *

All the procedures in this thesis were matched using either common listener training or common speaker training methods. In the light of this, children under the age of 2.5 years were selected to participate in Study 5 using a common speaker training procedure.

Issues of correspondence between common listener and common speaker procedures apart, there was an empirical justification for Study 5. Evidence from Study 4 showed, that at least for some children of this age group, training common listener responding does not always entail appropriate speaker behaviour — that is, naming. During Study 2, four children had shown appropriate listener behaviour after only being trained a common speaker relation. However, as with the results from Study 1a, this may have been due to their age: higher order naming may be expected to be better established within this age group (i.e., 2.5 – 4 years). Thus the empirical question remained of whether training common speaker responding, by its nature, trains appropriate listener responding, and hence naming, within a younger population. This was the second reason for Study 5.

Study 5: Categorisation Following Common Speaker Training in Children under 2.5 years

Both Skinner (1957) and Horne and Lowe (1996) maintain that, early in the development of verbal behaviour, listener and speaker functions are independent. Similarly, a huge body of psycholinguistic research has shown that comprehension (listener behaviour) and production (speaker behaviour) develop independently in early language development and that, in normal language learning, the former precedes the latter in the developmental timeline (see Vihman, 1996). Thus, in searching for falsification of the naming account, an indirect goal of the current research is to test the assumption of the independence of listener and speaker behaviour, and how this relates to naming (and therefore categorisation behaviour).

The findings from Study 2 show that four children taught only a common speaker relation to a set of arbitrary objects went on to show appropriate listener behaviour; that subsequently they went on to show a generalisation of a novel behaviour trained to a subset of the stimuli to other untrained stimuli; and that, by demonstrating generalisation, they had shown categorisation of the arbitrary stimuli. However, the children in Study 2 were relatively verbally sophisticated. Thus, in an attempt to demonstrate categorisation after training only speaker behaviour and in the absence of appropriate listener behaviour, children younger that 2.5 years were selected to participate in Study 5.

METHOD

Participants

Three participants, LN, JJ, and AF, took part in Study 5. Their ages ranged from 19 to 27 months at the start of the procedure (see Table 5.4).

Table 5.4. Participants' sex, age at start of procedure and age at first test..

Participant	Sex	Age at start month; days	Age at 1st Test month; days
LN	M	25;24	28;28
JJ	M	19;13	22;04
AF	F	22;11	27;24

F = Female; M = Male

Apparatus and Setting

These were identical to those of Study 1a (Chapter 4).

Stimuli

These were identical to those of Study 1a.

Procedure

All phases of the study are represented in Figure 5.5.

Phases 1 to 6

The procedure for Phases 1 through 6 was identical to that of Study 2.

Participants AF and LN left the nursery before finishing the procedure; they participated only as far as Generalisation Test 1 (Phase 5).

Phase 7: Categorisation by Selection Test with all 6 Experimental Stimuli

This was identical to that of Phase 7 of Study 4. Of the four participants in Study 5, only JJ participated in Phase 7.

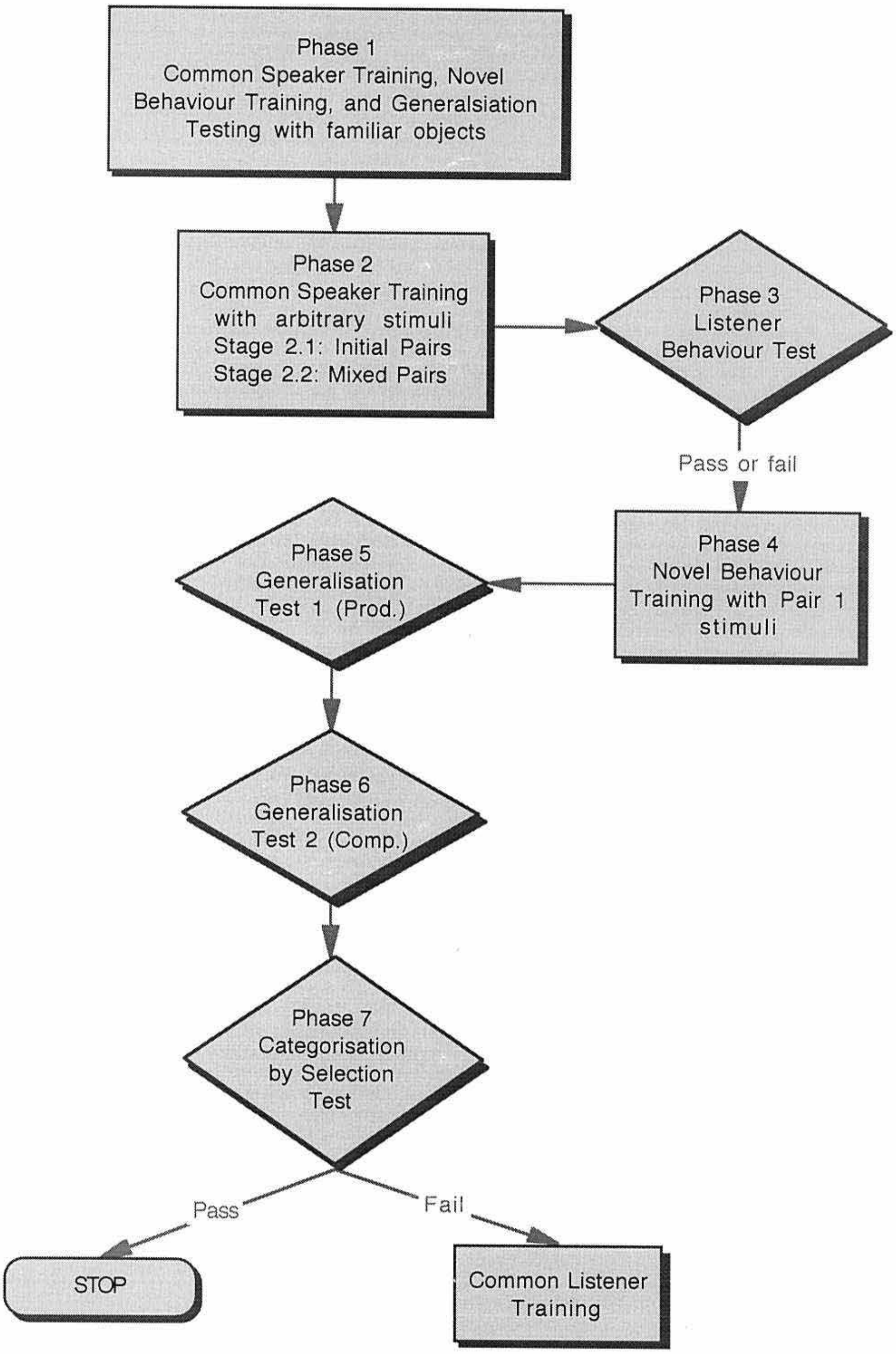


Figure 5.5: Flowchart representation of the procedure of Experiment 5.

RESULTS

Participants LN and AF completed Phase 1 through to Phase 5. JJ completed all phases of the Study (i.e., Phases 1 though 7).

Phase 1: Common Speaker Training, "In-repertoire" Behaviour Training, and Testing with Familiar Objects

Table 5.5 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common speaker training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 3.5 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

During Stage 1.1, all participants reached criterion performance in four blocks or less of training for each of the three stimulus pairs. All three children learned the "in-repertoire" behaviour to criterion performance within two blocks, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 5.5

Results of Phase 1: Common Speaker Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, & H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common Speaker training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
LN	1	1	1	1	1	1
JJ	4	2	2	2	1	1
AF	4	1	1	1	1	1

The results for Phase 2 through to Phase 5 for LN and AF, and for Phase 2 through to Phase 7 for JJ are represented in Figure 5.6

Phase 2: Common Speaker Training with Arbitrary Objects

The data presented for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 2.1: Common speaker training with arbitrary objects: Initial pairs. Participant LN required 10 blocks of training for the Initial Pairs 1, 7 for Initial Pair 2 and 3 for the Initial Pair 3. JJ required eight blocks of training for the Initial Pair 1, two for the Initial Pair 2, and seven for the Initial Pair 3. Participant AF required 15 blocks of training for Initial Pair 1, 4 for Initial Pair 2, and 2 for Initial Pair 3.

Stage 2.2: Common speaker training: Mixed pairs. Participant LN did not complete the mixed pairs training due to time constraints. Participant JJ required two blocks of training for Pair 1 and Pair 3 and five blocks for Pair 2. Participant AF required three blocks for Pair 1, five for Pair 2, and three for Pair 3.

Stage 2.3: Reduction to zero reinforcement. Participant LN did not participate in Stage 2.3 training due to time constraints. Both JJ and AF maintained criterion performance across one block of trials for each stimulus pair under a zero reinforcement schedule.

Figure 5.6

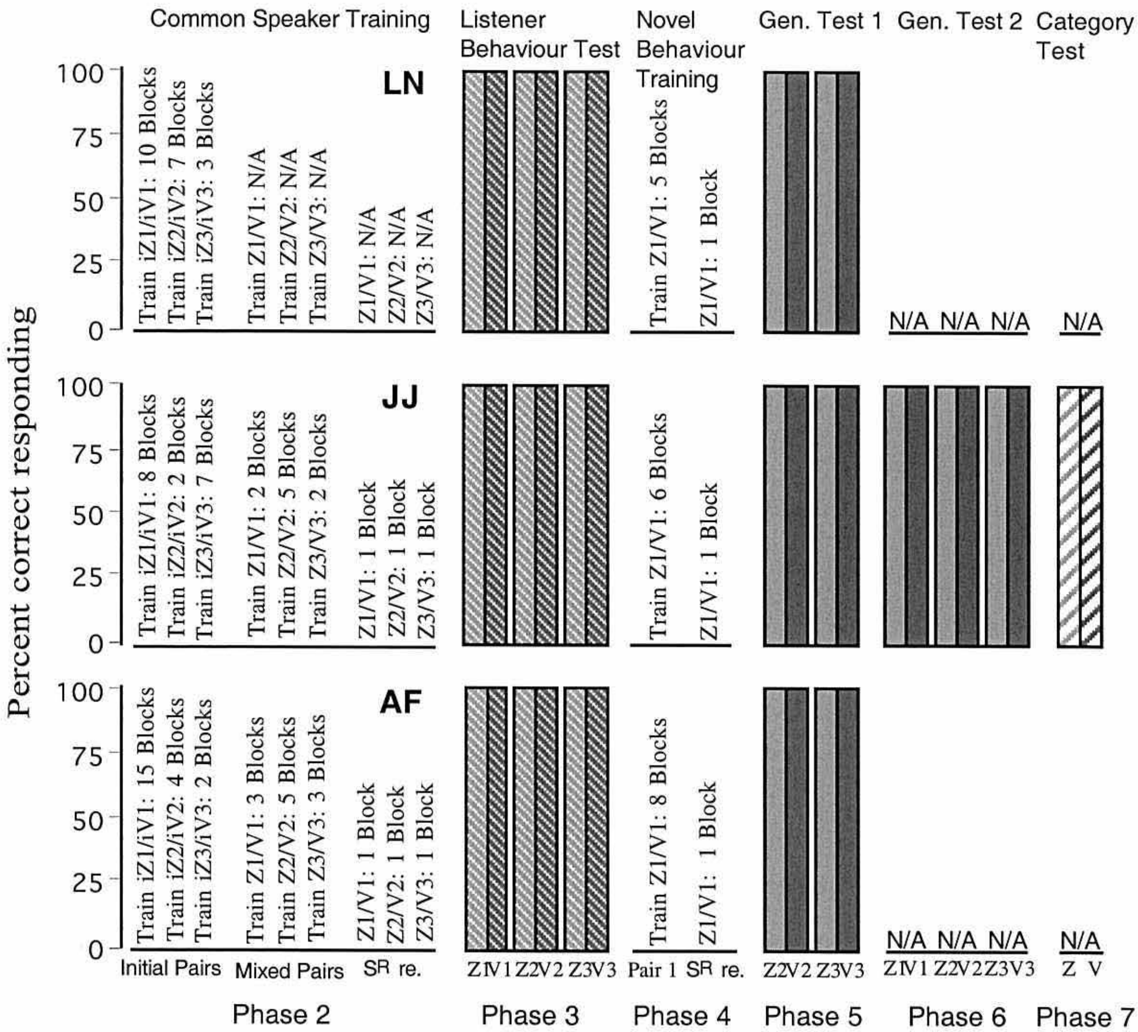


Figure 5.6. Performance of participants LN and AF on Phases 2 through Phase 5, and participant JJ on Phase 2 through Phase 7. Phase 2: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (SR re.) stages. Phase 3: Listener Behaviour Test, the percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (SR re.) stages. Phase 5: Generalisation Test 1, percent correct responses, out of 32 trials, 8 for each stimulus (N.B. 16 trials only were conducted with AF, 4 with each stimulus). Phase 6: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 7: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the zog stimuli and 9 for the vek stimuli.

The mean number of blocks required for the three participants to meet the criteria for all three stages of Phase 2 was 27 (range 18 - 35). Participant LN required a total of 18 training blocks, JJ 29 blocks, and AF 35 blocks.

Phase 3: Listener Behaviour Test.

Performance on the listener behaviour test (Phase 3) of each participant is shown in Figure 5.6 which presents percent correct responses over the 24 test trials, 4 trials for each of the individual stimuli. Criterion performance for listener responding was set at 75 percent, or three correct responses out of four for each stimulus, for both the zog and the vek stimuli.

All three participants made no errors on any of the 24 test trials; thus by Horne and Lowe's (1996) definition, naming had been established.

Phase 4: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figure 5.6 shows the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 4.1: Novel behaviour training. All three participants reached criterion on the novel behaviour training in eight blocks of training or less.

Stage 4.2: Reduction to zero reinforcement. All three participants achieved criterion responding in the absence of reinforcement for the novel behaviour training in one block of trials.

Phase 5: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figure 5.6 shows the percent correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted eight times for LN and JJ. The criterion level for Generalisation Test 1 was set at 75 percent for each of the stimuli in a test pair. Due to unforeseen circumstances, AF had to be withdrawn from the research at this point having completed only 16 test trials, 8 trials with the Pair 2 stimuli and 8 trials with the Pair 3 stimuli. Thus Figure 5.6 shows the percent correct responses over the 16 test trials for AF.

All three participants made no errors throughout the Generalisation Test 1; therefore all three showed generalisation.

Phase 6: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figure 5.6 shows the percent of correct responses over the 24 test trials, four trials for each of the six test stimuli for participant JJ only.

He made no errors on Generalisation Test 2

Phase 7: Categorisation by Selection Test.

Only JJ was exposed to the categorisation by selection test. Figure 5.6 shows the percent correct responses for JJ over the 18 test trials in Phase 7, 9 for the zog stimuli and 9 for the vek stimuli. Criterion level for success on the test was set at 33 percent correct responses (three out of nine) for the zog stimuli and for the vek stimuli.

Again, JJ made no errors on any of the trials.

Spontaneous verbal behaviour

During the common speaker training, none of the participants made any idiosyncratic verbalisations. During the Generalisation Test 2, LN said, "vek" once in the presence of the Pair 2 stimuli.

Participant AJ named the zog stimuli six times during the novel behaviour training phase.

During the novel behaviour training for the Pair 1 stimuli, JJ said "zog" 11 times and "vek" 11 times. During the Generalisation Test 2, he named the target stimuli on 20 out of the 24 trials. On Generalisation Test 3, he named both the classes of stimuli "zog" and "vek" while categorising them.

DISCUSSION

The primary goal of Study 5 was to test for categorisation after training only common speaker relations in the absence of appropriate listener responding; it also provided a matched procedure for Study 4 which trained common listener relations. Additionally, Study 5 tested a theoretical issue that arises from the naming account, one which has been supported by the Harris et al. (2000) research and also by the results from Study 2; that is, when normally developing young children are taught what was defined by Skinner (1957) as a tact response, they are in fact being taught a bidirectional relation incorporating both speaker and listener functions.

The findings from Study 5 demonstrate that, after receiving only common speaker training, all three children showed appropriate listener behaviour, and, subsequently, all three showed evidence of generalisation. Participant JJ also showed categorisation on the categorisation by selection test. Thus, consistent with the predictions of the naming account, all children trained the tact relation were trained naming.

Due to time constraints LN did not complete the entire training procedure outlined in Phase 2; although he reached criterion performance on the initial pairs stimuli, he did not participate in either the mixed pairs or the reduction in reinforcement stages of the study. The mixed pairs stage was incorporated into the procedure to ensure that control over the participants' responding was exerted by the individual stimuli — not by both stimuli in a particular pair configuration. Conceivably, for example, a child could respond to one of the stimuli within a pair by exclusion. That is, the conditional discrimination learning may be controlled by the correct (S+) or the incorrect (S-) choice (McIlvane, Kledaras, Munson, King, de Rose, & Stoddard, 1987; Stromer & Osborne, 1982). The mixed pairs stage reduced the possibility that this was the case. (The issue of exclusion is discussed in more detail in the concluding chapter of this thesis).

Similarly, the reduction in reinforcement stage of Phase 2 was incorporated in order to prepare the child for responding under a zero percent reinforcement schedule during the test sessions. Concerning the issue of non-responding, attempts were made to rule out competing explanations of non-responding under test conditions; the reduction in reinforcement stage was one such attempt. However, LN responded to all the test trials; therefore the fact that he did not complete the reduction in reinforcement stage did not result in him not responding.

Participant AF also failed to complete the entire procedure. AF was involved in a car crash at the time of the test sessions, and, although not physically hurt, she was distressed by the accident; she thus managed to complete only half of the scheduled trials for Generalisation Test 1. This fact does not compromise her results because she made no errors on the 16 test trials, 4 trials with each of the test stimuli: she thus showed evidence of generalising the novel behaviour to the untrained stimuli.

GENERAL DISCUSSION

The results from Study 4 provide evidence on two key issues. First, they support the results from the studies reported in Chapter 4 showing that children who name formally unrelated objects also categorise them. These findings are consistent with those of Harris et al. (2000) who showed that children taught a common speaker relations (i.e., a name) generally demonstrate categorisation of those named objects. Second, the results of two participants, CM and RH, provide tentative support for the hypothesis (Horne & Lowe, 1996) that naming is necessary for categorisation: when neither of these participants had a common name for the stimuli they failed the categorisation tests, but when they were taught to name, they passed them. Thus the data from these two participants shows that, when responding only as a listener, and thus responding *in the absence of naming,* they did not show categorisation of formally unrelated stimuli; but, when given further training to name (i.e., speaker training), these two participants subsequently showed categorisation.

Further, and one of the most important points of Study 5, these data showed categorisation of formally unrelated stimuli in one child aged 22 months (JJ); this is one of the youngest children to demonstrate categorisation of formally related stimuli reported in the literature to date. Moreover, JJ not only demonstrated categorisation by generalisation but also categorisation by selection.

* * *

There was also a procedural difference between the present research and that of the Randle (1999) research that may have a bearing on the issue of training listener relations in the absence of speaker relations. As mentioned in Chapter 3 (see *Putting the naming account to the test*), the tact test in Randle's research was incorporated after the categorisation test; in the studies reported in this chapter the tact test was before the tests for categorisation. The rationale behind conducting the tact test before the categorisation test was that without such a test there could be no direct evidence of whether the participants were naming prior to the categorisation tests; the participants, for example, might have been covertly naming during common listener training. Without a tact test, in the absence of overt responding by the participant, such functional behaviour would remain undetected. Nonetheless, it could be that the tact test in the studies reported thus far, along with the listener behaviour training, provided the context for naming the stimuli. Recall that the tact test occurred directly after the child reached criterion responding on the common listener training.

Because a key aim of these studies was to test for categorisation in the absence of naming behaviour, Study 6 (Chapter 6) replicated Study 1a except that the tact test was conducted *after* the test for categorisation. Additionally, as with Study 4, some of the participants in Study 6 were tested using the categorisation by selection method after completing Generalisation Test 1 and 2.

CHAPTER 6

Study 6: Testing for Categorisation Prior to the Tact Test (Common Listener Training)

The findings reported in the previous two chapters support some of the predictions of the naming account set out by Horne and Lowe (1996). They also raise an important issue.

The procedure employed in Studies 1a and 4, though it trained only listener relations, established naming in 9 of the 11 children. However, when Randle (1999) used a similar procedure only two of nine of their participants passed the naming tests. This raises the question of why the present procedure gave rise to a greater incidence of naming. This difference could be explained by a cohort effect but it is difficult to assess whether this was the case with any confidence. Alternatively, as mentioned, the timing of the tact test could have influenced the incidence of naming: in the Randle study the tact tests occurred *after* the categorisation tests; in Studies 1a and 4 they occurred *before* them. To test whether this was a significant procedural difference, in Study 6 the tact test was incorporated after the categorisation tests, as in Randle (1999).

METHOD

Participants

Five participants, FLJ, MW, AJ, and CD took part in Study 6. Their ages ranged from 31 to 46 months at the start of the procedure (see Table 6.1).

Table 6.1. Participants' sex, age at start of procedure, age at first test and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days	Griffiths GQ score
FLJ	F	46; 02	47; 21	108
MW	F	31; 29	34; 22	-
AJ	M	32; 08	35; 26	109
CD	M	41; 24	43; 00	-

F = Female; M = Male; (-) = Data not available

Apparatus and Setting

These were identical to those of Study 1a (Chapter 4).

Stimuli

These were identical to those of Study 1a.

Procedure

All phases of the study are represented in Figures 6.1 and 6.2. The procedure for Study 6 was identical to that of the common listener training employed in Study 1a, except in that the tact test was incorporated after the generalisation and categorisation tests, not *before* the test phases as with Studies 1a and 4. As with Study 4, a categorisation by selection test was introduced after Generalisation Test 1 and 2. For sake of clarity, the phases of Study 6 are described below.

Phase 1: Common Listener Training, "In-repertoire" Behaviour Training, and Testing with Familiar Objects

This was identical to that of Phase 1 of Study 1a.

Phase 2: Common Listener Training with Arbitrary Objects

This was identical to that of Phase 2 of Study 1a.

Phase 3: Training a Novel Behaviour to a Subset of the Stimuli

This was identical to that of Phase 4 of Study 1a.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

This was identical to that of Phase 5 of Study 1a.

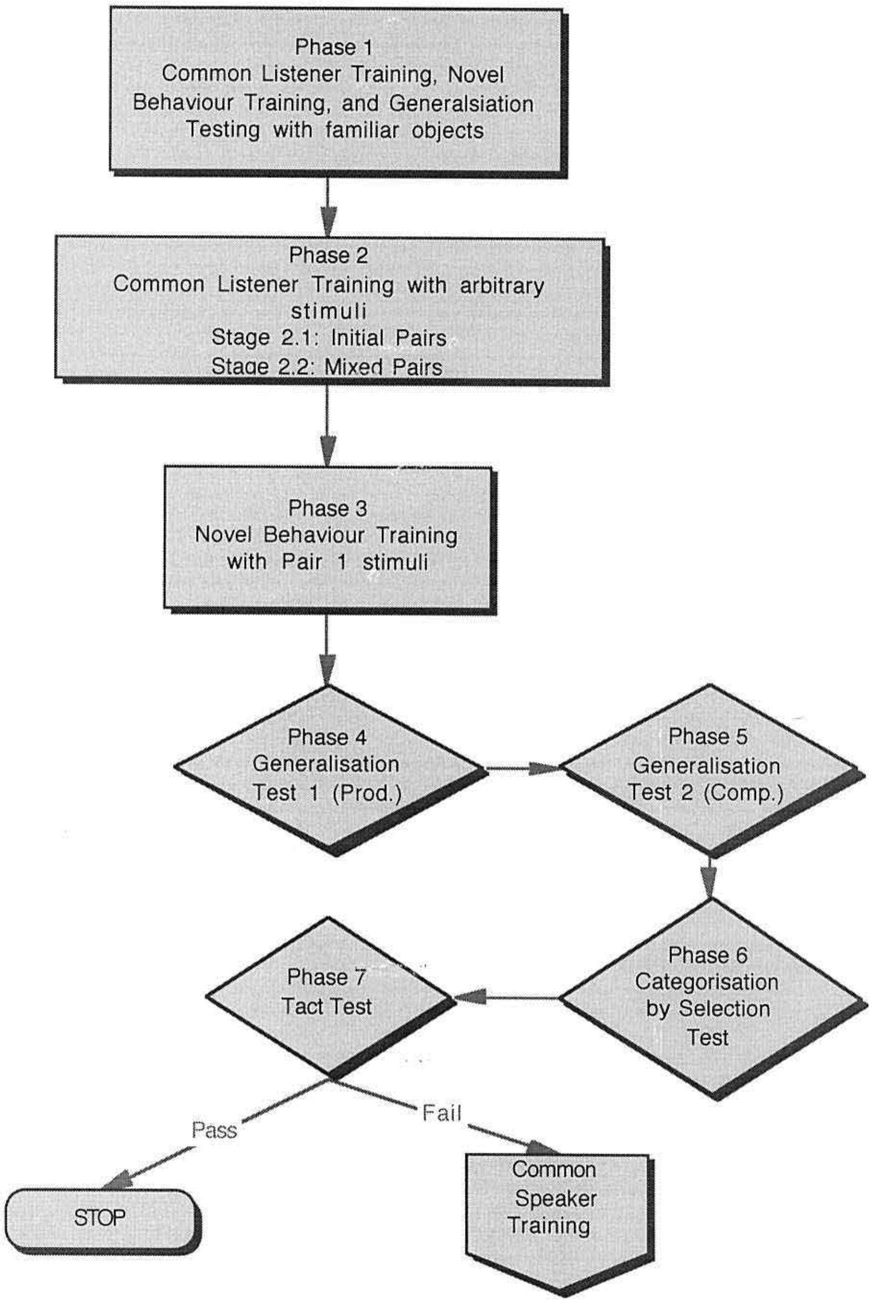


Figure 6.1: Flowchart representing Phases 1 through 7 of Experiment 6

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

This was identical to that of Phase 6 of Study 1a.

Phase 6: Categorisation by Selection Test Procedure with all 6 Experimental Stimuli

For FLJ, AJ, and MW this was identical to that of Phase 7a of Study 4. Participant CD underwent three category by selection tests. These were:

Categorisation by Selection Test 1: This test was identical to that of Phase 7a of Study 4.

Categorisation by Selection Test 2: This test was identical to that of Phase 7a of Study 4 except that the instruction, "What is this? Can you give me the others?" was used.

Categorisation by Selection Test 1 (repeat): As with Test 1, this test was identical to that of Phase 7a of Study 4.

Phase 7: Tact Test

This was identical to that of Phase 3 of Study 1a.

Continuation in the procedure after Phase 7 depended on the outcome of the generalisation and categorisation tests (Phase 4, Phase 5, & Phase 6). Two participants, FLJ and CD, showed evidence of generalisation and categorisation in the three test phases and both finished participating after Phase 7a. Participants MW and AJ failed not only the generalisation and categorisation tests but also the tact test. One of these, AJ, was unable to participate further in the research. The remaining child, MW, went on to participate in *Phase 8: Common Speaker Training*. Figure 6.2 shows the procedure for Phase 8 through Phase 11 of Study 6 for MW.

Common speaker training was similar to the common speaker training as described in Study 2; any differences are noted below for the separate phases.

There was no training with the familiar objects during the common speaker training because MW had previously demonstrated appropriate responding during Phase 1 of this study. Therefore training began with the arbitrary objects.

Phase 8: Common Speaker Training with Arbitrary Objects

The training in this phase was similar to that of Phase 2 of Study 2. The only difference was that the stimuli remained in their designated pair arrangement; therefore there was no initial pairs training stage.

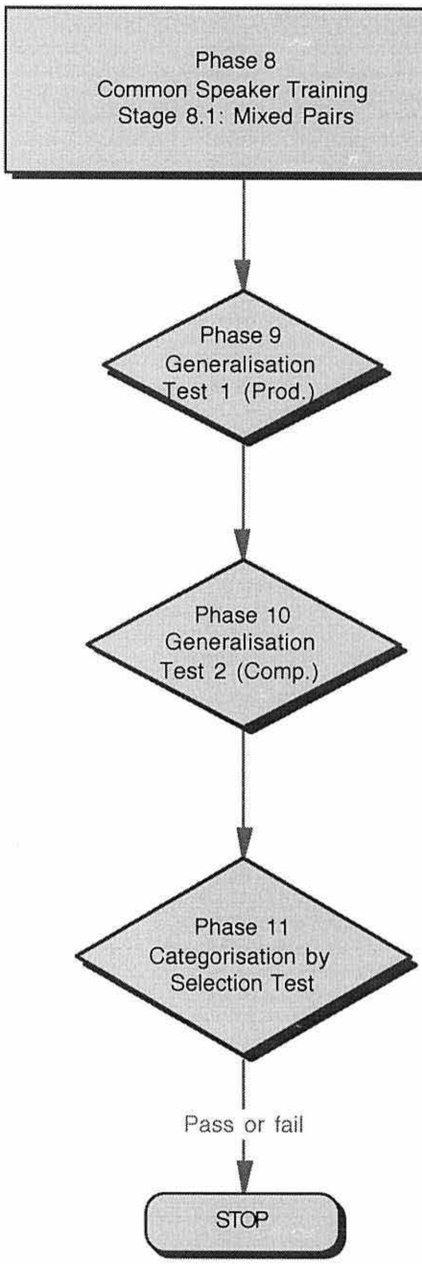


Figure 6.2: Flowchart representing Phases 8 through 11 of Experiment 6

Phase 9: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

This phase was identical to that of Phase 5: Generalisation Test 1 of Study 2.

Phase 10: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

This phase was identical to that of Phase 6: Generalisation Test 2 of Study 2.

Phase 11: Categorisation by Selection Test with all 6 Stimuli

This phase was identical to that of Phase 6: Categorisation by Selection Test below. MW's participation in the research finished after this phase.

RESULTS

Participants FLJ, AJ, and CD completed Phase 1 through 7a. Participant MW completed Phase 1 through 11.

Phase 1: Common Listener Training, "In-repertoire" Behaviour Training and Testing with Familiar Objects

Table 6.2 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common listener training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 6.2 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli on *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs*.

During Stage 1.1, all participants reached criterion performance in either one or two blocks of training for each of the three stimulus pairs. All four children learned the "in-repertoire" behaviour to criterion performance within two blocks or less, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 6.2

Results of Phase 1: Common Listener Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, & H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common listener training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
FLJ	1	1	1	1	1	1
MW	1	1	1	1	1	1
AJ	1	1	1	2	1	1
CD	2	2	2	1	1	1

Phase 2: Common Listener Training with Arbitrary Objects

The results for Phase 2 through Phase 7 are represented in Figures 6.3 and 6.4 The data presented for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Figure 6.3

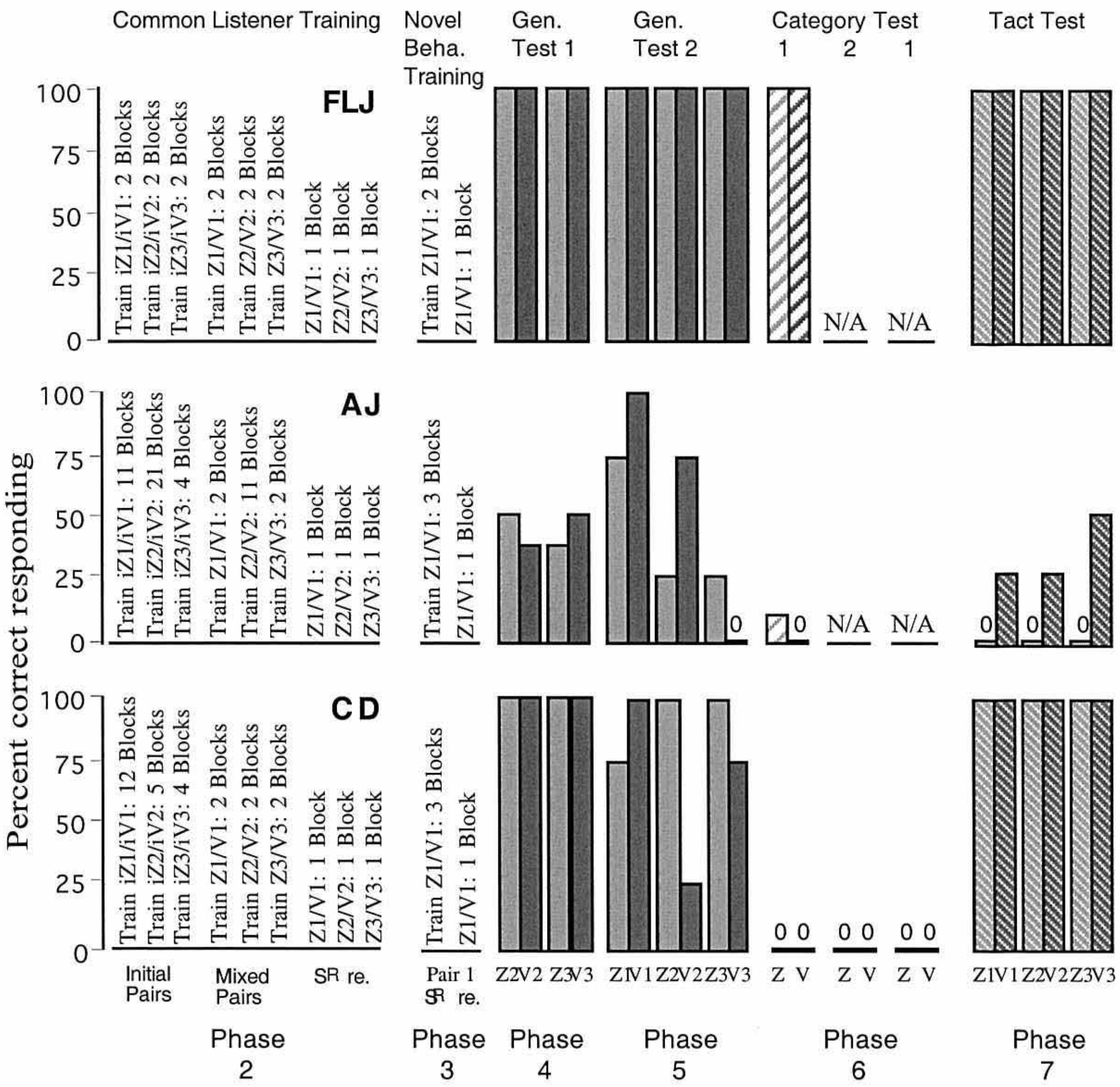


Figure 6.3. Performance of participants FLJ, AJ, and CD on Phases 2 through 7. Phase 2: Common Listener Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 3: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 4: Generalisation Test 1, percent correct responses, out of eight trials, for each of the four test stimuli. Phase 5: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 6: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 for the zog stimuli and 9 for the vek stimuli. (For Participant CD Phase 6 consisted of three tests: Category Test 1 using the "Look at this" instruction; Test 2 using the "What's this?" instruction; and Test 1 (repeat) the "Look at this" instruction). Phase 7: Tact Test, percent correct responses, out of 24 trials, 4 for each stimulus.

Figure 6.4

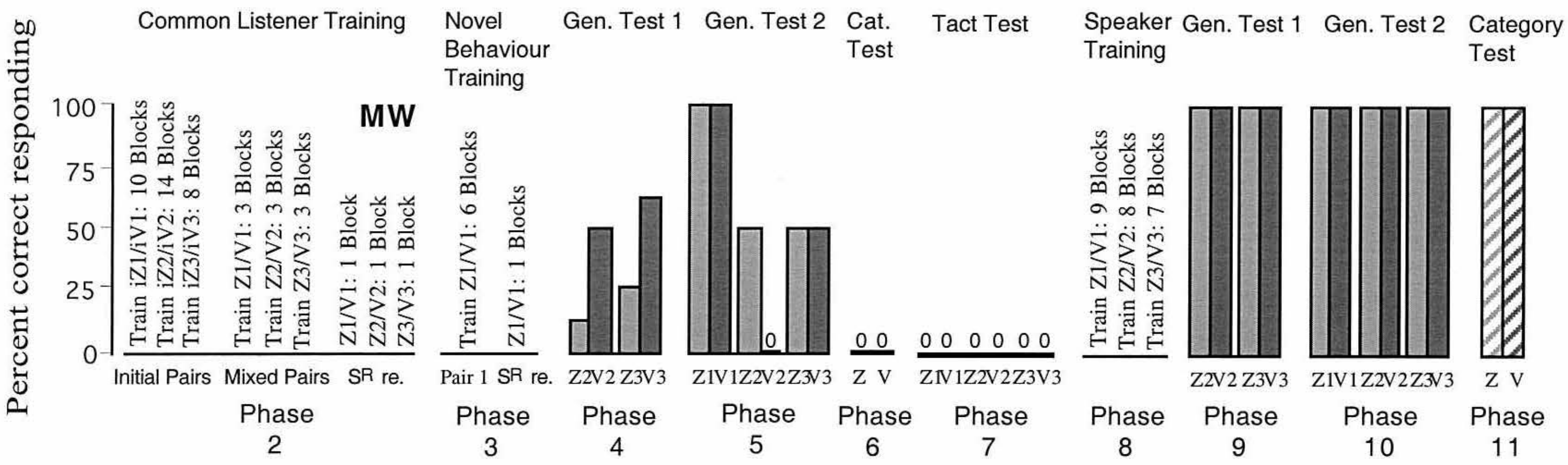


Figure 6.4. Performance of Participant MW on Phases 2 through 11: Phases 2 through 7 were as described in the caption of Figure 6.3; Phase 8: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs; Phase 9: Generalisation Test 1, as described in Phase 5 above; Phase 10: Generalisation Test 2, as described in Phase 6 above; and, Phase 11: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the zog stimuli and 9 for the vek stimuli.

Stage 2.1: Common listener training with arbitrary objects: Initial pairs. Participant FLJ required two blocks of training trials for each stimulus pair (i.e., iZ1/iV1, iZ2/iV2, and iZ3/iV3): AJ required 11 blocks for Initial Pair 1, 21 blocks for Initial Pair 2, and 4 blocks for Initial Pair 3; and CD required 12 for Initial Pair 1, 5 blocks for Initial Pair 2, and 4 blocks for Initial Pair 3 (see Figure 6.3).

Participant MW required 10 blocks of training to criterion on the Initial Pair 1 stimuli, 14 blocks for the Initial Pair 2, and 8 for the Initial Pair 3 stimuli (see Figure 6.4).

Stage 2.2: Common listener training: Mixed pairs. Participants FLJ and CD required only two blocks to attain criterion performance for all three of the mixed pairs stimuli (i.e., Z1/V1, Z2/V2, and Z3/V3).

MW reached criterion for all three pairs in three blocks; and AJ required 2 blocks for both Pair 1 and Pair 3, and 11 blocks for Pair 2.

Stage 2.3: Reduction to zero reinforcement. The number of blocks required to achieve criterion performance (seven out of eight trials correct) under a zero reinforcement schedule is also shown in Figures 6.3 and 6.4. All the children maintained criterion performance under a zero reinforcement schedule; therefore none required a return to a 50 percent or 100 percent schedule during the reduction to zero reinforcement procedure (see Stage 2.3).

After reaching criterion with each stimulus pair during Stage 2.2, all participants maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

The mean number of blocks required for the four participants to meet the criteria for all three stages of Phase 2 was 35 (range 15 - 51). Participant FLJ required a total of 15 training blocks; AJ required 51 blocks; CD required 30 blocks; MW required 44 blocks.

Phase 3: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figures 6.3 and 6.4 show the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 4, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 3.1: Novel behaviour training. All four participants reached criterion on the novel behaviour training in six blocks of trials or less.

Stage 3.2: Reduction to zero reinforcement. All four participants achieved criterion responding in the absence of reinforcement for the novel behaviour training in two blocks of training trials or less.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figures 6.3 and 6.4 show the percentage of correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted eight times. The criterion level for Generalisation Test 1 was set at 75 percent for each stimulus in a test pair.

Participants FLJ and CD scored 100 percent correct on both test pairs. Therefore both FLJ and CD met the criterion for success on the test. Participant AJ scored 44 percent correct responses for both test pairs; that is, 50 percent for the Z2 and V3 and 37.5 percent for the V2 and Z3 stimuli.

Participant MW scored 31 percent correct with the Pair 2 stimuli and 56 percent correct with the Pair 3 stimuli; that is, 13.5 percent for the Z3, 50 percent for the V2, 25 percent for the Z3, and 67 percent for the V3. Thus both MW and AJ failed to meet the test criterion.

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figures 6.3 and 6.4 show for each child the percent correct responses over the 24 test trials in Phase 6, 4 trials for each of the 6 test stimuli. The criterion level for the Generalisation Test 2 was 75 percent correct responses for each of the stimuli in a test pair.

Participant FLJ made no errors on the test. Participant CD scored 87.5 percent correct responses for both the Pair 1 and the Pair 3 stimuli and 62.5 percent correct for the Pair 2 stimuli. Participant CD thus met the criterion for success on the test for the Pair 1 and 3 stimuli, but not the Pair 2 stimuli.

Participant AJ scored 87.5 percent correct for the Pair 1 stimuli, 50 for the Pair 2 stimuli, and 12.5 for the Pair 3 stimuli. Participant MW scored 100 percent for the Pair 1 stimuli, 25 percent for the Pair 2 stimuli, and 50 percent for the Pair 3 stimuli. Thus neither AJ nor MW showed criterion performance on the Generalisation Test 2 for Pairs 2 and 3, but they did for the Pair 1 stimuli.

Phase 6: Categorisation by Selection Test.

Figures 6.3 and 6.4 show for each child the percent correct trials over the 18 test trials in Phase 7, 9 for the zog and 9 for the vek stimuli. Criterion level for success on the test was set at 33 percent correct responses (or three from nine) for the zog stimuli and for the vek stimuli (see Phase 7 of Study 4).

Participant FLJ made no errors on the test. Participant CD participated in three categorisation by selection tests. These were: (a) *Categorisation by Selection Test 1* (this test used the instruction, "Look at this, can you give me the others?"); (b) *Categorisation by Selection Test 2* (this test used the instruction, "What is this? Can you give me the others?"); and (c) *Categorisation by Selection Test 1 (repeat)* (as with Test 1, this test used the instruction, "Look at this, can you give me the others?"). Participant CD made no correct responses on any of the three categorisation by selection tests (see Figure 6.3).

Participant MW scored no correct trials. Participant AJ scored one correct trial for the Z3 stimulus but failed on the other 17 trials (see Figure 6.4).

Phase 7: Tact Test.

Performance on the tact test of each participant is shown in Figures 6.3 and 6.4, which presents the percent correct responses over the 24 test trials, four trials for each of the individual stimuli. The criterion for successful tacting was set at 75 percent, or three correct responses out of four for each stimulus, for both the zog and the vek stimuli (see Phase 3, Procedure section of Study 1a).

Participants FLJ and CD showed 100 percent correct performance with all the test stimuli. These results show, that in the course of learning listener behaviour, both had learned appropriate speaker behaviour; thus naming had been established.

Participant AJ scored zero percent correct for the zog stimuli and 33 percent correct for the vek stimuli.

Participant MW made no correct responses on any of the tact test trials. Thus neither MW nor AJ achieved criterion performance on the tact test. Participants FLJ, CD, and AJ finished participating in the study after Phase 7. Only MW went on to participate in common speaker training.

Phase 8: Common Speaker Training with Arbitrary Objects

Participant MW reached criterion for all three pairs in nine blocks or less.

Phase 9: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

On the repeat of Generalisation Test 1, MW made no errors.

Phase 10: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension)

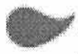
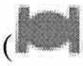
On the repeat of Generalisation Test 2, MW made no errors.

Phase 11: Categorisation by Selection Test with all 6 Stimuli

On the repeat of the Categorisation by Selection test, MW made no errors.

Spontaneous verbal behaviour

Participants FLJ's, MW's, and AJ's verbalisations during common listener training (Phase 2) are reported in Table 6.3. Participant CD did not make any verbalisations during the study.

During the training of the function (Z1/V1) FLJ said, "zoggy, the one that goes like that (participant waves) is like a windmill" ( ). She also said, "That looks like rain doesn't it?" (pointing to the vek stimulus - ). During Generalisation Test 1, she said, "I don't do it right or wrong do I? Once I did the vek and the zog." She also said, "The vek goes like this (participant claps). The big one () goes like this (participant waves)". Participant FLJ's verbalisations suggested that she may have learned the names during the training; this was confirmed by her tact test results.

Participant MW said "zog" on only one occasion and there was no strong evidence from her verbalisations that she had learned to name; this was confirmed by her failure on the tact test.

During the common listener training AJ said "zog" on 33 occasions and "vek" on 11 occasions. His vocalisations during the common listener training suggested that he may have learned the stimulus names. However, he did not reach criterion performance on the tact test. During the Tact test he said, "a little man" (pointing to the zog stimulus - ), "Christmas tree" (pointing to the vek stimulus -), and "goes round" (holding the zog stimulus - ). It is therefore possible that AJ had existing names (at least for three of the stimuli), and that these names had interfered with the experimentally defined names.

Table 6.3: Children's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
FLJ	iZ1/iV1	No prompt	The zog's the one with two pointy bits and the vek is the circle one ( and )
	Z1/V1	Can you give me the zog?	It's the wrong one really...doesn't matter though...the vek used to go with the other zog. The round one went with that one (pointing to the zog stimulus)
	Z2/V2	Can you give me the vek?	It's the wrong vek I think...I think it's the one like that (participant points two fingers together)
MW	iZ2/iV2	Can you give me the zog?	zog
	Z2/V2	Can you give me the vek?	I stick my finger in it (holding the stimulus )
	Z3/V3	Can you give me the vek?	It's like a dog (pointing to the stimulus - )
AW	iZ1/iV1	Can you give me the zog?	zog x 5
	iZ3/iV3	Can you give me the zog?	zog x 6
		Can you give me the vek?	vek x 11; not zog x 2 (pointing to the stimulus)
	Z1/V1	Can you give me the zog?	zog x 3; zog there
		Can you give me the vek?	vek x 6; vek there; this one's vek; that's vek
	Z2/V2	Can you give me the zog?	zog x 19; your watch (pointing to the stimulus)

DISCUSSION

The aim of Study 6 was to test for categorisation of formally unrelated stimuli after teaching only common listener behaviour in the absence of appropriate speaker behaviour. The key feature of the design of Study 6 was the position of the tact test after the tests for categorisation.

Evidence of categorisation behaviour in the absence of naming or other verbal behaviours would falsify the naming account. Study 6 showed that two participants, FLJ and CD, demonstrated generalisation of a novel behaviour to untrained stimuli, and that one, FLJ, also showed categorisation by selection. Participants FLJ and CD subsequently demonstrated both listener (trained) and speaker (untrained) behaviours on the tact test; that is, they demonstrated naming. The two other participants, MW and AJ, did not show a generalisation of the novel behaviour, or categorisation on the selection test; and, importantly, neither on the tact test did they show evidence of naming. After failing these tests, MW received common speaker training (i.e., training to name); she subsequently demonstrated generalisation and categorisation on the three tests. These results support the hypothesis that naming in necessary for the categorisation of formally unrelated stimuli.

Two lines of evidence surfaced from the data from Study 5. First, neither MW nor AJ categorised, and this did not occur for MW until she was trained to name the stimuli. These results are consistent with both the findings of Randle (1999) which showed children failed to show categorisation after being taught only listener relations, and the data from CM and RH in Study 4. Second, both children who showed categorisation also showed naming. Again, this provides support for the naming account and is consistent with the studies conducted by Harris et al. (2000) and Randle (1999).

The salient finding of Study 6 is the fact that half the participants failed to learn naming from only receiving common listener training. This suggests that, at least for some children, the tact test occurring after testing for categorisation (as with the Randle studies) may be less likely to give rise to naming. However, the small number of children used in this study prevents firm conclusions form being made; there is a need for further studies to clarify this issue.

The children who failed to show appropriate speaker behaviour following common listener training in Study 6 were older than those in Study 4. This may suggest that the position of the tact test may be important in the incidence of naming behaviour despite the fact that the small number prevents strong conclusions. None of the children of the similar age to MW and AJ failed to show appropriate speaker behaviour in the other studies in which the tact test did appear after the common listener training.

Interestingly, both MW and AJ passed with the Pair 1 stimuli on the Generalisation Test 2 but failed the test with the Pair 2 and Pair 3 stimuli; this was also demonstrated by both CM and RH in Study 4. As discussed in Chapter 5, such a performance is predicted in the Horne and Lowe (1996) account of naming because both children had been trained to *produce* the novel behaviour during the Phase 3 training. According to Horne and Lowe's account, speaker training may also entail appropriate listener responding; Generalisation Test 2 was a listener behaviour test. This suggests that, although they had shown appropriate responding on the test (i.e., to the Pair 1 stimuli), MW and AJ did not generalise this responding to the test stimuli — the stimuli were not part of a class.

There was evidence from AJ's verbalisations during the tact test that he had alternative names for at least some of the stimuli. Further, these names were not common names; rather they were in line with a "shape bias" and thus controlled by the individual objects. That is, AJ had spontaneously named some of the stimuli using names from his existing verbal repertoire and these names may have interfered with him learning the experimentally defined names, and hence, prevented him categorising those stimuli.

Participant CD also demonstrated a similar pattern of responding to BB from Study 4. That is, he passed both tests of generalisation but failed to show evidence of categorisation on the categorisation by selection test. Further, this was despite receiving the repeat of the selection test using the prefix "What's this?" This supports the contention that the categorisation by generalisation test may be a more sensitive test of categorisation.

* * *

Study 7 was designed to match Study 6 except that participants were given common speaker training.

Study 7: Testing for Categorisation Prior to the Listener Behaviour Test Following Common Speaker Training

Study 6 suggested that, at least for some children aged between 2 and 4 years, the timing of the tact test within a common listener training procedure may affect whether they name stimuli, and whether they categorise those stimuli. Both the children who failed to categorise did not show naming. These findings are in accord with those of Randle (1999) study and those of RH and CM of Study 4. Both of these studies demonstrated listener behaviour in the absence of appropriate speaker behaviour, and in the absence of categorisation behaviour.

In Studies 2 and 5 children taught common speaker relations showed appropriate listener behaviour; all subsequently showed categorisation behaviour. It has been hypothesised that teaching common speaker relations may, in many circumstances, also teach appropriate listener responding (Horne & Lowe, 1996). The results from Studies 2 and 5 are in agreement with this hypothesis. However, in these studies, the listener behaviour tests were incorporated *before* the tests for generalisation. Conceivably, as with the common listener training, the timing of the listener behaviour test may have provided the context for full naming. This was investigated in Study 7 in which the listener behaviour test was incorporated into the procedure *after* the tests for categorisation.

METHOD

Participants

Three participants, RC, EW, and CS took part in Study 7. Their ages ranged from 30 to 43 months at the start of the procedure (see Table 6.4).

Table 6.4. Participants' sex, age at start of procedure, age at first test and Griffiths test scores.

Participant	Sex	Age at start month; days	Age at 1st Test month; days	Griffiths GQ score
RC	F	30; 13	31; 00	112
EW	F	43; 10	43; 25	129
CS	F	36; 10	36; 23	109

F = Female

Apparatus and Setting

These were identical to those of Study 1a (Chapter 4).

Stimuli

These were identical to those of Study 1a.

Procedure

All phases of the study are represented in Figure 6.5. The procedure for Study 7 was similar to that of the common speaker training employed in Study 2, except that the listener behaviour test was incorporated after the generalisation and categorisation tests; with Study 2 and Study 4 the listener behaviour tests were before the test phases. In all other respects the procedure for Study 7 was identical to that described in Study 2; also, as in Study 5, a categorisation by selection test was introduced after Generalisation Test 1 and 2. For clarity, the phases of Study 7 are described briefly below.

Phase 1: Common Speaker Training, "Novel" Behaviour Training, and Testing with Familiar Objects

This was identical to the that of Phase 1 of Study 2.

Phase 2: Common Speaker Training with Arbitrary Objects

This was identical to that of Phase 2 of Study 2.

Phase 3: Training a Novel Behaviour to a Subset of the Stimuli

This was identical to that of Phase 4 of Study 2.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the untrained Stimuli (Production)

This was identical to the that of Phase 5 of Study 2.

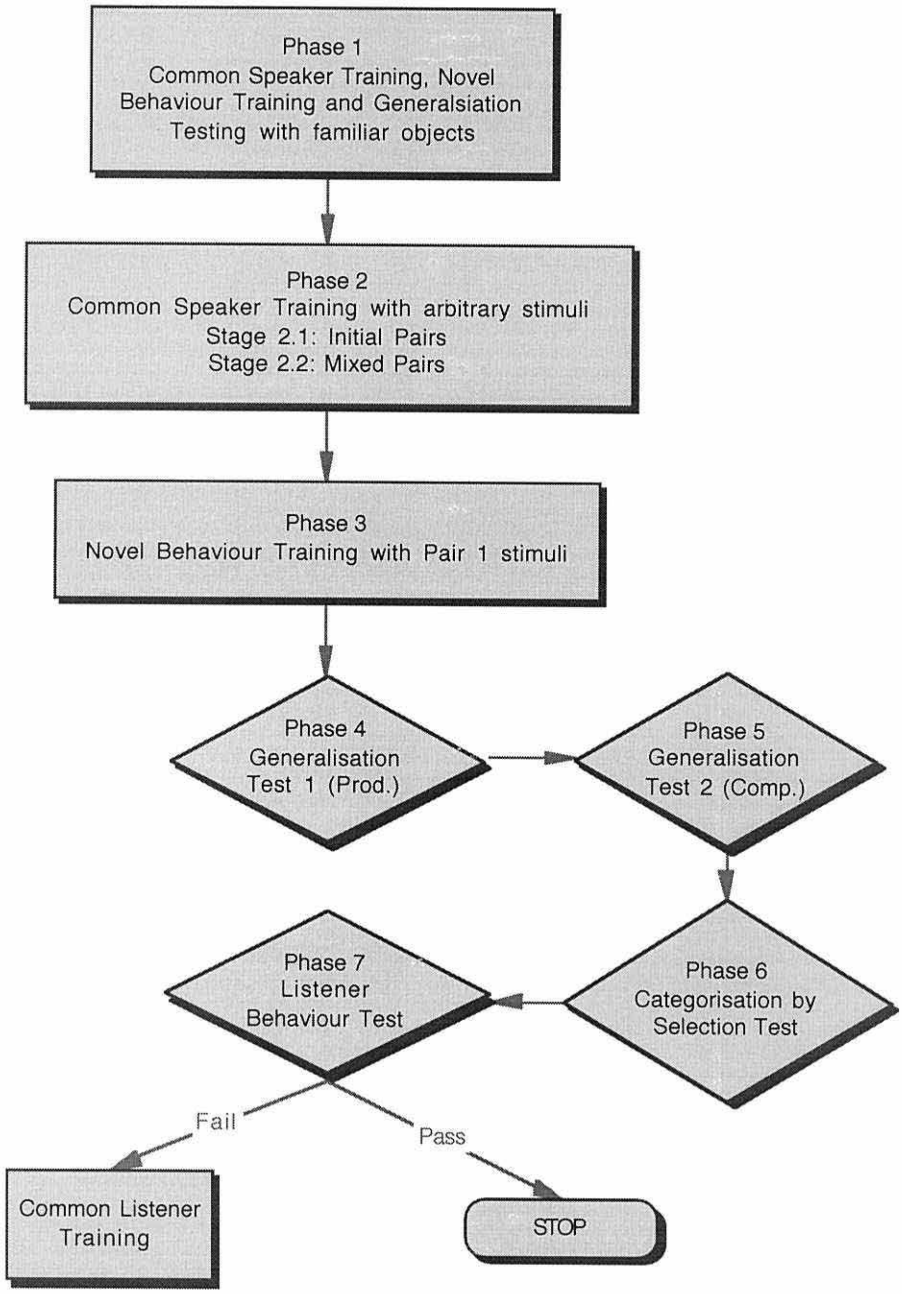


Figure 6.5: Flowchart representing Phase 1 through 7 of Experiment 7

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

This was identical to that of Phase 6 of Study 2.

Phase 6: Categorisation by Selection Test Procedure with all 6 Experimental Stimuli

This was identical to that of Phase 7 of Study 5.

Phase 7: Listener Behaviour Test

This was identical to that of Phase 3 of Study 2.

RESULTS

The three participants completed all phases of the procedure.

Phase 1: Common Speaker Training, "In-repertoire" Behaviour Training, and Testing with Familiar Objects

Table 6.5 shows the number of blocks of eight trials taken by each participant to attain criterion performance (i.e., seven out of eight correct responses within one block) for the two training stages of Phase 1. These were: *Stage 1.1: Common speaker training*, with each of the three familiar object pairs, and *Stage 1.2: Training the "in-repertoire" behaviour*, with the Pair 1 stimuli only. Table 6.5 also shows the number of blocks of eight test trials required to reach criterion with the Pair 2 and Pair 3 stimuli during *Stage 1.3: Testing for the occurrence of the "in-repertoire" behaviour to the untrained stimulus pairs.*

During Stage 1.1, all participants reached criterion performance in four blocks of training or less for each of the three stimulus pairs. All three children learned the "in-repertoire" behaviour to criterion performance within one block, and all passed the test for the occurrence of the "in-repertoire" behaviour to both Pair 2 and Pair 3 stimuli (to the instruction, "Look at this; can you show me how this goes?") within one block.

Table 6.5

Results of Phase 1: Common Speaker Training with familiar objects. Criterion level for all three stages of Phase 1 was seven out of eight correct responses within one block of eight trials. Stage 1.1: number of blocks (eight trials in each block) of training to criterion with each of the three pairs of familiar objects (i.e., H1/C1, H2/C2, & H3/C3). Stage 1.2: number of blocks of training to criterion for the "in-repertoire" behaviour with the H1/C1 pair only. Stage 1.3: number of test trial blocks to criterion for the occurrence of the "in-repertoire" behaviour with both the H2/C2 and H3/C3 pairs.

	Stage 1.1 Common Speaker training			Stage 1.2 "In-repertoire" behaviour training	Stage 1.3 "In-repertoire" behaviour Test	
Participant	H1/C1	H2/C2	H3/C3	H1/C1	H2/C2	H3/C3
RC	1	1	1	1	1	1
EW	1	1	1	1	1	1
CS	1	1	1	1	1	1

The results for Phase 2 through Phase 7 for all participants are represented in Figure 6.6.

Phase 2: Common Speaker Training with Arbitrary Objects

The data presented for Phase 2 are the number of blocks of training trials to achieve criterion performance for the three stimulus pairs in each of the three stages. Criterion performance was seven out of eight correct responses within one training block of eight trials maintained over two consecutive blocks; thus at least two blocks of trials were required to attain criterion performance.

Stage 2.1: Common speaker training with arbitrary objects: Initial pairs. All three participants learned the initial pair discriminations in less than nine blocks of training trials.

Stage 2.2: Common speaker training: Mixed pairs. All three participants reached criterion in two blocks of training trials for all three of the mixed pairs stimuli.

Stage 2.3: Reduction to zero reinforcement. All three participants maintained criterion performance across one block of trials for each stimulus pair under a zero reinforcement schedule.

The mean number of blocks required for the three participants to meet the criteria for all three stages of Phase 2 was 19 (range 16 - 22). Participant RC required a total of 16 training blocks, EW required 22 blocks, and CS required 19 blocks.

Figure 6.6

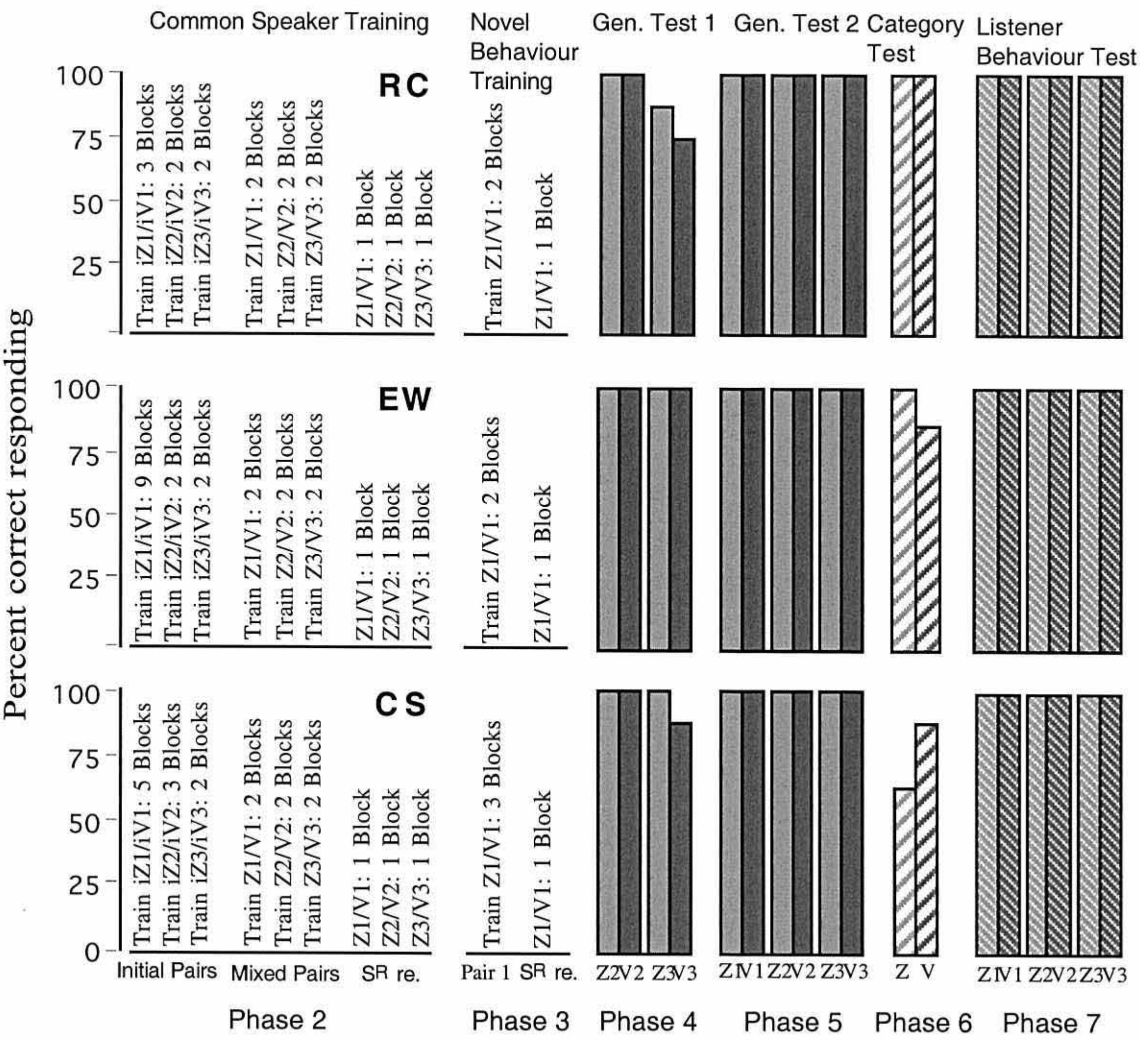


Figure 6.6. Performance of participants RC, EW, and CS on Phases 2 through Phase 7. Phase 2: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages.. Phase 3: Novel Behaviour Training, the number of trial blocks to criterion for Pair 1 only, for the Training, and Reduction in Reinforcement (S^R re.) stages. Phase 4: Generalisation Test 1, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 5: Generalisation Test 2, percent correct responses, out of four trials, for each of the six test stimuli. Phase 6: Categorisation by Selection Test, percent correct responses, across 18 trials, 9 trials for the zog stimuli and 9 for the vek stimuli. Phase 7: Listener Behaviour Test, the percent correct responses, out of 24 trials, 4 for each stimulus.

Phase 3: Training the Production of the Novel Behaviours to a Subset of the Stimuli.

Figure 6.6 shows the number of blocks to criterion for both the training and the reduction in reinforcement stages of Phase 3, when novel behaviours were trained to the Pair 1 stimuli. The criterion level for the training stage was seven out of eight correct responses within one block across two consecutive blocks.

Stage 3.1: Novel behaviour training. All three participants reached criterion on the novel behaviour training in three blocks of training or less.

Stage 3.2: Reduction to zero reinforcement. All three participants achieved criterion responding in the absence of reinforcement for the novel behaviour training in one block of trials.

Phase 4: Generalisation Test 1 - Testing for the Generalisation of the Novel Behaviour to the Untrained Stimuli (Production)

Figure 6.6 shows the percent correct responses over the 32 test trials of Phase 5, 16 trials with each stimulus pair; thus each stimulus was targeted eight times. The criterion level for Generalisation Test 1 was set at 75 percent for each of the stimuli in a test pair.

All three participants reached criterion performance on both test pairs; all three therefore showed generalisation of the novel behaviour.

Phase 5: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Comprehension).

Figure 6.6 shows the percent of correct responses over the 24 test trials, four trials for each of the six test stimuli.

All three participants made no errors on Generalisation Test 2

Phase 6: Categorisation by Selection Test.

Figure 6.6 shows the percent correct responses over the 18 test trials in Phase 7, 9 for the zog stimuli and 9 for the vek stimuli. Criterion level for success on the test was set at 33 percent correct responses for the zog stimuli and 33 percent correct responses for the vek stimuli.

Participant RC made no errors on the test. Participant EW scored 100 percent for the zog stimuli and 83 percent for the vek stimuli. Participant CS scored 66 percent for the zog stimuli and 89 percent for the vek stimuli. All three participants thus showed evidence of categorisation on the test.

Phase 7: Listener Behaviour Test.

Performance on the listener behaviour test of each participant is shown in Figure 6.6, which presents percent correct responses over the 24 test trials, four trials for each of the individual stimuli. Criterion performance for listener responding was set at 75 percent, or three correct responses out of four for each stimulus, for both the zog and for the vek stimuli.

None of the participants made any errors on the 24 test trials; thus, by Horne and Lowe's (1996) definition, naming had been established.

Spontaneous verbal behaviour

Participants CS and EW did not make any vocalisations other than those required by the study (i.e., “zog” and “vek”). Participant RC said, “The same” during the categorisation by selection test.

DISCUSSION

The primary aim of Study 7 was to test for categorisation after training only common speaker relations in the absence of appropriate listener responding. The study also provided a matched procedure for Study 6 which trained common listener relations. As with Study 6, the key feature of Study 7 was the position of the listener behaviour test that occurred after the tests for categorisation rather than before as with both Studies 2 and 5.

All three participants demonstrated both categorisation by generalisation and selection after only common speaker training; and all three subsequently showed appropriate listener behaviour to all the experimental stimuli. These findings accord with those of Studies 2 and 5, and with those of Harris et al. (2000); these showed that naming arbitrary stimuli gives rise to categorisation of those stimuli.

Additionally, the results support the hypothesis that training speaker relations in children aged between 2 and 4 years also trains appropriate listener relations, and therefore naming. Further, the fact that the children showed such test results after receiving only common speaker training supports the contention that they were naming prior to the generalisation tests. However, because the listener behaviour test occurred after the tests for generalisation in Study 7, this is speculative. Nonetheless, the results of Studies 2 and 5 thus support the hypothesis that children who are taught a unidirectional tact response also respond appropriately as listeners; teaching a tact often entails teaching a bidirectional relation incorporating speaker and listener functions (Horne & Lowe, 1996).

* * *

In a further study, Harris et al. (2000) tested for generalisation of untrained behaviours across two modalities. Study 8a was concerned with extending this research and investigating the multi-modal nature of naming. The issue is whether behaviours that enter into an existing name relation can function to evoke that name, and therefore the appropriate listener responding that is entailed. The second aim of Study 8a was to investigate the extension of the existing three-member classes established in Study 6 to six-member classes (Set 2).

Study 8a: Categorisation Following Common Listener Training Through the Gestural Modality - Extension to six-member classes

Harris et al. (2000) trained common speaker relations via the gestural modality to a set of three arbitrary objects to three children aged between 3 and 4 years. For example, the child was taught to make a "fist" to a one set of stimuli and to touch their "shoulders" to the other set. The children were then trained a vocal response to a subset of those stimuli (i.e., to tact "zag" and "vek"). Harris et al. found that the vocal response generalised to the other untrained stimuli in the class. All the participants in the Harris et al. study were trained via common speaker relations in the gestural modality.

Study 8a was designed to test whether the vocal responses trained to the Set 1 stimuli would generalise to a novel set of stimuli (Set 2) trained via common listener relations in the gestural modality. (NB. In the following four studies all training that involves training in the gestural mode will be referred to as *gestural listener training* (Eperiements 8a & 8b) or *gestrual speaker training* (Studies 9a & 9b). This is to differentiate gestural training from the vocal listener and speaker training.)

One participant, FLJ, was trained to respond as a listener to the novel behaviours (wave and clap) rather than, as with other studies, to the vocal stimuli (*/zog/* and */vek/*). Thus the common gestural listener relation trained to the novel Set 2 stimuli was the same behavioural function trained to the Pair 1 of Set 1 in Study 6. Given that the participant had been trained with the vocal stimuli to the stimuli (Set 1) during Study 6, the test of generalisation was concerned with whether these vocal responses would generalise to the untrained Set 2 stimuli.

METHOD

Participants

Participant FLJ had previously participated in Study 6: common listener training; she demonstrated both naming and categorisation on the tests.

During Study 8a FLJ remained in the same condition as that of her original training (i.e., common listener training). She was 47 month old at the start of the procedure (see Table 6.6).

Table 6.6 Participant's sex and age at start of the procedure and age at first test.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
FLJ	F	47; 29	48;27

F = Female

Apparatus and Setting

These were identical to those described in Study 1a.

Stimuli

These were identical to those described in Study 1a. The 6 experimental stimuli used in Study 8a were chosen from the 7 remaining from the original pool of 13 used for FLJ in Study 6 (see Figure 4.3).

Procedure

All phases of the study are represented in Figure 6.7. Common gestural listener training in Study 8a was similar to that of Study 1a except that the child was trained to respond as a listener to the novel behaviours clapping and waving and not to the vocal stimuli */zog/* and */vek/*. The trial format, reinforcement schedules, and criterion level were identical to those of Study 1a. There was no training with familiar objects; therefore the procedure for Study 8a began with the training of the arbitrary stimuli.

Phase 1: Common Gestural Listener Training with Arbitrary Stimuli

Stage 1.1: Common gestural listener training with arbitrary objects: Initial pairs. The six stimuli were divided into three initial pairs; each pair consisted of one "wave" and one "clap" stimulus. These were coded for experimental purposes as initial wave four (iW4) initial clap four (iC4), iW5-iC5, and iW6-iC6. A trial consisted of one stimulus pair being presented on the table in front of the child (i.e., one "wave" and one "clap" object). Trials were organised into blocks of eight and were randomly counterbalanced within each block. Only one of the stimuli was targeted on each trial, and both stimuli were removed from the table and repositioned for each successive trial given the instruction, "Look at these, can you give me the one that goes like this?" The experimenter then modelled one of the behaviours that was designated to accompany the target stimulus (i.e., either clapping or waving) and waited for the child to select one of the stimuli.

The experimenter responded with social praise if the child was correct, or, if incorrect, provided corrective feedback. Criterion was reached when the participant responded correctly on seven out of eight trials within a block of eight over two consecutive blocks. After criterion was reached with the Initial Pair 1 stimuli (i.e., iC1/iW1), the training procedure was repeated, first, with the Initial Pair 2 stimuli and, second, the Initial Pair 3 stimuli; then the study progressed to the next training stage.

Stage 1.2: Common gestural listener training: Mixed pairs. After the participant had reached criterion with all three of the initial stimulus pairs, the pairs were randomly mixed in order to enhance control by the individual stimuli. For instance, iW4 might be paired with iC5, iW5 with iC4, and iW6 with iC5. In all other respects the training and learning criterion for each pair was identical to that of Stage 1.1. The stimulus pairs remained in the new arrangement (i.e., mixed pairs) for the remainder of the procedure; after here they are denoted as Pair 4, 5, or 6, or individually as W4/C4, W5/C5, or W6/C6.

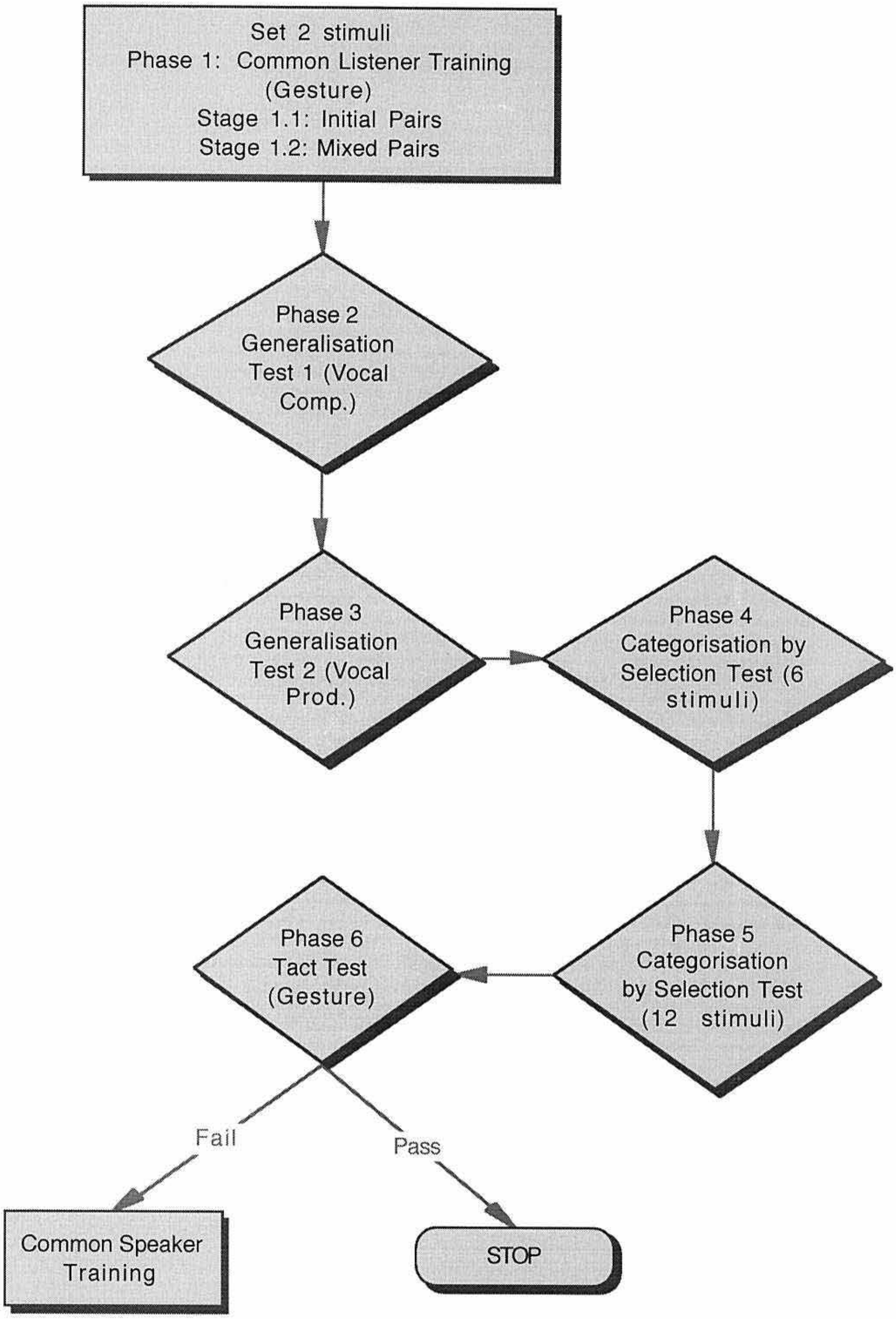


Figure 6.7: Flowchart representing Experiment 8a

Stage 1.3: Reduction to zero reinforcement. The reduction in reinforcement stage was as described in Stage 2.3 of Study 1a

.Phase 2: Generalisation Test 1 - Testing for the Generalisation of Listener Responding (Vocal Comprehension) to the Untrained Stimuli

Stage 2.1: Maintenance of training. Prior to each of the test sessions, in order to ensure all of the trained relations were intact, it was necessary to demonstrate maintenance of the original trained relations for the Set 1 (i.e., Pairs 1, 2, & 3) stimuli trained in Study 6; that is, those that utilised the request, "Can you give me the zog/vek". There was no vocal common listener training to any of the Set 2 stimuli used in Study 8a. Thus, prior to testing, FLJ was exposed to four unreinforced trials for each of the three Set 1 stimulus pairs.

Following this maintenance training, unreinforced gestural listener behaviour test trials (i.e., those that utilised the request, "Can you give me the one that goes like this?") were conducted with each of the three Set 2 stimulus pairs from Study 8a.

Stage 2.2: Testing for generalisation of the listener responding (vocal comprehension) to the untrained stimuli. This stage, as with all test stages, was conducted by Experimenter 2 with the one-way screen in place. One of the three test pairs (Set 2) was placed on the table in front of the child in a pre-specified random order. Experimenter 2 assured the participant was attending and said, "Can you give me the zog/vek?"

Experimenter 2 waited for the participant to respond, and when he or she had done so, removed the stimuli from the table. The next two stimuli were then placed on the table for the subsequent trial. Over the 48 trials, each stimulus was targeted 8 times, 4 times on the left and 4 times on the right. Trial format and mastery criterion were as described in Phase 5 of Study 1a.

Phase 3: Generalisation Test 2 - Testing for the Emergence of Speaker Behaviour (Vocal Production)

Prior to the test trials commenced, maintenance of training trials were conducted as described above.

Generalisation Test 2 tested for the generalisation of the production of the vocal speaker response. One of the three pairs (Set 2) was placed on the table in front of the participant in a pre-specified random order. Experimenter 2 ensured the participant was attending and said, "What's this?" Trial format and criterion levels were as described in Phase 6 of Study 1a.

Phase 4: Categorisation by Selection Test with all Six Stimuli (Set 2)

This was identical to that described in Phase 7 of Study 4.

Phase 5: Categorisation by Selection Test with 12 Stimuli (Sets 1 & 2)

This was similar to that described in Phase 7 of Study 4. The differences are noted in the relevant stages below. There was no training with familiar objects, as was reported in Stage 7.1 of Study 4, because the child had already been exposed to this stage in Phase 4 and had therefore shown appropriate responding. The stimuli used in Phase 5 were the six Set 1 stimuli from Study 6 and the six Set 2 stimuli from Study 8a.

Stage 5.1: Categorisation by selection test with arbitrary objects. Experimenter 2 placed the 12 arbitrary stimuli in a pre-specified random order on the table in front of the child. Experimenter 2 then picked up the target stimulus and said, "Look at this; can you give me the others?" The experimenter then waited for the child to respond, and after the child had done so, removed all the stimuli from the table and repositioned them for the next trial. Twelve trials were conducted in all; this was in order that each stimulus was targeted once in a pre-specified random order and position.

If the child responded by giving five stimuli, the trial was marked as valid; therefore only trials in which the child selected five stimuli were recorded.

Phase 6: Tact Test

After completing the other test phases, the child was tested to see whether she would respond appropriately as a speaker to the Set 2 stimuli in the gestural modality. That is, the child had been trained to select the appropriate stimuli on seeing the Experimenter perform one of the two behaviours, but would she now also perform those behaviours to the correct stimuli given the instruction, "Look at this; can you show me how it goes?"

Each pair was placed on the table separately and the Experimenter targeted one of the stimuli and asked, "Look at this; can you show me how it goes?" Each stimulus was targeted four times, twice on the right and twice on the left in a pre-specified random order.

Continuation in the procedure beyond Phase 6 depended on the outcome in the generalisation and categorisation tests (Phase 3, 4, & 5). Participant FLJ showed evidence of generalisation and categorisation in the three test phases; therefore her participation in Study 8a finished at Phase 6.

RESULTS

Phase 1: Common Listener Training with Arbitrary Stimuli

The results for Phase 1 through Phase 7 are represented in Figure 6.8 for Participant FLJ.

Stage 1.1: Common listener training with arbitrary objects: Initial pairs. FLJ required two blocks of training for all three pairs.

Stage 1.2: Common listener training: Mixed pairs. Participant FLJ again reached criterion in two blocks for all three pairs.

Stage 1.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 1.2, FLJ maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

Participant FLJ required a total of 15 training blocks to meet the criteria for all three stages of Phase 1.

Figure 6.8

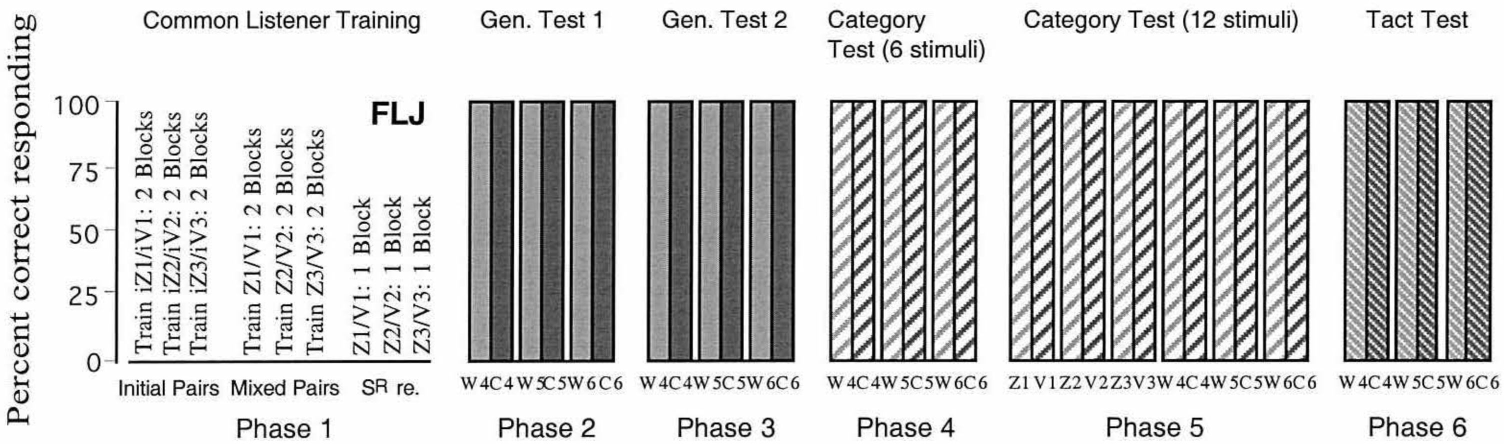


Figure 6.8. Performance of Participant FLJ on Phases 1 through 6: Phase 1: Common Listener Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 2: Generalisation Test 1, percent correct responses, out of 48 trials, 8 for each stimulus. Phase 3: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the wave and 9 for the clap stimuli. Phase 5: Categorisation by Selection Test (12 stimuli), percent correct responses, out of 12 trials, one trials for each of the Set 1 and the Set 2 stimuli. Phase 6: Tact Test, percent correct responses, out of 24 trials, 4 trials for each stimulus of Experiment 6b (Set 2).

Test Phases: Phase 2: Generalisation Test 1, Phase 3: Generalisation Test 2, Phase 4: Categorisation by Selection Test with all Six Stimuli, Phase 5: Categorisation by Selection Test with 12 Stimuli, and Phase 6: Tact Test.

Figure 6.8 shows the percent correct responses for the five test phases: 48 test trials of Phase 3, 24 test trials of Phase 4, 18 test trials of Phase 5, 12 test trials of Phase 6, and 24 test trials of Phase 6.

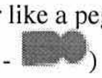
Participant FLJ made no errors on any of the five tests; therefore she demonstrated both naming and categorisation. The criterion level for the test phases was set at 75 percent for each stimulus in a test pair.

Spontaneous verbal behaviour

All FLJ's verbalisations made during common listener training (Phase 1) are indicated in Table 6.7. There was no strong evidence that she had named the stimuli during the training. However, on the tact test, she did show appropriate speaker behaviour to all the stimuli.

During the second trial of the category by selection test, FLJ said, "we've done that one already"; the experimenter said, "shall we do it again then?", and FLJ replied, "Okay, then the zog and zog and zog" while selecting all the zog stimuli from the stimuli on the table.

Table 6.7: Participant FLJ's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
FLJ	Z4/V4	Can you give me the one that goes like this? (clap)	It looks like a diamond (pointing to the vek stimulus - )
	Z5/V5	Can you give me the one that goes like this? (clap)	It looks like a person...or like a peg (pointing to the stimulus - )
	Z6/V6	Can you give me the one that goes like this? (wave)	The zig-zog one x 2 (); that one looks like a ring ().
		Can you give me the one that goes like this? (clap)	It looks like thunder ()

DISCUSSION

The first aim of Study 8a was to test for categorisation of formally unrelated stimuli after teaching only common gestural listener behaviour in the absence of appropriate gestural speaker behaviour. As with Study 6, the position of the tact test after the tests for categorisation was a key feature of the design of Study 8a. The second aim of Study 8a was to test for the formation of classes via the gestural rather than the vocal modality.

Participant FLJ showed a generalisation of the vocal response from the Set 1 stimuli of Study 6 to the Set 2 stimuli of Study 8a. She subsequently demonstrated speaker (untrained) behaviours on the tact test; that is, she demonstrated gestural naming.

Harris et al. (2000) showed that vocal functions generalise through a class of arbitrary stimuli trained through the gestural modality. This study employed a common listener training procedures, whereas Harris et al. employed only the common speaker training; thus this study extends Harris et al.'s findings. Because FLJ demonstrated both listener and speaker behaviours to the stimuli in the gestural modality, these findings corroborate Harris et al.'s findings that when children show a common response to a group of stimuli they may be naming those stimuli though the manual modality.

Study 8b: Categorisation Following Common Listener Training Through the Gestural Modality - Extension to nine-member classes

Study 8b sought to discover whether the six-member classes would extend to nine-member classes. As with Study 8a, the basic pair discriminations were trained through the gestural modality.

METHOD

Participants

Participant FLJ participated in Study 8b. Her age at the start of the study was 49 months (see Table 6.8).

Table 6.8 Participants' sex and age at start of the procedure and age at first test.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
FLJ	F	50; 04	51;01

F = Female

Apparatus and Setting

These were identical to those of Study 1a.

Stimuli

A new set of 6 arbitrary wooden shapes of identical green colour and approximately the same size were used in Study 8b (Set 3 stimuli; see Figure 6.9). Three of these were randomly designated as "wave" and three as "clap".

Figure 6.9:

Procedure

All phases of the study are represented in Figure 6.10. Phase 1 through Phase 5 of common listener training were identical to Study 8a, except that the Set 3 stimuli were used. Thus the six Set 3 stimuli were designated into three initial pairs each made up of one "wave" and one "clap" stimulus. These were coded for experimental purposes as: initial wave seven and initial clap seven (iW7/iC7); initial wave eight and initial clap eight (iW8/iC8); and initial wave nine and initial clap nine (iW9/iC9). Otherwise they were coded as Pair 7, 8, and 9.

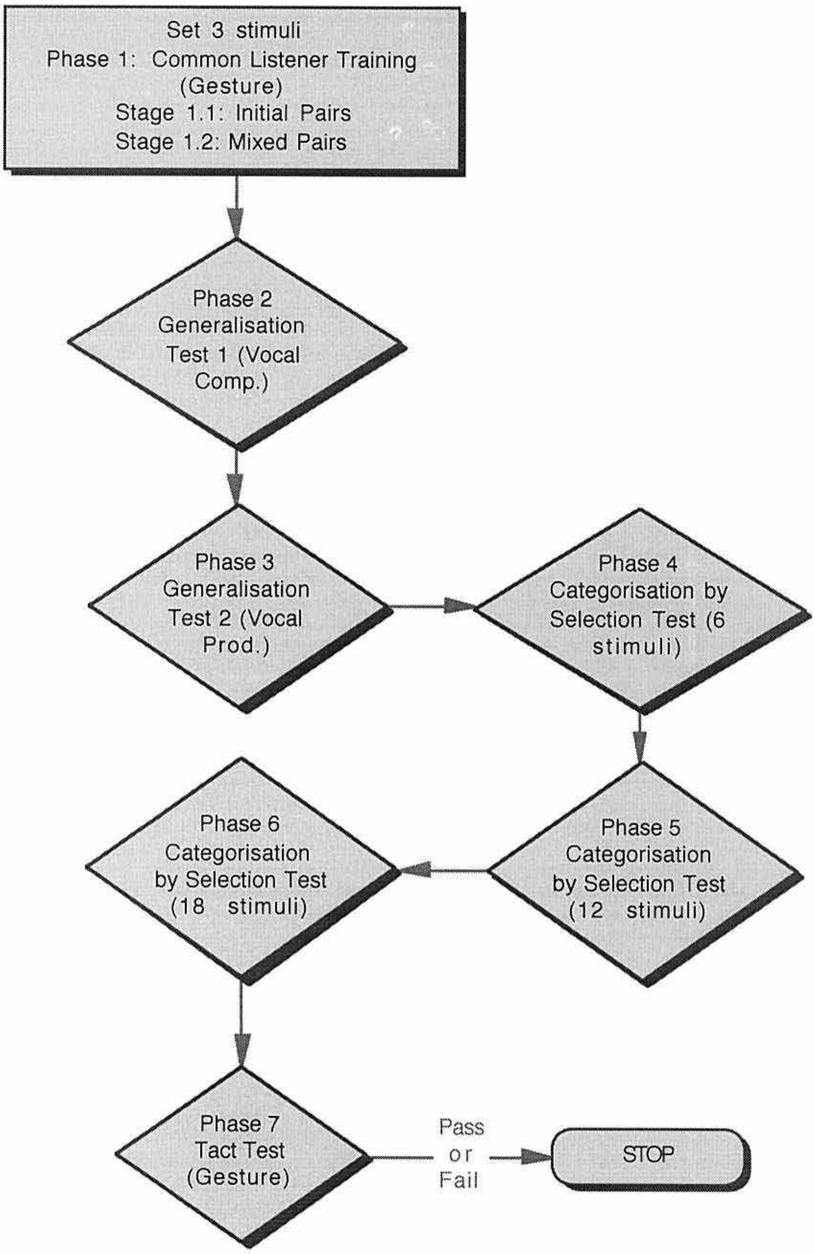


Figure 6.10 Flowchart representing Experiment 8b

Phase 6: Categorisation by Selection Test with 18 Stimuli

This was similar to Phase 5 of Study 8a except that all 18 stimuli were used. One zog and one vek stimulus from each of the three stimuli sets, Set 1, Set 2, and Set 3, were presented in prespecified random order to be a target. Thus a total of six test trials were conducted.

If the child responded by giving eight of the stimuli, the trial was deemed valid. If the child gave more than eight stimuli, the trial was deemed invalid and the experimenter replaced the stimuli in their position and said, "No, I don't want all of them; just give me the others like this one." Therefore only trials in which the child selected eight stimuli were recorded.

Phase 7: Tact Test

This was identical to Phase 6 of Study 8a except that the Set 3 stimuli were tested.

The procedure finished with FLJ at Phase 7.

RESULTS

Phase 1: Common Listener Training with Arbitrary Stimuli

The results for Phase 1 through Phase 7 are represented in Figure 6.11 for FLJ.

Stage 1.1: Common listener training with arbitrary objects: Initial pairs. Participant FLJ required two blocks of training for all three pairs.

Stage 1.2: Common listener training: Mixed pairs. Participant FLJ again reached criterion in two blocks for all three pairs.

Stage 1.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 1.2, FLJ maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

Participant FLJ required a total of 15 training blocks to meet the criteria for all three stages of Phase 1.

Test Phases: Phase 2: Generalisation Test 1, Phase 3: Generalisation Test 2, Phase 4: Categorisation by Selection Test with all Six Stimuli, Phase 5: Categorisation by Selection Test with 18 Stimuli, and Phase 6: Tact Test.

Figure 6.11 shows the percent correct responses for the five test phases: the 48 test trials of Phase 3, 24 test trials of Phase 4, 18 test trials of Phase 5, 6 test trials of Phase 6, and 24 test trials of Phase 6.

Participant FLJ made no errors on any of the five tests; therefore she demonstrated both naming and categorisation. The criterion level for the test phases was set at 75 percent for each stimulus in a test pair.

Figure 6.11

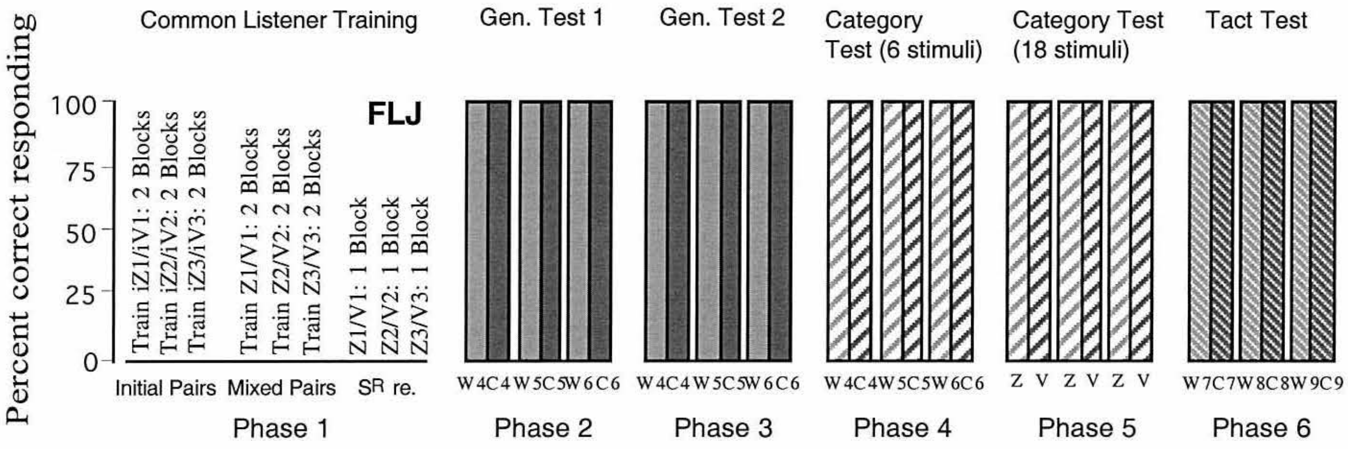


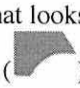
Figure 6.11. Performance of Participant FLJ on Phases 1 through 6: Phase 1: Common Listener Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages. Phase 2: Generalisation Test 1, percent correct responses, out of 32 trials, 8 for each stimulus. Phase 3: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Categorisation by Selection Test (6 stimuli), percent correct responses, out of 18 trials, 9 trials for the wave and 9 for the clap stimuli. Phase 5: Categorisation by Selection Test (18 stimuli), percent correct responses, out of 6 trials, 3 trials with the zog stimuli and 3 trials with the vek stimuli, one zog and one vek from each of the 3 stimulus sets. Phase 6: Tact Test, percent correct responses, out of 24 trials, 4 trials for each stimulus of Experiment 6b (Set 3).

Spontaneous verbal behaviour

All FLJ's verbalisations made during common listener training (Phase 1) are indicated in Table 6.9.

During the category by selection tests FLJ said, "That's a zog. That's a zog", and pointing to the zog stimuli, she then gathered all the vek stimuli together. She also said, "Those are all the veks" after gathering all the veks into one pile.

Table 6.9: Participant FLJ's verbalisations during common listener training, indicating stimuli present and experimenter's verbal prompt.

		Vocalisations during common listener training	
Child	Stimuli	Experimenter's prompt	Child's Vocalisations
FLJ	IZ7/iV7	Can you give me the one that goes like this? (clap)	It looks like a traffic light ().
	IZ8/iV8	Can you give me the one that goes like this? (wave)	That looks like a watch ().
		Can you give me the one that goes like this? (clap)	That looks like a mushroom ().
	IZ9/iV9	Can you give me the one that goes like this? (wave)	That looks like a sleigh...that looks like a sleigh for Father Christmas ().
		Can you give me the one that goes like this? (clap)	The puncher ().

DISCUSSION

The aim of Study 8b was to examine the extension of arbitrary classes from existing six-member classes to nine-member classes via the gestural modality. As with Study 8a, a key feature of the design was the position of the tact test after the tests for categorisation. Participant FLJ demonstrated that the existing six-member classes established during Studies 6 and 8a extended to incorporate a further set of arbitrary stimuli following common listener training in the gestural modality.

Further, FLJ demonstrated, not only a generalisation of the vocal listener responding (i.e., selecting the correct objects in hearing */zog/* or */vek/*), and the generalisation of the vocal production (i.e., saying "zog" and "vek"), but also categorisation of those stimuli on a categorisation by selection test; this required her to select, upon seeing 1 exemplar, 8 stimuli from an array of 17 arbitrary objects. Participant FLJ subsequently demonstrated speaker (untrained) behaviours on the tact test: she demonstrated manual naming. This provides evidence that children of four years of age can categorise at least nine formally unrelated objects that have been given a common name. This result extends and corroborates the findings of Harris et al., (2000) and Randle (1999) that showed the formation of six-member classes of arbitrary objects given a common name. Further, this is the first demonstration of categorisation by generalisation and categorisation by selection of nine-member classes of arbitrary stimuli in a child of this age.

Study 9a: Categorisation Following Common Speaker Training Through the Gestural Modality - Extension to six-member classes

Studies 8a and 8b were designed to investigate the generalisation of a vocal function through classes trained via the gestural modality following common listener training. Study 9a was designed to match Study 8a except that the participants were trained to produce the clapping and waving responses to the new set of stimuli (i.e., common speaker training). Additionally, Study 9a examined the extension of the existing three-member classes formed in Study 7 to six-member classes following common speaker training.

Study 9a was also designed to replicate the findings from the studies conducted by Harris et al. (2000) that investigated the formation of classes through he gestural modality. Study 9a also incorporates key procedural features of the design of Study 7. These include never presenting the same class stimuli together during the training (this was a feature of the Harris et al. design), and testing for listener behaviour after categorisation (Harris et al. did not incorporate a direct test for listener behaviour).

METHOD

Participants

All three children, RC, EW, and CS, that took part in Study 9a had previously participated in Study 7: common speaker training; all three demonstrated both naming and categorisation on tests during Study 7.

During Study 9a the participants remained in the same condition to their original training (common speaker training). The participants' ages ranged from 32 to 42 months at the start of the procedure (see Table 6.10).

Table 6.10 Participants' sex and age at start of the procedure and age at first test.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
RC	F	31; 12	32; 03
EW	F	43; 29	44; 21
CS	F	36; 28	38; 08

F = Female

Apparatus and Setting

These were identical to those of Study 1a.

Stimuli

These were identical to those of Study 1a. The 6 experimental stimuli used in Study 9a were chosen from the 7 remaining from the original pool of 13 used for the participants in Study 7 (see Figure 4.3).

Procedure

All phases of the study are represented in Figure 6.12. Common speaker training of Study 9a was similar to that of Study 8a except that training involved speaker relations and not listener relations. The differences are noted below for each of the separate stages.

Phase 1: Common Gestural Speaker Training with Arbitrary Stimuli

Stage 1.1: Common gestural speaker training with arbitrary objects: Initial pairs. Stimulus allocations and trials format was as with Study 8a.

The Experimenter ensured the participant was attending and said, "Look at this; it goes like this." The Experimenter then modeled one of the gestural behaviours and said, " Can you show me how it goes?" Criterion level and trial format were as described in Study 8a.

Stage 1.2: Common speaker training: Mixed pairs. This was identical to that of Study 8a.

Stage 1.3: Reduction in reinforcement. Reduction to zero reinforcement was identical to that of previous studies.

Phase 2: Generalisation Test 1 - Testing for the Generalisation of Speaker Responding (Vocal Production) to the Untrained Stimuli (Set 2)

The Phase 2 procedure was similar to that of Phase 2 of Study 8a; the differences are noted below.

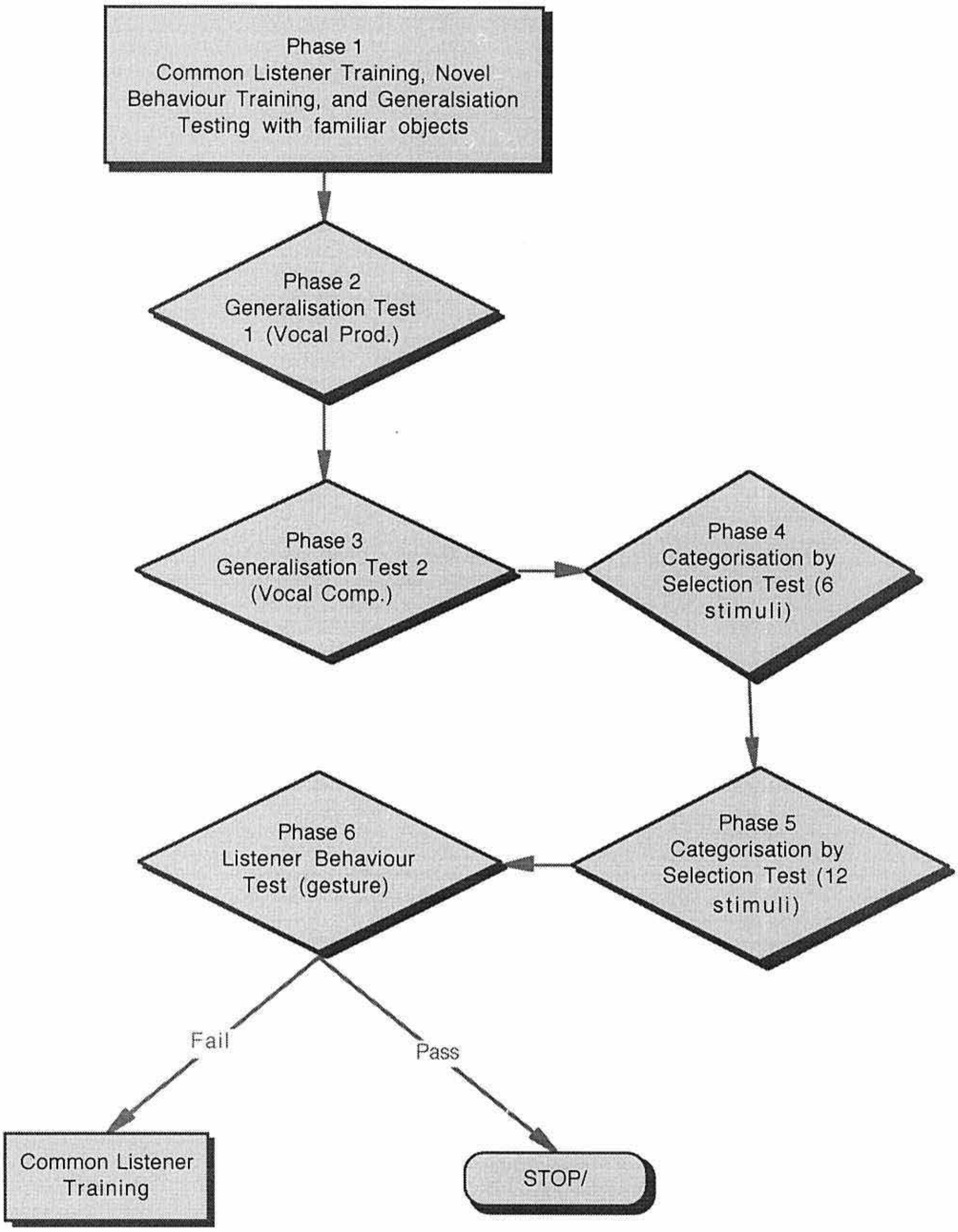


Figure 6.12: Flowchart representing of Experiment 9a

Stage 3.1: Maintenance of training. Prior to each of the test sessions, to ensure all the trained relations were intact, it was necessary to demonstrate maintenance of the original trained relations for the Set 1 (i.e., Pairs 1, 2, & 3) stimuli trained in Study 7 (i.e., those that utilised the request, "What is this?"). There was no vocal common speaker training to any of the Set 2 stimuli used in Study 9a. Thus, prior to testing, the participants were exposed to four unreinforced trials for each of the three Set 1stimulus pairs.

Following this maintenance training, unreinforced gestural speaker behaviour test trials (i.e., those that utilised the request, "Can you show me how this goes?") were conducted with each of the three Set 2 stimulus pairs from Study 9a.

Stage 2.2: Testing for generalisation of the speaker responding (vocal production) to the untrained stimuli (Set 2). One of the three test pairs was placed on the table in front of the child in a pre-specified random order. Experimenter 2 ensured the participant was attending and, whilst pointing to the target stimuli said, "Look at this; can you tell me what it is?" Over 48 trials, each stimulus was targeted 8 times, 4 times on the left and 4 times on the right. Trial format and mastery criterion were as described in Phase 5 of Study 1a.

Phase 3: Generalisation Test 2 - Testing for the Emergence of Listener Behaviour (Vocal Comprehension).

The procedure in this stage was similar to Phase 6 of Study 7 except that Study 9a tested for the generalisation of the *comprehension* of the vocal response as opposed to the *production*. Each of the six stimuli was targeted 4 times over the 32 test trials, twice on the left and twice on the right.

Phase 4: Categorisation Test with all Six Stimuli

This was identical to that of Phase 4 of Study 8a (12 trials).

Phase 5: Categorisation Test with all 12 Stimuli

This was identical to that of Phase 5 of Study 8a.

Phase 6: Listener Behaviour Test

The child was next tested to determine whether she would respond appropriately as a listener to the Pairs 4, 5, and 6 stimuli. The issue concerned whether she would now select the appropriate stimuli on seeing the experimenter perform one of the two behaviours given the question, "Which one goes like this?"

Each pair was placed on the table separately and the experimenter targeted one of the stimuli and asked, "Can you give me the one that goes like this?"

All three participants showed evidence of generalisation and categorisation in the three test phases; therefore their participation in Study 9a finished at Phase 6.

RESULTS

All three participants completed the study.

Phase 1: Common Speaker Training with Arbitrary Stimuli

The results for Phase 1 through Phase 6 are represented in Figure 6.13 for RC, EW, and CS.

Stage 1.1: Common speaker training with arbitrary objects: Initial pairs. All three participants reached criterion in three blocks of training or less for all three pairs.

Stage 1.2: Common speaker training: Mixed pairs. All three participants reached criterion in two blocks or less for all three pairs.

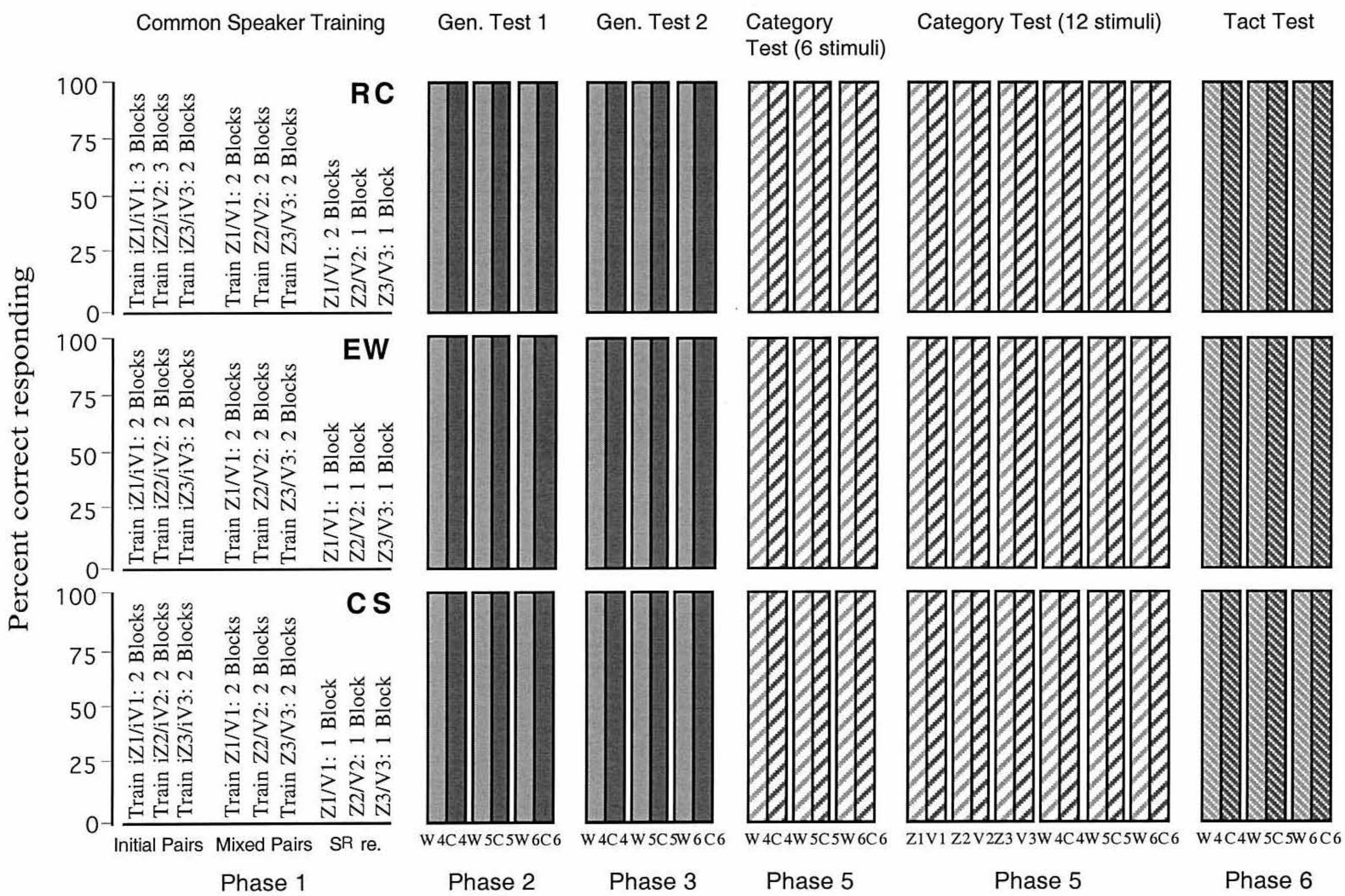
Stage 1.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 1.2, CS and EW maintained criterion performance without reinforcement across one block of trials for each stimulus pair. Participant RC required two block of trials for the Pair 4 stimuli and one block of trials for both the Pair 5 and the Pair 6 stimuli.

Participant RC required a total of 18 training blocks, and CS and EW a total of 15 blocks.

Figure 6.13

Figure 6.13: Performance of RC, EW, and CS on Phases 1 through 7: Phase 1: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages.. Phase 2: Generalisation Test 1, percent correct responses, out of 48 trials, 8 for each stimulus. Phase 3: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the wave and 9 for the clap stimuli. Phase 5: Categorisation by Selection Test (12 stimuli), percent correct responses, out of 12 trials, one trials for each of the Set 1 and the Set 2 stimuli. Phase 6: Tact Test, out of 24 trials, 4 for each stimulus of Study 9a (Set 2).

Figure 6.13


Common Speaker Training
Gen. Test 1
Gen. Test 2
Category Test (6 stimuli)
Category Test (12 stimuli)
Tact Test
Percent correct responding
0
25
50
75
100
RC
Train iZ1/iV1: 3 Blocks
Train iZ2/iV2: 3 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 2 Blocks
Z2/V2: 1 Block
Z3/V3: 1 Block
EW
Train iZ1/iV1: 2 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
CS
Train iZ1/iV1: 2 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
Initial Pairs
Mixed Pairs
SR re.
W4 C4 W5 C5 W6 C6
Z1 V1 Z2 V2 Z3 V3 W4 C4 W5 C5 W6 C6
Phase 1
Phase 2
Phase 3
Phase 5
Phase 5
Phase 6

Test Phases: Phase 2: Generalisation Test 1, Phase 3: Generalisation Test 2, Phase 4: Categorisation by Selection Test with all Six Stimuli, Phase 5: Categorisation by Selection Test with 12 Stimuli, and Phase 6: Listener Behaviour Test.

Figure 6.13 shows the percent correct responses for the five test phases: the 48 test trials of Phase 3, 24 test trials of Phase 4, 18 test trials of Phase 5, 12 test trials of Phase 6, and 24 test trials of Phase 6.

All three participants made no errors on any of the five tests; therefore all three demonstrated both naming and categorisation. The criterion level for the test phases was set at 75 percent for each stimulus in a test pair.

Spontaneous verbal behaviour

None of the participants made any verbalisations other than those required by the study (i.e., "zog" and "vek").

DISCUSSION

The primary aim of Study 9a was to test for categorisation after training only common speaker relations via the gestural modality in the absence of appropriate listener responding; it also provided a matched procedure for Study 8a which trained common listener relations via the gestural modality. As with Study 8a, the listener behaviour test occurred after the tests for categorisation.

All three participants demonstrated both categorisation by generalisation and categorisation by selection after only common speaker training; and all three subsequently showed appropriate listener behaviour to all the experimental stimuli on the listener behaviour test. These findings accord with those of Studies 2 and 5, and with those of Harris et al. (2000); these show that naming arbitrary stimuli gives rise to categorisation of these stimuli. Additionally, the results support the hypothesis that that children who are taught a unidirectional tact response also respond appropriately as listeners; thus teaching a tact often entails teaching a name. The data show that a vocal name response may generalise to other stimuli that have not been directly trained with that response if those stimuli share a common gestural function. This data thus extend and replicate the Harris et al. (2000) data that showed generalisation of a vocal response through a class of stimuli trained via the gestural modality. Additionally, the data showed selection of five arbitrary stimuli from an array of 11 on the categorisation by selection tests in a child of 32 month of age. This is the youngest child reported in the literature to show this.

Study 9b: Categorisation Following Common Speaker Training Through the Gestural Modality - Extension to nine-member classes

Study 9b sought to discover whether the six-member classes of stimuli trained would extend to nine-member classes. Harris et al. (2000) found that children extend a three-member class to a six-member class following common speaker training in the vocal modality. Study 9a investigated this extension of classes further while at the same time training common speaker relations through the gestural modality. Study 9b also matched Study 8b.

METHOD

Participants

The same three children who participated in Study 9a participated in Study 9b. Their ages ranged from 32 to 44 months at the start of the procedure (see Table 6.11).

Table 6.11 Participants' sex, age at start of the procedure and age at first test.

Participant	Sex	Age at start month; days	Age at 1st Test month; days
RC	F	32; 10	33; 10
EW	F	44; 24	45; 06
CS	F	38; 15	39; 03

F = Female

Apparatus and Setting

These were identical to those of Study 1a.

Stimuli

The same Set 3 stimuli were used in Study 9b as were used in Study 8b (see Figure 6.9). Three of these were randomly designated as "wave" and three as "clap".

Procedure

All phases of the study are represented in Figure 6.14. Phases 1 through Phase 5 of common speaker training were identical to the training in Study 9a, except in that the Set 3 stimuli were used. Thus the six Set 3 stimuli were designated into three initial pairs each made up of one "wave" and one "clap" stimulus. These were coded for experimental purposes as: initial wave seven and initial clap seven (iW7/iC7); initial wave eight and initial clap eight (iW8/iC8); and initial wave nine and initial clap nine (iW9/iC9). Otherwise they were coded as Pair 7, 8, and 9.

Phase 6: Categorisation by Selection Test with 18 Stimuli

This was identical to that of Study 8b.

Phase 7: Listener Behaviour Test

This was identical to that of Phase 6, of Study 9a except that the Set 3 stimuli were tested. The procedure finished at Phase 7.

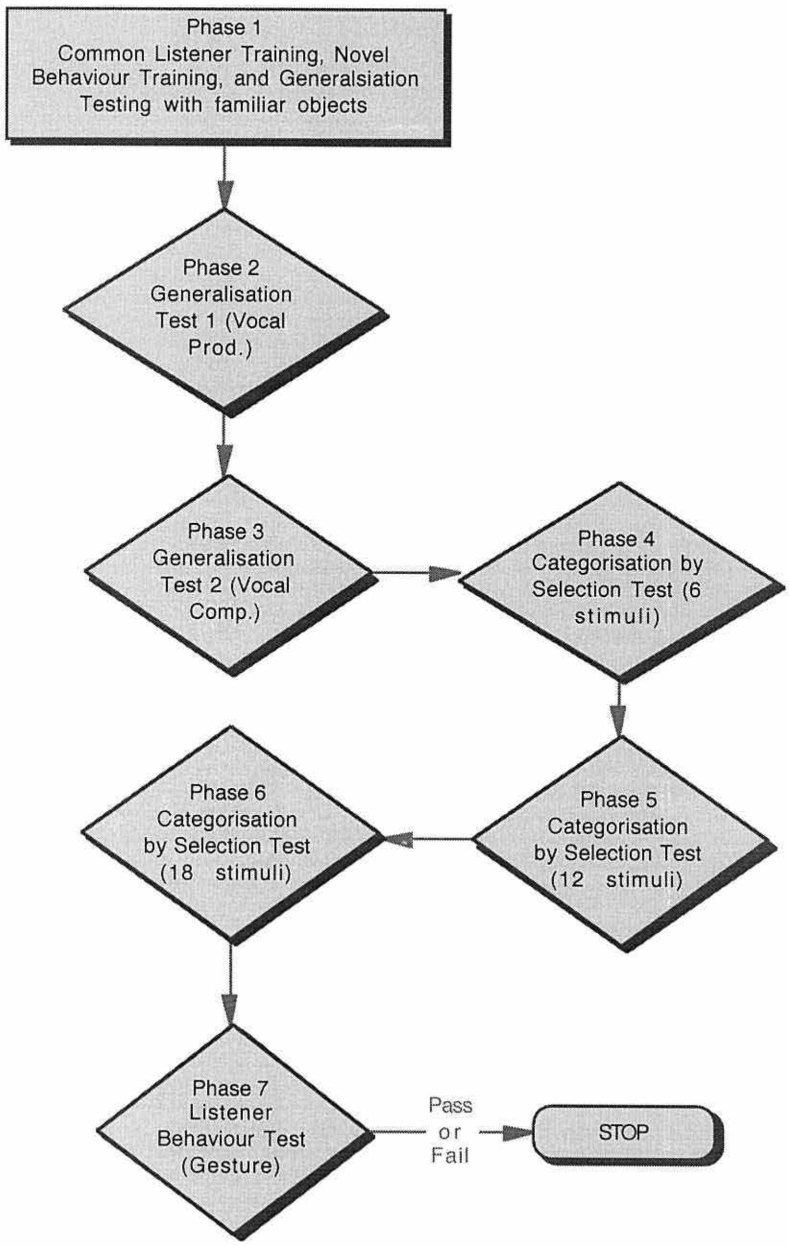


Figure 6.14: Flowchart representing of Experiment 9b

RESULTS

All three participants completed the study.

Phase 1: Common Speaker Training with Arbitrary Stimuli

The results for Phase 1 through Phase 6 are represented in Figure 6.15 for Participants RC, EW, and CS.

Stage 1.1: Common speaker training with arbitrary objects: Initial pairs. All three participants reached criterion in three blocks of training or less for all three pairs.

Stage 1.2: Common speaker training: Mixed pairs. All three participants reached criterion in two blocks for all three pairs.

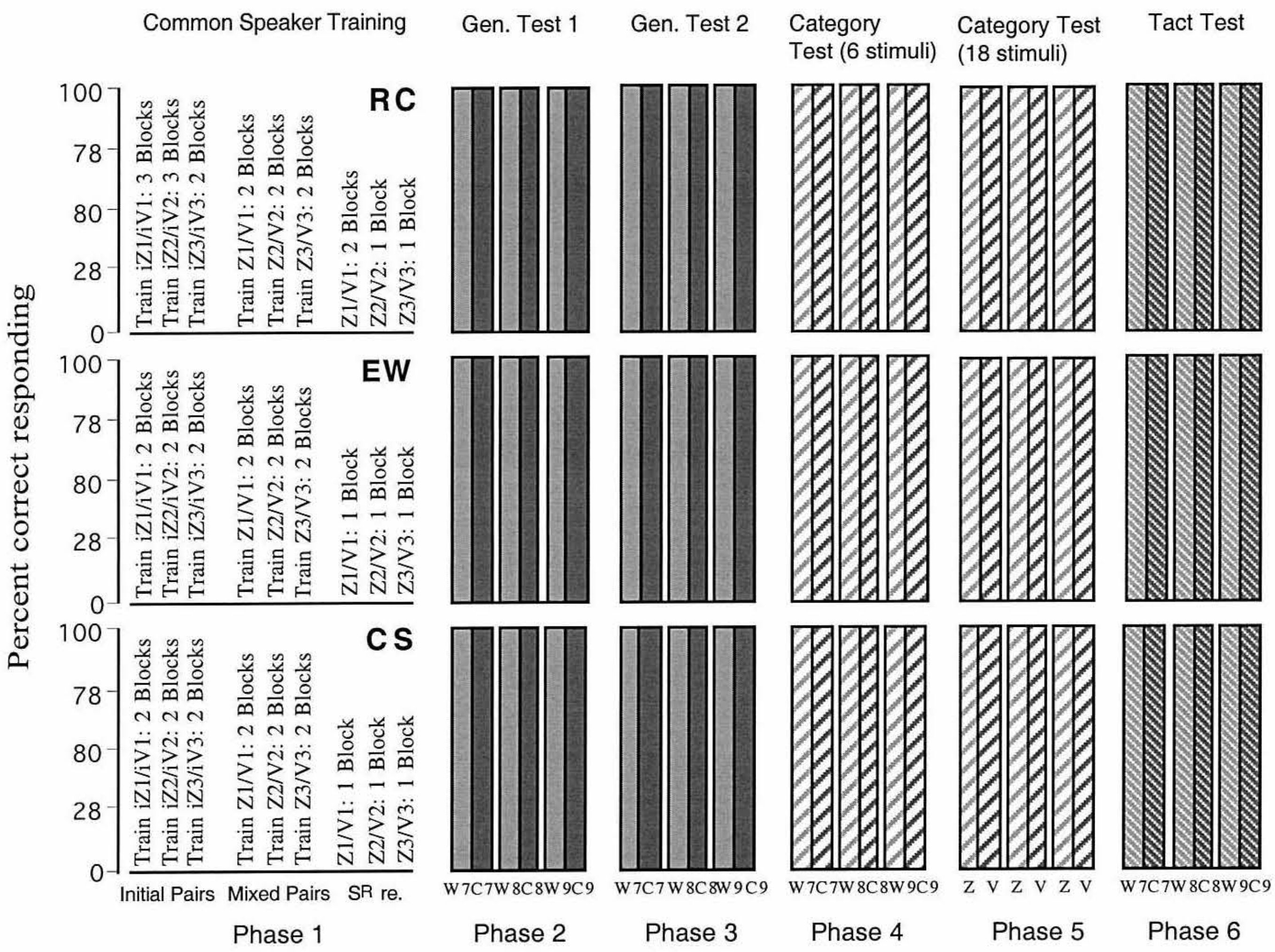
Stage 1.3: Reduction to zero reinforcement. After reaching criterion with each stimulus pair during Stage 1.2, all three participants maintained criterion performance without reinforcement across one block of trials for each stimulus pair.

Participant RC required a total of 17 training blocks; CS and EW each required a total of 15 blocks.

Figure 6.15

Figure 6.15: Performance of RC, EW, and CS on Phases 1 through 6: Phase 1: Common Speaker Training, the number of training blocks to criterion (seven out of eight) for each of the three pairs for the Initial Pairs, Mixed Pairs, and Reduction in Reinforcement (S^R re.) stages.. Phase 2: Generalisation Test 1, percent correct responses, out of 48 trials, 8 for each stimulus. Phase 3: Generalisation Test 2, percent correct responses, out of 24 trials, 4 for each stimulus. Phase 4: Categorisation by Selection Test, percent correct responses, out of 18 trials, 9 trials for the wave and 9 for the clap stimuli. Phase 5: Categorisation by Selection Test (18 stimuli), percent correct responses, out of 6 trials, 3 trials with the zog stimuli and 3 with the vek stimuli, one from each class selected from each of the three sets of stimuli. Phase 6: Tact Test, percent correct responses, out of 24 trials, 4 for each stimulus of Study 9b (Set 3).

Figure 6.15



Common Speaker Training
Gen. Test 1
Gen. Test 2
Category Test (6 stimuli)
Category Test (18 stimuli)
Tact Test
Percent correct responding
100
78
80
28
0
RC
Train iZ1/iV1: 3 Blocks
Train iZ2/iV2: 3 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 2 Blocks
Z2/V2: 1 Block
Z3/V3: 1 Block
EW
Train iZ1/iV1: 2 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
CS
Train iZ1/iV1: 2 Blocks
Train iZ2/iV2: 2 Blocks
Train iZ3/iV3: 2 Blocks
Train Z1/V1: 2 Blocks
Train Z2/V2: 2 Blocks
Train Z3/V3: 2 Blocks
Z1/V1: 1 Block
Z2/V2: 1 Block
Z3/V3: 1 Block
Initial Pairs
Mixed Pairs
SR re.
W7C7W8C8W9C9
Z V Z V Z V
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6

Test Phases: Phase 2: Generalisation Test 1, Phase 3: Generalisation Test 2, Phase 4: Categorisation by Selection Test with all Six Stimuli, Phase 5: Categorisation by Selection Test with 18 Stimuli, and Phase 6: Listener Behaviour Test.

Figure 6.15 shows the percent correct responses for the five test phases: the 48 test trials of Phase 3, 24 test trials of Phase 4, 18 test trials of Phase 5, 6 test trials of Phase 6, and 24 test trials of Phase 6.

All three participants made no errors on any of the five tests; therefore all three demonstrated both naming and categorisation. The criterion level for the test phases was set at 75 percent for each stimulus in a test pair.

Spontaneous verbal behaviour

The only verbalisation that was made during Study 9b was by CS. During the training of the Z7/V7 stimuli she said, "That has to go like that (and then she clapped and waved)."

DISCUSSION

The primary aim of Study 9b was to test for extension of arbitrary six-member classes to nine-member classes. It also provided a matched procedure for Study 8b. As with Study 9a, the listener behaviour test in Study 9b occurred after the tests for categorisation.

All three participants demonstrated both categorisation by generalisation and categorisation by selection after only common speaker training; and all three subsequently showed appropriate listener behaviour to all the experimental stimuli on the listener behaviour test. These findings accord with those of Studies 8a.

The data show that, when trained a common speaker response via the gestural modality, children form classes with arbitrary stimuli. Any existing names also generalise to those new stimuli without direct training. Further, the present data demonstrates that children as young as 33 months old can, on seeing one exemplar, select 8 other arbitrary stimuli form an array of 17 if they have a common name for those stimuli. This provides evidence of the youngest child to pass such categorisation tests with two nine-member classes of formally unrelated stimuli. These results thus extend the findings of Study 8a with one child, to four children, who, when being taught a common response to a number of stimuli through the gestural modality, come to treat those stimuli as "equivalent" on a categorisation by selection test.

GENERAL DISCUSSION

The findings of Study 6 provide preliminary evidence that the timing of a tact test may affect a child's naming of stimuli to which he or she has been trained to previously respond only as a listener. This is in accord with Randle (1999) results; it is also in accord with the evidence from developmental literature, namely, that which shows the independence of speaker and listener functions early in the development of verbal behaviour (Vihman, 1996). However, as regards common speaker training, the evidence suggests that training speaker relations also trains appropriate listener relations; thus the evidence from Study 7 supports the claim made be Horne and Lowe (1996) that (at least in normally developing children) the training of speaker relations also involves the training of appropriate listener relations, and therefore naming.

All participants had shown in previous studies that they had learned to name the zog and vek stimuli. Also, in Study 8a, 8b, 9a, and 9b, participants showed that they could respond as both listeners and speakers to the trained behaviours; thus by Horne and Lowe (1996) definition of naming, it can be argued that these behaviours functioned as manual names, or signs. Given this, the naming account predicts generalisation of the existing vocal functions through the class, and therefore that the children named the stimuli "zog" and "vek" by virtue of the training through the manual modality. On the other hand, the children in Studies 8a, 8b, 9a, and 9b had existing name repertoires of "zog" and "vek" that were established in Studies 6 and 7; thus they may have named the new Set 2 and Set 3 stimuli during the training with the clapping and waving behaviours because these behaviours had been trained to the Pair 1 stimuli from Set 1. Indeed the child's vocalisation during the studies suggested that this may have been the case.

Either way, functions encapsulated within the name repertoire generalised to untrained stimuli by virtue of them being named, using either the vocal or the gestural modalities. This suggests that, once a behaviour has entered into an existing name relation, novel objects trained with that behaviour (in this case clapping and waving) will also come to occasion the name associated with them. As Horne and Lowe (1996) maintain, when novel behaviours enter into a child's existing name relations "each of these new events join the previously encountered stimuli as potential discriminative stimuli for the emission of the verbal response" (p. 204). The data from Studies 8a, 8b, 9a, and 9b support this contention.

CHAPTER 7

Conclusions

Summary of findings

The studies described in the foregoing chapters were designed to test Horne and Lowe's (1996) prediction that naming is necessary for the categorisation of formally unrelated objects and events: if a child is not behaving as both listener and speaker at the time of categorising, categorisation of arbitrary objects should not occur.

In order to falsify the account, categorisation must be shown in the absence of naming. Thus, in all of the studies reported in this thesis, participants were explicitly trained in only one of the component elements of naming, either common listener or common speaker relations.

Study 1a tested for categorisation following training in only common listener relations to two sets of arbitrary shapes; all four participants, aged between 2.5 and 4 years, demonstrated appropriate speaker behaviour, and hence naming, after common listener training; and all four demonstrated categorisation by generalisation. Study 1a demonstrated the extension of the three-member classes to six-member classes. Study 2 tested for categorisation following training in only common speaker relations to two sets of arbitrary shapes; all four participants, aged between 2.5 and 4 years, demonstrated appropriate listener behaviour, and thus naming, after common speaker training; and all four demonstrated categorisation by generalisation. Study 3 tested for categorisation after training in the comprehension of novel behaviour following either common listener training or common speaker training in two children; both demonstrated full naming and categorisation, one after common listener training, the other after common speaker training.

Study 4 attempted to establish common listener relations in the absence of speaker relations in children younger than 2.5 years old. Of the six participants in the study, four demonstrated both appropriate speaker behaviour and categorisation by generalisation; three of these four children also demonstrated categorisation by selection. Two of the children did not demonstrate appropriate speaker behaviour following common listener training; neither did they demonstrate categorisation by generalisation or categorisation by selection. Following common speaker training (i.e., training to name), however, both children demonstrated categorisation by generalisation, and one also demonstrated categorisation by selection. Study 5 explicitly trained common speaker relations in children younger than 2.5 years old. Of the three participants in the study, all demonstrated both appropriate listener behaviour (i.e., naming) and categorisation by generalisation; one child, aged 22 months, also demonstrated categorisation by selection.

Of the 10 participants in Studies 1a and 4, 8 demonstrated full naming following common listener training. Study 6 attempted to train common listener relations in the absence of appropriate speaker relations by not testing for speaker behaviour until after the children had been tested for categorisation. Of the four participants aged between 2.5 and 4 years in Study 6, two demonstrated categorisation by generalisation and selection; both passed the tact test and therefore showed naming. The remaining two children failed all the categorisation tests; they also failed to show naming on the tests. However, one of these children (MW), following common speaker training (i.e., training to name), demonstrated categorisation by generalisation and selection (the other child, AJ, did not receive common speaker training). Likewise, Study 7 attempted to train common speaker relations in the absence of appropriate speaker relations by not testing for listener behaviour until after the tests for categorisation. All three participants demonstrated categorisation, and all demonstrated appropriate listener responding. Studies 8a and 8b examined the extension of classes via the training of common listener relations through the gestural modality. Study 8a demonstrated extension from three-member classes to six–member classes; Study 8b demonstrated extension from six-member classes to nine–member classes. Studies 9a and 9b examined the extension of classes via the training of common speaker relations through the gestural modality and demonstrated extension to six- and nine-member classes, respectively.

To summarise:

Twenty-six children participated in the studies reported in this thesis (see Table 7.1). Of the 15 who were trained common listener relations, 11 showed evidence of naming and all 11 demonstrated categorisation by generalisation; 6 of these 11 were also given the categorisation by selection test and 4 passed. Nine of these children demonstrated naming prior to the categorisation tests, and two after. Of the 15, 4 did not pass naming tests, and neither did they demonstrate categorisation on either categorisation by generalisation or selection. Three of these four children then underwent additional common speaker training; all three passed the categorisation by generalisation test. Two of these three were also given the categorisation by selection test and both passed.

Of the 26 children, 11 were trained common speaker relations; all 11 passed naming tests and all categorised successfully on a categorisation by generalisation test; 4 of these also passed a categorisation by selection test. Of these 11 children, 8 demonstrated full naming prior to categorisation, and 3 after.

Thus, of the 26 children, 4 failed to show categorisation after only demonstrating common listener relations. However, after receiving common speaker training, three of these four passed the categorisation by generalisation test bringing the total to 25 out of 25 children who had naming and were successful on the categorisation by generalisation tests (AJ did not receive common speaker training). Eleven of these children also received the categorisation by selection test; eight passed on their first test but three required additional instructional prompts ("What's this"), one of these three (FJ) passed given this additional prompt, the remaining two (BB & AJ) failed all tests of selection.

These findings support Horne and Lowe's (1996) naming account and the hypotheses that common listener responding alone is not sufficient, and that full naming may be necessary, to bring about categorisation of formally unrelated objects.

Table 7.1: Summary of results. Studies, outcome following training, and number of children successful on each successive test and training phase. The top panel includes all children who participated in the common listener training condition and the bottom panel includes all the children in the common speaker training condition.

Training	Total Number	Outcome on Name test	Gen. Test 1- Prod	Gen. Test 2- Comp	Category Test	Name training	Gen. Test 1- Prod	Gen. Test 2- Comp	Category Test
Common listener training	15 Children	Naming 11/15	11/11	11/11	4/5				
		No Naming 4/15	0/4	0/4	0/4	3	3/3	3/3	2/2
Common speaker training	11 Children	Naming 11/11	11/11	11/11	4/4				

The higher order nature of naming

Two questions arise from these findings regarding the demonstration of naming after training in unidirectional relations: why should exposure to common listener training give rise to full naming in the majority of children? and why should exposure to common speaker training give rise to full naming in all of them?

Horne and Lowe (1996) maintain that naming is a higher order relation (and see Catania, 1998a). They suggest that higher order naming incorporates both listener and speaker behaviour in such a way that the presence of either relation may presuppose the other. They state:

> when higher order naming skills have been established, even if caregivers ostensibly teach the child only conventional listener behavior . . . she will

> nevertheless also exhibit the corresponding speaker behavior. Likewise, when only speaker behaviour is ostensibly taught . . . the child also acquires listener behavior . . . we have shown that once the higher order name relation has been learned by the child, there may be no need for the verbal community to provide reinforcement to establish appropriate speaker and listener behavior; it may be sufficient, for example, for caregivers merely to point to and utter the name of a novel object for the full name relation, incorporating both speaker and listener behavior, to be established. (p.207).

Why should common listener relations give rise to naming? In 11 out of 15 children in the present research, training a unidirectional listener relation resulted in the children also learning corresponding speaker relations, and therefore naming. Given a certain level of verbal sophistication it may be expected that children who can reliably select an object on hearing the object's name (listener responding) may also be able to produce that utterance (speaker responding) when the context requires.

Horne and Lowe (1996) describe how "emergent" behaviours may arise: after learning to listen and echo, the conditions may be present for the child to name objects and events even if the tact component of the name relation is not explicitly trained. For example, if a child responds as a listener by selecting or orienting to a shoe in response to a listener stimulus */shoe/*, and also echoes the stimulus, "shoe", the child is uttering the verbal response (echoic) in the presence of the object. The conditions by which the object can become discriminative for the verbal response are therefore in place (see Chapter 3).

With this in mind, given a training history of echoic responding, and the common listener training as described in these studies, the conditions for the child to name the stimuli may be present, provided the child echoes the listener stimulus given by the experimenter in the presence of the object. The child's prior exposure to reinforced echoing in the context of language learning episodes with the verbal community may be a controlling factor in the child's tendency to echo a heard vocal stimulus; this is the case even if this is not a scheduled contingency within the confines of the study. Further, echoing of the verbal stimulus may be reinforced during the listener training trials. As Catania (1998a) notes, a reinforcing stimulus strengthens not only the response that it immediately follows but also other responses that have previously occurred before in the stream of behavioural responses. Thus, if the child echoes the listener stimulus, this may be strengthened by subsequent scheduled reinforcement for the child's success for selection during the trials.

Evidence to corroborate this assertion comes from the fact that most of the children who participated in this study, and who demonstrated naming following common listener training, also demonstrated echoing of the listener stimuli during training trials (see sections on spontaneous verbal behaviour). Thus it seems, for those children that did demonstrate naming on the tact test, the conditions for them to name were provided during the common listener training when they echoed the verbal stimulus in the presence of the class objects. This said, some children, for example HT & CD, said very little during the common listener training, yet both of these children passed the tact test. From the position of the naming account naming in the absence of previous evidence of overt responding may indicate that the child was covertly echoing the verbal stimulus during the common listener training procedure. Thus the evidence obtained from incorporating a tact test prior to categorisation in common listener training could shed light on covert naming. A reason for the child relying on covert as opposed to overt naming is that the contingencies of reinforcement during common listener training specify selection, but not overt vocalisation.

Interestingly, most spontaneous verbal behaviour occurred during the early training sessions of common listener relations, and these tended to fade as the training progressed. For instance, the three children that completed Study 1a and participated in Study 1b (CG, PW, & SO) showed far less evidence of overt vocalisation during the training sessions of Study 1b than they did in Study 1a. This was also the case with FLJ (Study 6 & 8a).

Further evidence of echoing in the presence of an object brings about naming comes from recent studies of the development of naming. For example, Bell, Horne, and Lowe (2000) provide longitudinal evidence that, following listener training, reinforced echoing in the presence of objects can bring about the conditions for naming of those objects. Conversely, when, following listener training, echoing is reinforced in the absence of the relevant objects (i.e., off-task echoing), naming of those objects does not emerge.

The conditions for naming to arise may be especially prevalent if tact test is part of the experimental procedure: the test for tacting may change the context of the study from a selection context that does not require verbal responding to a naming context that does. The children in Studies 1a and 4 received the tact test immediately after achieving criterion on the common listener training procedure, and 11 out of those 15 children showed naming. Conversely, half the children (two out of four) in Study 6, who received the tact test after tests for categorisation, failed to name following listener training. This latter finding is supported by Randle's (1999) research; this also tested for speaker behaviour after testing for categorisation and found no naming following common listener training in seven out of nine children.

The evidence suggests, therefore, that the temporal position of the tact test may be important in providing children with the context to name during a selection task. In many cases, children may not require the tact test in order to name; this is because their history of exposure to extra-experimental contingencies may be sufficient for them to echo and name given only a listener stimulus. This may be especially the case when the children have an extensive naming repertoire and therefore an extensive history of reinforced echoing. For other children, the selection context of listener training may be insufficient to bring about the naming of those stimuli. However, because only four children participated in Study 6, this issue requires further research before a firm conclusion can be drawn.

Despite naming occurring in the majority of children in the present research following explicit training in a unidirectional relations (hear word → select object), four children trained common listener relations did not demonstrate naming. According to Horne and Lowe (1996), the learning of listener behaviour typically precedes the learning of speaker behaviour, and therefore listener and speaker behaviours are initially independent relations. There is considerable developmental evidence that supports the view that comprehension precedes production in the development of language in the young child (see Vihman, 1996). It is only later, when higher order naming is in place, that teaching one relation may also establish the other (Horne & Lowe, 1996).

Three of the four children who did not demonstrate naming required direct training in the corresponding speaker relations (one participant did not receive speaker training). All four children who failed to show both naming and categorisation showed little evidence of naming during the common listener training procedure (see sections on spontaneous verbal behaviour). Thus, by Horne and Lowe's (1996) account, if the children did not echo the verbal stimulus in the presence of the object, which was the case for these participants, the conditions were not present for the object to gain control over the echoic response and the children should not name.

One participant (HT) demonstrated an independence of the listener and speaker functions of the novel behaviour during Study 3: he was trained to select the Pair 1 objects on seeing the experimenter perform one of the novel behaviours (i.e., a listener relation), and, on testing he demonstrated generalisation of this responding by selecting the untrained objects. However, he did not demonstrate appropriate speaker behaviour on the second test; this required him to produce the behaviour to the untrained objects. He thus required direct training in the production of the novel behaviour after receiving training only in comprehension (listener responding).

This disassociation between listener and appropriate speaker behaviour was also demonstrated both in the Randle (1999) studies and in the studies conducted by Bell et al. (2000). For example, Bell et al. found that listener relations do not give rise to speaker relations; they trained novel listener relations in 18 children aged between 12 and 18 months and none of the young infants demonstrated appropriate speaker relations. Thus, in some contexts at least, naming does not appear to emerge as a consequence of listener training.

Why should common speaker relations give rise to naming? In contrast to the common listener training, all the children in this research who were taught common speaker relations showed appropriate listener responding, and this was irrespective of whether the listener behaviour test occurred before (Studies 2, 3, & 5) or after (Studies 7, 9a, & 9b) the tests for categorisation.

None of the children trained in common speaker relations required direct training in listener relations, and all demonstrated categorisation. This is consistent with the naming account (Horne & Lowe, 1997, p. 290), according to which, teaching a tact relation is in effect teaching a name. Prior to training speaker behaviour, caregivers first train an extensive repertoire of listener responses; when the child's vocal utterances increase, this is followed by the caregivers shaping these utterances into the child's echoic repertoire (Skinner, 1957). In a typical language learning episode, the caregiver, whilst attending to an object, says the name of the object and asks the child to echo the name. The caregiver then reinforces appropriate listener and echoic responding; that is, orienting to the object and uttering the word. According to Horne and Lowe (1997), "The vital feature here is that both the child's speaker behaviour (i.e., her utterance of the word) and her listener behaviour (i.e., her looking at or reaching for the object) are differentially reinforced" (p. 290). Thus a child's previous name training will have established certain patterns of responding such that on hearing a novel verbal stimulus, she orients to the caregiver and then to the object the caregiver is looking at. While looking at the object, the child echoes the word, and this can provide the conditions whereby the object can become discriminative for the utterance that was previously only an echoic response. The behavioural sequence of hearing the word, orienting to the object, echoing the heard stimulus while looking at the object, and re-orienting to the object is then reinforced by the caregiver. As Horne and Lowe (1997) write, "In reinforcing the would-be-tact, caregivers at one and the same time reinforce both echoic behavior and appropriate listener behavior" (p. 290).

Evidence for the teaching of a name given only speaker training was demonstrated in three children in the Randle (1999) study and nine children in the Harris et al. (2000) study. The present findings add to this evidence and indicate that teaching a tact is sufficient to teach corresponding listener relations (i.e., naming); this was demonstrated in 11 children in this thesis. Developmental research has also suggests that, once an infant has learned to make a verbal production in relation to a particular object (i.e., a tact), she invariably also responds appropriately to that object as a listener (Harris, Yeeles,, Chasin, & Oakley, 1995; Huttenlocher & Smiley, 1987).

Spontaneous verbal behaviour. The literature reviewed in Chapter 2 indicates that children respond to novel objects with a "shape bias" (Gathercole, et al., 1999; Markman, 1992). Ten of the children in this study also demonstrated idiosyncratic naming of stimuli that was largely based on the objects shape (see sections on spontaneous verbal behaviour). Interestingly for the present thesis, of the 10 children that did show this type of naming, 8 were trained via the common listener procedure; only JT and BH from the common speaker training procedures showed evidence of naming in line with a shape bias, and these responses were infrequent.

This also raises the broader issue regarding the number of spontaneous verbalisations made during the two procedures. In general, the children who participated in the common listener training made more spontaneous verbalisations during the procedure than did those who participated in the common speaker training. This may have been because, in common speaker training, the child is required to produce the experimentally defined verbalisations "zog" and "vek". This is not the case in common listener training, and therefore the common listener training procedure may lend itself to the production of idiosyncratic names; the evidence from this thesis supports this. However, if this is the case, it has implications for much of the research that has been conducted with verbally sophisticated participants using selection based, or matching, procedures. Procedures that do not specify some form of verbal behaviour may lend themselves to an increase in spontaneous naming or other forms of verbal behaviour. Further, as is evident from the current research, if overt vocalisation is not explicitly specified in a procedure, it may become or remain covert; this fact, however, does not prevent verbal behaviour serving a functional role in the formation of classes: it just makes it difficult to detect because of the private nature of covert responding (Horne & Lowe, 1996).

Implications for competing accounts of symbolic behaviour

Implications for stimulus equivalence. Sidman (1994) maintains that stimulus equivalence is innately given. Potential problems with this conception of stimulus equivalence were reviewed in Chapter 3 of this thesis. Do the results of the studies in this thesis help to resolve any of these issues?

According to Sidman's account, the method of training should not affect the outcome on categorisation tests once the basic conditional discriminations have been learnt; given that the child can reliably select three separate objects on hearing a common listener stimulus, those stimuli should, according to Sidman's account, become equivalent. Thus, given training in relations A1 → B1, A1 → C1, and A1 → D1 (i.e., listener training), the A1, B1, C1, and D1 stimuli should display all the defining properties of stimulus equivalence—reflexivity, symmetry, and transitivity. Therefore, given that a novel behavioural function is trained to one of these stimuli, for example a B1 → E1 relation, all other stimuli within that class should also, via equivalence, evoke that untrained behaviour.

These results, along with the evidence from Randle (1999), have implications for stimulus equivalence as an account of verbal behaviour. In the present research, four children learned only listener relations and all four failed to categorise, until, that is (for three of these children), they had been trained to name. If Sidmans's (1994) account were correct, the children should have shown the following relations:

(a) B1 → A1, C1 → A1, and D1 → A1 symmetry, or speaker behaviour; (b) C1 → E1 and D1 → E1 transitivity, or generalisation; and (c) B1 → C1, B1 → D1, and C1 → D1 transitivity, or categorisation. This failure to respond in line with equivalence theory occurred despite the fact that the basic conditional discriminations were intact. The results of the present thesis do not accord with Sidman's account of stimulus equivalence. They are, however, predicted by the naming account; this is because the children did not name the stimuli involved.

It could be argued that such a generalisation may not have happened for unspecified reasons — contextual confound occurring during the test, for example. Research has indicated occasions when such generalisation or "transfer" failed to manifest on tests even when equivalence classes had been demonstrated (Dougher & Markham, 1996; Wulfert & Hayes, 1988).

The results from this thesis do not support this for two reasons.

First, all four of the children who did not name were given the categorisation by selection test. During this test, one exemplar of a potential class was displayed and the task required selection of the other two potential members. Thus, using the above example of conditional discrimination training, the A1, B1, C1, and D1 stimuli should have become equivalent, and, given the categorisation by selection test each child should have demonstrated transitive relations and have selected all combinations of the stimuli given any of the others as a sample (e.g., they should have selected the C1 and D1 comparison stimuli on seeing the B1 as a sample). This was not the case in the present research, and neither was it the case in the Randle (1999) studies.

Second, if other contextual features of the study were responsible for the failure of the four children to show generalisation, then similar findings should have been shown in some of the other 11 children who were also taught common listener relations. This did not occur. It is more plausible to suggest that the four children didn't show untrained behaviours because the children did not give them a common name.

Given common speaker training, as was conducted in some of the studies in this thesis, equivalence theory also predicts categorisation. Thus, given the training in the conditional relations, B1 → A1, C1 → A1, and D1 → A1 (i.e., speaker training), the A1, B1, C1, and D1 stimuli should have become equivalent. Evidence for transitive relations and categorisation was demonstrated following this training in the present studies. However, the point to emphasise is that equivalence theory makes no distinction on the method of acquiring conditional relations, nor does it maintain that the method of acquisition should result in different outcomes on tests of categorisation. Sidman (1994) maintains that listener (he uses the term *receptive*) and speaker (he uses the term *expressive*) behaviours may be the same process (p.116).

A further issue raised from the current research concerns the fact that some of the children passed the initial tests of categorisation (categorisation by generalisation), but failed the subsequent categorisation by selection tests (e.g., BB & CD). Possible reasons for this have been discussed in previous chapters. However, these findings also have implications for equivalence theory.

Having demonstrated some of the relations defined by equivalence, for example, symmetry in the tact test, and transitivity on the categorisation by generalisation test, the participants (i.e., BB & CD) should have demonstrated, according to Sidman's account, categorisation by selection. On the other hand, Horne and Lowe (1996) mention, "Whether or not subjects succeed on equivalence tests is not a matter of straightforward logical or mathematical relations but rather of a behavioural process that varies with a number of factors" (p.237). It is thus not a mathematical certainty that categorisation behaviour will be shown; this is because complex behaviour in any context is multiply determined.

Implications for relational frame theory. According to relational frame theory, generalised arbitrarily applicable relational responding provides the conditions whereby, if a child has a prior learning history in, for example, categorisation (a frame of co-ordination), and given the same contextual cues, this learning history should allow relational responding to be applicable to novel stimuli. In all the studies reported in this thesis, the children were given categorisation by generalisation and selection training with the familiar objects (Phase 1: pre-training). Given this reinforced pre-exposure, and given the contextual cues of the test situation, categorisation should have occurred following common listener training with novel objects. However, the four children who did not name did not pass the categorisation tests, and this was despite reinforced pre-training that arguably established the "frame" and contextual cues to do so.

This should also have been the case for the children who did not pass the test of categorisation by selection but did pass the generalisation test. Both CD (Study 6) and BB (Study 4) passed both tests of generalisation but failed all the tests of selection, even when they were given the contextual cue, "What's this?" This serves to reinforce the point that success on different categorisation tests is not a mathematical or logical given. Further, according to relational frame theory, as with Sidman's stimulus equivalence, there should be no difference between the outcomes on categorisation tests following common listener and common speaker training.

Relational frame theorists may maintain that the history provided by the pre-training phases was insufficient to establish a frame of co-ordination. What constitutes a sufficient history, however, has not been specified by relational frame theorists. As discussed in Chapter 3, the most detailed specification of a learning history has been supplied by relational frame theory concerns the learning of a name. Hayes and colleagues maintain that learning a name is an example of a frame of co-ordination (Hayes & Hayes, 1992; Lipkens et al., 1993). However, they incorporate generalised imitation and conditioned hearing into their account in order to explain the problem of the non-symmetrical nature of naming behaviours.

Hayes and colleagues have described the conditions whereby conditioned hearing may occasion object naming (and see Carr & Blackman, 1996; Dugdale, 1996; Remington, 1996). The findings of this thesis also have implications for this issue. There should be no reason why children who, following common listener training and failure to demonstrate speaker behaviour on the tact test, should not have learned, for example, the see zog → hear */zog/* (conditioned response) → say "zog" (imitation) chain of responding. This is because, just as those children who had shown speaker behaviour on the tact test, they too were exposed to hear */zog/* → see zog pairings — that is, the conditions whereby conditioned hearing could arise. All that would have been required is that the child also had a generalised imitative repertoire for naming to also arise. This did not occur until the object → word pairings had been directly reinforced — that is, a tact relation had been trained.

Further corroboration of this comes from Randle (1999) and Bell et al. (2000) who both, following training of listener relations, incorporated off-task echoic training into these procedures; that is, echoing the verbal stimulus *in the absence* of the object. Therefore the participants had learnt both the listener relations (the conditions whereby the object could evoke a conditioned hearing response) and had demonstrated echoic responding of that verbal stimulus; thus, given the conditioned hearing explanation of naming as described by Hayes and colleagues (Hayes, 1992; Lipkens et al. 1993), the conditions should have been present for the participants to name the stimuli. However, this did not happen, and the children in these studies also learned to name only when reinforced for vocalising *in the presence* of the object—that is, a tact relation had been trained.

The Lipkens et al. (1993) study is crucial in relational frame theory research. They trained one infant, Charlie, aged 17 months a tact relation (object → word), and on test he demonstrated an appropriate "mutually entailed" response (i.e., word → object). Lipkens et al. write, "The existence of derived stimulus relations in a 17-month-old infant constricts somewhat the view that such relations are dependent upon language mediation, because only very simple language processes can be implicated" (p. 235). They go on to state, "[T]he emergence of name-object symmetry itself presumably does not depend upon language mediation" (p. 235). Nevertheless, it is difficult to rule out the possibility that, during the training of the tact in their study, the infant was reinforced for an orienting response (see Horne & Lowe, 1997, p. 290). This training process describing why the training of a tact may entail the training of appropriate listener behaviour has been explained above (see The higher order nature of naming). The training of listener as well as speaker relations during the tact training may mean that the claims of evidence for derived mutual entailment in one young infant may be premature.

Conversely, when Lipkens et al. (1993) trained their participant, Charlie, a word → object relation, they found no evidence of "mutual entailment". Thus the listener training did not occasion appropriate speaker behaviour, but the speaker training did occasion the appropriate listener behaviour. A more parsimonious explanation for this demonstration of "mutual entailment" following speaker training but failure to demonstrate "mutual entailment" following listener training is that, in the tact training, corresponding word → object relations were also inadvertently trained (Horne & Lowe, 1996, 1997). One benefit of the Horne and Lowe analysis is that there is no recourse to "emergent" or "derived" relations;

rather, the behaviour evidenced is explained as a predictable outcome of a typical language learning episode.

Evaluation of the naming account

Chapter 2 discussed the relationship between categorisation and language, but the key issue of how they are related remained unresolved. For instance, both the psycholinguistic and crosslinguistic evidence testify to a close correlation with the onset of the naming spurt and basic level categorisation (Gopnik & Choi, 1990, 1992; Gopnik & Meltzoff, 1987, 1992). Gopnik and Choi's (1990) data demonstrated that half the children in their study exhibited both the naming spurt and categorisation in the same experimental session and that some of the children in the study showed the naming spurt prior to categorisation, and some after.

Further problems with the psycholinguistic research reviewed in Chapter 2 revolve around the stimuli that are typically used and the lack of control as regards exposure to categorisation tasks. For example, psycholinguistic research is typically undertaken with stimuli that are either identical or very similar to each other (basic level). In addition, research has demonstrated that exposure to certain categorisation tasks facilitates the sorting of formally related objects (Namy, Smith, & Gerskoff-Stowe, 1997). The psycholinguistic research reviewed in Chapter 2 did not control for this exposure. Conclusions built on such research are thus hampered in their ability to make clear claims as to the direction of causality.

The evidence from the present thesis and other recent experimental work on naming provides evidence for a strong correlation between naming and categorisation. But, moving from a correlational account to causal evidence requires a number of criteria to be satisfied. These are, for example: (a) if naming is absent, categorisation should be absent; (b) when naming is present, categorisation can occur; (c) there should be a correspondence in the behavioural timeline of naming and the categorisation of formally unrelated objects; and (d) other processes occurring simultaneously must not be able to account for such behavioural changes. The evidence for the naming account is summarised in the light of these four criteria.

If naming is absent, categorisation should be absent. The evidence indicates that when naming is not present, categorisation does not occur: the four participants that demonstrated only common listener relations, but not the appropriate speaker relations, and therefore did not demonstrate naming, did not demonstrate categorisation. This evidence is supported by the findings from the Randle (1999) study.

It has been argued that organisms that do not name do not categorise formally unrelated objects and events. The evidence reported in Chapter 3 highlighted a number of problems with research claiming to show symbolic categorisation in nonhumans. It was argued that the strong claims for such categorisation behaviour in nonhumans are not justified by the evidence of current research; this is because, for example, in the strongest claim for stimulus equivalence, in the sea lion "Rio" (Schusterman & Kaskak, 1993), procedural peculiarities may explain the results found (see Horne & Lowe, 1997). More importantly, this research has not be replicated in other animals and thus stands alone as an example of success amongst many examples of failure (D'Amato et al., 1985; Lipkens et al., 1988; Sidman, et al., 1982). Because replication of single participant research is *a necessary requirement* before making strong claims of generality (Kazdin, 1982, 1989), support for this evidence (e.g., Fields, 1996; McIlvane & Dube, 1996; K. Saunders & Green, 1996; R. Saunders & Spradlin, 1996) may be premature.

As regard the claims for untrained generalisation (transfer of function) in pigeons, it could be argued that the results from the participants reported in this thesis demonstrated similar results to those found by, for example, Urcuioli et al. (1995) — the participants who were trained common speaker relations (i.e., many-to-one training) demonstrated generalisation, but the participants who were trained common listener relations (i.e., one-to-many training) did not. However, this is ignoring the fact that *all* the participants in the present research who demonstrated common listener relations and did not generalise also did not name those stimuli. Conversely, all the participants that demonstrated generalisation also named. There is no correlate of this pattern of behavioural responding in the studies conducted with nonhumans, and until evidence suggests that unidirectional training can bring about bidirectional responding in nonhumans, it is more parsimonious not to equate the findings of research conducted with nonverbal species and verbal humans.

Thus the evidence points to the necessity of naming to the categorisation of formally unrelated objects and events because in the absence of naming, categorisation of arbitrary objects does not occur, but, when naming is evident, categorisation behaviour often also occurs. Regarding the results from this thesis, the evidence that full naming is not in place is suggested by the strong correlation of the failure to categorise and the failure to show speaker behaviour on tact tests trials, both prior to categorisation (Study 4) and after (Study 6).

When naming is present categorisation can occur. This has been shown to be the case in the evidence reported in this thesis: all 25 children who showed naming of the stimuli in the present research showed evidence of categorisation by generalisation. This is supported by the results of both Randle (1999) and Harris et al. (2000).

Naming, however, may not be sufficient to bring about categorisation of arbitrary stimuli: other factors may be required, and the naming of a set of stimuli does not guarantee that a participant will always pass behavioural tests of categorisation. Evidence to this effect has been shown in the results of this thesis: some participants passed the generalisation tests but failed the categorisation by selection tests. The important factor in demonstrations of naming-driven categorisation is that naming behaviours are initiated, and each element of the name relation (i.e., listener and speaker relations) come to occasion the other. Thus categorisation is not only dependent on the child's existing naming repertoire; it is also dependent on whether the child brings relevant names to bear on a categorisation task.

This is highlighted by the evidence that some of the participants in the studies reported in this thesis failed to categorise on initial tests of categorisation by selection until they were prompted to name the stimuli overtly. Thus it appears the overt prompt to name functioned to bring the relevant naming repertoires to occur in the test context and the participants categorised the stimuli. Participants' failure to pass categorisation by selection tests until prompted to overtly name have been reported by both Randle (1999) and Harris et al. (2000).

There should be a correspondence in the behavioural timeline of naming and categorisation. Categorisation should be demonstrated at the same time as naming behaviour is demonstrated, not before, and not after. The most salient evidence of the correspondence in the behavioural timelines in the present research comes from the three children who failed categorisation tests when they did not show naming but passed such tests immediately following name training. There is no obvious explanation for this success other than the change in their naming behaviours during that period of training.

Other research has shown that categorisation is absent until the participants are trained to name. For example, Lowe and Beasty (1987; and see Dugdale & Lowe, 1990) demonstrated that children under 4 years, who initially failed equivalence tests, passed after they were taught to name the sample-comparison pairs on baseline trials. Evidence also exists that naming behaviour may impair the formation of experimentally defined classes. For example, Dugdale and Lowe (1990) demonstrated that, for some children aged between 4 and 6 years, being given names for classes of stimuli interferes with class formation; this is because the new names contradicted the existing names those children had given to the stimuli.

Other processes occurring simultaneously must not be able to account for the change. A third "general" process may be responsible for both the occurrence of naming and the correlated occurrence of categorisation. Stimulus equivalence and relational framing may be regarded as examples of such a process because both claim to underlie symbolic categorisation and verbal behaviour. The problems with these two accounts have been detailed both in Chapter 3 and in this chapter.

Conceivably, there could also be a maturational process that accounts for the independent development of both categorisation and language. The psycholinguistic evidence reported in Chapter 2 does not support this view because the research points to *specific* relations between the development of certain types of words and certain types of behaviour; a general maturational process would not show this pattern because such a process would result in "global" rather than specific development (Gopnik & Meltzoff, 1992; Gopnik & Choi, 1990). Similarly, the arguments noted above for the corresponding development in the behavioural timeline of naming and categorisation provide evidence against a third "general" factor as an explanation.

Methodological and design issues

Language level. The four children who failed to name the arbitrary objects were normally developing children, and thus, according to Horne and Lowe (1996), would have acquired an extensive naming repertoire and higher order naming. This raises the question of why these children did not name the stimuli after being taught to respond as listeners. Horne and Lowe maintain that if a child does not echo the verbal stimulus in the presence of an object, naming of those objects may not occur (see Chapter 3). Whether this is the case is an empirical matter. Bell, Horne, and Lowe's (2000) data suggests that, even when children can echo a listener stimulus reliably and show appropriate listener responding to the same listener stimulus, naming emerges only when one of two conditions are present: first, the child echoes the verbal stimulus in the presence of the object and thus provides his or herself with the condition whereby the object can come to control a tact response; second, the child is taught explicitly by the experimenter to echo in the presence of the object and is thus taught to name as defined by Horne & Lowe.

Therefore, the explanation of why these children did not name despite the fact that they would have had an existing naming repertoire, rests on the theoretical predictions emanating from the naming account. This prediction is also supported by the data from the spontaneous verbal responses of the four children who did not show either naming or categorisation: none of the children demonstrated extensive echoing of the listener stimulus in the presence of the objects, and none demonstrated spontaneous (i.e., untrained) tacting during the listener training trials.

One of the limitations of the present design was the lack of data collected on the language levels of the participants. Most of the children were given the Griffiths test, and all showed that they were normally developing on this scale. Similar criticisms can be levied at other research studying equivalence or categorisation type phenomena. Nonetheless, such language data should be taken in any future research endeavour in this area. However, this said, it has been difficult to identify suitable tests of language development within the age of children used in these studies. Certainly any research endeavour that identified or developed such language measures with very young children would be of enormous benefit to research in this area.

The need for a pre-test for categorisation. It could be argued that seemingly arbitrary stimuli may share some formal characteristics that would afford categorisation of those stimuli (see, e.g., Horne & Lowe, 1996; Sidman, 1994). One solution to this problem would have been to include a pre-test phase for the individual participants to ensure that the stimuli were in fact formally unrelated. A pre-test categorisation phase is a necessary control in research that uses stimuli in which participants have had, or are likely to have had, previous experience. For example, Sidman and Tailby (1982) note, "Previous studies using English language symbols had required extensive pretests to ensure that the subjects could not already do the critical matching and naming" (p. 8).

The stimuli used in the present design were chosen for their arbitrary nature from a pool of 13 wooden shapes. Each child had a unique configuration of these stimuli that was chosen at random from that pool. A pre-test analysis was not conducted in the present research. Instead, it employed a twofold method for controlling for any unspecified formal relations between the individual stimuli: first, 6 stimuli were randomly allocated to the individual participants from the pool of 13; second, the 6 stimuli were then randomly allocated to the experimentally defined classes of zog and vek. Because of this, any physical similarities between stimuli that may have existed were controlled for. This method of control is common in equivalence type research (see e.g., Sidman & Tailby, 1982).

Similarly, Sidman and Tailby argue against the use of pre-tests in studies that use random allocations of stimuli with which participants are not likely to have had previous experience. For example, they write:

> In order to eliminate both the time required for pretests and the problems created by giving children tasks they were unable to perform, and to avoid the methodological dilemma of whether or not to reinforce correct responses during pretest, this experiment used Greek letters and letter names, stimuli that could be presumed unfamiliar to the subjects and therefore not requiring pretest at all. (p. 8).

If, however, by chance some of the stimuli allocated to an individual child in the present research had shared some formal features —features that afforded their categorisation —then four observations would have been expected from the data.

First, the stimuli that did share formal features would have as likely been allocated to the same experimentally defined class as different experimentally defined class. It would therefore have been expected that some of the children would have formed classes that cut across the experimentally defined classes. The results of the studies in this research indicate that this did not occur.

Second, if formal features of the stimuli afforded some relation between them, this is likely to have been identified by the child's naming behaviour (this may have occurred with TO, see Chapter 4, Experiment 2) and participants would have been likely to designate formally related stimuli as being "the same" (see, e.g., the discussion on the shape bias, Chapter 2).

Third, it would also be expected that there would be some correlation of such object categorisation across individuals — the same stimuli would be categorised by different children regardless of the experimentally defined classes to which those stimuli had been allocated. Again there was no evidence of this.

Finally, it would be expected that classes of varying sizes would emerge during the categorisation tests — classes of two, three, four, perhaps even five stimuli, from the six stimuli presented. The fact that all the children who categorised formed two categories of three stimuli that matched exactly the experimentally defined allocations is at variance with the suggestion that any formal relatedness between the experimental stimuli acted to confound the present findings.

Single case designs and correlational evidence. It could be argued that the current design is not a strict experimental design: rather, it is a correlational design, that is, based on the correlations that only those children who name categorise and only those children who do not name do not categorise. An example of a typical correlational design within the single case research paradigm can be described as an AB design in which an intervention is administered after some measure of baseline. The explanation of any effects observed due to such AB designs is hampered by the fact that variables other than the intervention could be responsible for any observed changes — variables such as history, chance, or observational effects, for instance. Typically in single case research, such factors are controlled in a number of ways; these include the use of a return to baseline or reversal design (ABAB), a multiple baseline design, or a combination of both (Kazdin, 1982).

In a reversal design the intervention is removed after some period in order to determine whether the behaviour returns to pre-intervention levels. In this manner, the reversal design can more confidently ascertain whether the effects were due to the intervention. In a multiple baseline design, the intervention is introduced after a varying period of time with each participant (i.e., multiple baseline across participants). If the behaviour of all the participants changes only after the introduction of the intervention, the experimenter can more confidently conclude that the effect is due to the intervention rather than to other unspecified factors. Generality is achieved in such research by reproducing the effects with multiple participants (Kazdin, 1982; but see Johnston & Pennypacker, 1993).

In common with most of the similarly designed equivalence type research (e.g., Pilgrim & Galazio, 1995, 1996; Sidman & Tailby, 1982), the current design is an example of what can be called a *criterion based design*. In such designs the object of the research is to investigate so called "emergent" or "derived" (i.e., untrained) relations — to train certain relations to a pre-specified criterion level, and subsequently to test for the "emergence" of other untrained relations. In the present design, this involved training either common listener relations or common speaker relations to a set of arbitrary stimuli to a criterion level and subsequently testing (a) whether naming was present, and (b) whether the children categorised those stimuli. In the case of a typical equivalence experiment (e.g., Sidman & Tailby, 1982), this involves the training of A → B and B → C relations to criterion and subsequently testing for the "emergence" of untrained reflexive, symmetrical, and transitive relations.

In the present design the independent variable manipulated was the training of either common listener or common speaker relations. This is a defensible approach given both the predictions that emerge from the naming account and the history of similarly designed research emanating from the equivalence paradigm. Although, on this last issue, it is acknowledged that recourse to a history of similar research is not an argument for the validity of an approach per se, it merely makes the point that other researchers have found it useful to use similar experimental designs.

In the present research, the common listener and the common speaker behaviour are the independent variables. If the design is translated into a typical baseline-intervention type design that is common in single case research, the present research design would translate into the following formats. First, the common listener training procedure would translate as a $B_1A_1A_2$ format, in which B_1 is the common listener intervention, A_1 is the naming test (i.e., in this context a tact test), and A_2 is the categorisation test (note that in Experiment 6 this would be a $B_1A_2A_1$ design). When the children who failed to name were given common speaker training (i.e., name training) this would amount to a B_2 phase. Thus, for the children who received both common listener and common speaker training, the design would translate into a $B_1A_1A_2B_2A_2$ design (or $B_1A_2A_1B_2A_2$ for Experiment 6). Second, the common speaker training procedure would translate as a $B_2A_3A_2$ format, in which B_2 is the common speaker intervention, A_3 is the naming test (i.e., in this context a listener behaviour test), and A_2 is the categorisation test (note that in Experiment 7 this would be a $B_2A_2A_3$ design). Because all the children given this design passed the naming tests, there was no need to train common listener behaviour (i.e., the B_1 Phase).

Evidence of the "emergence" of categorisation would be indicated, though not proven of course, if, and only if, categorisation occurred after the children had demonstrated naming. The evidence for this would be stronger if this occurred only after naming had been demonstrated across multiple participants (Kazdin, 1982). The evidence would be strengthened if, on each occasion that naming did not occur, categorisation did not occur, and if this double test failure also occurred with multiple participants. The evidence would be further strengthened if these participants were exposed to a name training phase (of varying duration with each participant) and immediately after such training they demonstrated categorisation. Finally, the evidence would be strengthened if the categorisation tests were conducted at varying periods with each individual participant—that is, each participant experienced training phases that varied in duration and were therefore tested at different times.

One potential improvement to the current design would have been the introduction of a multiple probe such that the participants were tested for categorisation at different times during the procedure, whether or not they had demonstrated naming. In this manner it would be easy to demonstrate whether categorisation emerges only after naming or whether it emerges because of other factors—for instance, after some period of experience with the stimuli. However, despite the potential merits of such a design, it would introduce the potential confounding problem of repeated training and testing procedures (e.g., Wulfert & Hayes, 1988).

The second potential improvement to the current design would have been the use of a multiple baseline design. In such a design it would have been necessary for a number of children to have been trained, in for example common listener relations, at the same time and brought up to criterion responding for all three pairs of stimuli. Then, after a specified period of criterion responding, only one of the children was given a naming tests followed by a categorisation test. Then the other participants would have been treated in a same manner on a staggered introduction of the naming and categorisation tests. If after failing such tests, name training was introduced, again on a multiple baseline across participants, evidence for the naming account could be confidently concluded if the changes in categorisation behaviour coincided only with the changes in the child's naming behaviours. Although in principle such a design would have been strong, in practice it would have faced the problem of increasing the level of participant attrition, particularly with those children that were kept on maintenance training while waiting for their intervention. Furthermore, although not a strict multiple baseline design, the present research did introduce name and categorisation tests with individual participants at different times and after different periods of training.

A third design consideration would be the use of a within-subject design. For example, if a child, having been taught common listener behaviour to two sets of objects, demonstrates naming with only one of these sets, then naming theory would predict that the child would categorise only the stimuli that had been named, and not the stimuli to which the child was only responding as a listener. Such within-subject designs would have the potential to provide strong evidence for or against the naming account. However, a potential problem with such a design is that, possibly, once the child had learned to name one set of objects within a particular experimental context, the context could have provided the history for similar responding with the second set of stimuli. This difficulty may be overcome by the use of two separate experimental contexts — different rooms and different stimuli, for instance. Nonetheless, despite the practical difficulties, the benefits of such within-subject demonstrations would make the attempts worthy of consideration for future research.

Exclusion. It could be argued that responding by exclusion could be an explanation for some of the results found because all the generalisation test trials involved the presentation of one zog and one vek stimulus (see also p. 235). If the child was responding in terms of exclusion then it is difficult to see how the child would have come to show naming as defined by Horne and Lowe (1996). This is because the participants were only taught a unidirectional relation (either common listener or common speaker). Conceivably the child could have formed only one class of stimuli, say the veks, and could be responding to zogs by exclusion. Thus on trials were a zog stimulus was the target the process could have been described as "point to the other" (listener training) or "say 'zog' to the other" (speaker training).

There are four reasons why this is unlikely given the present design and the data collected. First, the untrained emergence of either common listener or common speaker behaviour would not have been expected for the "exclusion" stimuli if exclusion as a process was responsible for the responding for one of the classes. Second, it would have been expected that the participants would respond to either one of the stimuli within a pair, but not always the stimulus from the same class. That is, why would exclusion result in for example only the veks being named and all the zogs being responded to by exclusion, or vice versa? Third, to suggest that exclusion was responsible for the seeming classification of some of the stimuli would be to violate the law of parsimony because it would suggest that topographical evidence of tacting obtained from the research was, in fact, evidence of some other process. Finally, it would not be expected that ill defined processes such as exclusion would occur across multiple participants.

Future directions.

One objective of the studies in this thesis was to falsify the Horne and Lowe (1996) account of naming. In order to disprove the theory, evidence of categorisation would need to be demonstrated in the absence of naming behaviours. This did not occur with any of the children in this research, but future research should continue the endeavour. The current findings suggest a number of ways this should proceed.

First, efforts should focus on children who are just acquiring names for objects and events; these children, aged between 15 to 20 months, are more likely to show a disassociation between listener and speaker relations — children first learn to listen, then they learn to speak. Following from this, it is hypothesised that attempts to train listener relations in the absence of appropriate speaker behaviour may be more successful than attempts to teach common speaker relations in the absence of appropriate listener behaviour.

Second, the present research found that two out of four children who received the tact test after the categorisation tests failed to demonstrate naming (Study 6). This is supported by the evidence from nine children from the Randle (1999) study. These studies suggest that, in the aim of demonstrating common listener relations in the absence of naming, tact tests should be conducted after tests for categorisation. However, as mentioned, this issue requires further research because the numbers involved in the particular studies investigating this issue were small.

Third, the method of categorisation may also be important in demonstrations of symbolic behaviour. The present research has suggested that categorisation by generalisation is an effective method of testing for categorisation behaviours in addition to the categorisation by selection method used in other research on naming (Harris, et al., 2000; Randle, 1999). Indeed, the results of this thesis suggest that, in certain contexts, categorisation by generalisation may be a more sensitive method of testing for categorisation.

According to the naming account, naming is a learned higher-order relation comprising three more basic relations. Preliminary research investigating the development of individual names in young infants has been conducted by Bell et al. (2000). For example, Bell et al. demonstrated that listener, echoic, and tact relations are independent in the young infant. Further, they remain so until naming is established via directly reinforced echo-tact relations; that is, when the child is reinforced for echoing a listener stimulus in the presence of the object. Bell et al. also demonstrated that higher order naming "emerges" within the confines of the experimental situation they studied, after a minimum of six reinforced examples of echo-tact relations. However, these studies were only preliminary and more empirical investigations are required into the controlling variables that occasion naming behaviours in young infants. Such research has obvious implications for language training in applied settings (Stromer, MacKay, & Remington, 1996).

One of the problems experienced by people with learning difficulties is the inability to generalise learning between situations (and see Harris, 1998). The results of this thesis highlight the importance of functional language in the generalisation of untrained behaviours. Although the studies reported here are not of a clinical nature, the finding that naming behaviour is an effective source of generalisation may have relevance to work with clinical populations. Remington (1991) writes:

> the effect of an intervention that creates functional language skills must produce major changes in the functioning of people with mental handicap. Apart from simply enhancing efficient control over their environments, verbal behaviour opens a gateway to a completely different mode of relating to experience. (p 16).

A number of the behavioural programmes that deal with children with autistic spectrum disorders focus on verbal behaviour (e.g., Leaf & McEachin, 1999; Greer, 1997; Sundberg & Partington, 1998). In the Comprehensive Application of

Behavior Analysis to Schooling (CABAS) system (Greer, 1997), for instance, Skinner's (1957) classification of verbal behaviour is a salient focus for the intensive curriculum. In this training program, a child is taught first to respond as a listener, then as a speaker (this entails echoic responding), then a speaker-listener to self, a reader, writer, and so on through Skinner's verbal classification. This is also the case for other ABA programmes (e.g., Sundberg & Partington, 1998).

Because the naming account is based on Skinner's functional analysis, it fits well into such programmes. Indeed, because the naming account explains emergent and generalised behaviours — behaviours that, it is argued, Skinner's account fails to explain — the account also informs practice. Stromer, et al. (1996) note, "Both basic and applied science will benefit from the thorough study of the conditions under which naming — whether spoken, signed, written or constructed — participates in the formation and elaboration of feature and arbitrary stimulus classes" (p.427). The results from the present thesis indicate that children who do not show the appropriate naming behaviours do not generalise functions from one object to another, and by extension, from one situation to another.

Conclusion.

The first aim of this thesis was to test the prediction that naming is necessary for the categorisation of formally unrelated objects. The naming account is a theoretical proposal that builds on Skinner's analysis of verbal behaviour while drawing on the ideas of both Mead (1934) and Vygotsky (1978, 1986). According to Horne and Lowe (1996), the account address the shortcoming of Skinner's analysis, and the name relation specifies how names embody meaning, reference, understanding, and explain symbolic categorising behaviour, including success on stimulus equivalence tests.

Horne and Lowe (1996) specify the conditions under which children learn their first names and how these names combine listener and speaker functions that enable children to categorise objects and events in their world. Naming *is* classifying behaviour. The studies reported in this thesis accord with this claim and provide support for the Horne and Lowe (1996) naming account; however, further research is required in order to fully test the various features of this account.

The second aim of this thesis, theoretical issues aside, was to investigate categorisation behaviours in general, and more specifically, the generalisation of untrained ("emergent") behaviours through classes of stimuli. One important behavioural effect that naming entails, and one which the studies in this thesis highlight, is this: behaviours taught to a subset of a class will not only occur in relation to that subset, they will also enter into the name relation of the class of which the subset is a member. Thus the behaviour is evoked, not only by directly trained objects, but also by other class objects that bear the same name; what is more, this occurs even when class members are formally unrelated. The behaviour may be said to come "free" by virtue of inclusion in a name relation. Such behaviours can be evoked by the name alone, and in the absence of direct contact with the named object or event. This is what is meant by verbal generalisation. The implications for the learning of organisms behaving in this manner are pervasive.

REFERENCES

Alessi, G. (1987). Generative strategies and teaching for generalization. *The Analysis of Verbal Behavior, 5*, 15–27.

Andresen, J. T. (1992). The behaviorist turn in recent theories of language. *Behavior & Philosophy, 20*, 1–19.

Anisfield, M. (1984). *Language development from birth to three*. London: Lawrence Erlbaum Associates.

Barnes, D., & Keenan, M. (1993). A transfer of functions through derived arbitrary and nonarbitrary stimulus relations: Erratum. *Journal of the Experimental Analysis of Behavior. Special Issue: The nature of reinforcement, 60*, 16.

Barnes, D., McCullaugh, P. D., & Keenan, M. (1990). Equivalence class formation in non-hearing impaired children and hearing impaired children. *The Analysis of Verbal Behavior, 8*, 19–30.

Barnes, D., & Roche, B. (1996). Relational frame theory and stimulus equivalence are fundamentally different: A reply to Saunder's commentary. *Psychological Record, 46*, 489–507.

Bates, E., Shore, C., Bretherton, I., & McNew, S. (1983). Names, gestures, and objects: Symbolization in infancy and aphasia. In K. Nelson (Ed.), *Children's Language* (Vol. 4, pp. 59–121). Hillsdale, NJ: Lawrence Erlbaum.

Bell, M. H., Lowe, C. F., & Horne, P. J. (2000). *How is naming learned?* Paper presented at the 4th European Meeting for the Experimental Analysis of Behaviour, Amiens, France.

Bentall, R. P., Dickins, D. W., & Fox, S. R. (1993). Naming and equivalence: Response latencies for emergent relations. *Quarterly Journal of Experimental Psychology: Comparative and Physiological Psychology, 46B*, 187–214.

Bentall, R. P., Lowe, C. F., & Beasty, A. (1985). The role of verbal behavior in human learning: II. Developmental differences. *Journal of the Experimental Analysis of Behavior, 43*, 165–180.

Bickerton, D. (1995) *Language and human behaviour*. The Jessie & John Danz Lectures. Seattle, WA: University of Washington Press.

Boelens, H. (1996). Accounting for stimulus equivalence: Reply to Hayes and Wilson. *Psychological Record, 46*, 237–242.

Bowerman, M. (1989). Learning a semantic system: What role do cognitive predispositions play? In M. L. Rice & R. L. Schiefelbusch (Eds.), *The* *teachability of language* (pp. 133–169). Baltimore, MD: Paul H. Brookes Publishing.

Bowerman, M. (1994). From universal to language-specific in early grammatical development. *Philosophical Transactions of the Royal Society, London, B436*, 37–45.

Bowerman, M. (1996). Learning how to structure space for language: A crosslinguistic perspective. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), *Language and space* (pp. 385-436). Cambridge, MA: The MIT Press.

Bruner, J. S. (1977). Early social interaction and language acquisition. In H. R. Schaffer (Ed.), *Studies in mother-infant interaction* (pp. 271–289). New York: Academic Press.

Bruner, J. S. (1978). *Joint attention: Its origin and role in development*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Carr, D., & Blackman, D. E. (1996). Equivalence relations, naming, and generalized symmetry. *Journal of the Experimental Analysis of Behavior, 65*, 245–247.

Catania, A. C. (1998a). *Learning (4th ed.)*. Upper Saddle River, NJ: Prentice-Hall.

Catania, A. C. (1998b). The taxonomy of verbal behavior. In K. A. Lattal & M. Perone (Eds.), *Handbook of research methods in human operant behavior* (pp. 405–433). New York: Plenum Press.

Catania, A. C., Horne, P. J., & Lowe, C. F. (1989). Transfer of function across members of an equivalence class. *The Analysis of Verbal Behavior, 7*, 99–110.

Chapman, M., & Lindenberger, U. (1988). Functions, operations, and decalage in the development of transitivity. *Developmental Psychology, 24*, 542–551.

Chomsky, N. (1959). Review of *Verbal Behavior* by B. F. Skinner. *Language, 35*, 26–58

Chomsky, N. (1980). *Rules and representations*. New York: Columbia University Press.

D'Amato, M. R., Salmon, D. P., Loukas, E., & Tomie, A. (1985). Symmetry and transitivity of conditional relations in monkeys (Cebus apella) and pigeons (Columba livia). *Journal of the Experimental Analysis of Behavior, 44*, 35–47.

Davidson, T. L., Aparicio, J., & Rescorla, R. A. (1988). Transfer between Pavlovian facilitators and instrumental discriminative stimuli. *Animal Learning & Behavior, 16*, 285–291.

Deacon, T. (1997). *The symbolic species: The co-evolution of language and the human brain*. Penguin Books Ltd. London.

DeCasper, A. J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science, 208*, 1174–1176.

DeLong, R. E., & Wasserman, E. A. (1985). Stimulus selection with duration as a relevant cue. *Learning & Motivation, 16*, 259–287.

Devany, J. M., Hayes, S. C., & Nelson, R. O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior, 46*, 243–257.

Dixon, L. S. (1977). The nature of control by spoken words over visual stimulus selection. *Journal of the Experimental Analysis of Behavior, 27*, 433–442.

Dixon, M. H., & Spradlin, J. E. (1976). Establishing stimulus equivalences among retarded adolescents. *Journal of Experimental Child Psychology, 21*, 144–164.

Donahoe, J. W., & Palmer, D. C. (1994). *Learning and complex behavior*. Boston: Allyn & Bacon.

Dougher, M. J., & Markham, M. R. (1994). Stimulus equivalence, functional equivalence and the transfer of function. In S. C. Hayes, L. J. Hayes, M. Sato, & J. Ono (Eds.), *Behavior analysis of language and cognition* (pp. 71–90). Reno, NV: Context Press.

Dougher, M. J., & Markham, M. R. (1996). Stimulus classes and the untrained acquisition of stimulus functions. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus class formation in humans and animals: Advances in psychology, No. 117* (pp. 137–152). Amsterdam: Elsevier.

Dugdale, N. (1996). Naming, stimulus equivalence, and conditioned hearing. *Journal of the Experimental Analysis of Behavior, 65*, 272–274.

Dugdale, N., & Lowe, C. F. (1990). Naming and stimulus equivalence. In D. E. Blackman & H. Lejeune (Eds.), *Behaviour analysis in theory and practice: Contributions and controversies* (pp. 115–138). Hove: Lawrence Erlbaum Associates.

Dugdale, N., & Lowe, C. F. (2000). Testing for symmetry in the conditional discriminations of language-trained chimpanzees. *Journal of the Experimental Analysis of Behavior, 73*, 5–22.

Dymond, S., & Barnes, D. (1994). A transfer of self-discrimination response functions through equivalence relations. *Journal of the Experimental Analysis of Behavior, 62*, 251–267.

Dymond, S., & Barnes, D. (1995). A transformation of self-discrimination response functions in accordance with the arbitrarily applicable relations of sameness, more than, and less than. *Journal of the Experimental Analysis of Behavior, 64*, 163–184.

Dymond, S., & Barnes, D. (1996). A transformation of self-discrimination response functions in accordance with the arbitrarily applicable relations of sameness and opposition. *Psychological Record, 46*, 271–300.

Edwards, C. A., Jagielo, J. A., Zentall, T. R., & Hogan, D. E. (1982). Acquired equivalence and distinctiveness in matching-to-sample by pigeons: Mediation by reinforcer-specific expectancies. *Journal of Experimental Psychology: Animal Behavior Processes, 8*, 244–259.

Eikeseth, S., & Smith, T. (1992). The development of functional and equivalence classes in high-functioning autistic children: The role of naming. *Journal of the Experimental Analysis of Behavior, 58*, 123–133.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development, 8*, 181–195.

Fields, L. (1996). The evidence for naming as a cause or facilitator of equivalence class formation. *Journal of the Experimental Analysis of Behavior, 65*, 279–282.

Fields, L., & Verhave, T. (1987). The structure of equivalence classes. *Journal of the Experimental Analysis of Behavior, 48*, 317–332.

Foster, S. H. (1990). Developmental pragmatics. In H. Winitz (Ed.), *Human communication and its disorders: A review* (pp. 64–134). Norwood, NJ: Ablex Publishing Corp.

Gathercole, V. C. (1979). The acquisition of more and less: A critical review. *Kansas Working Papers in Linguistics, 4*, 99–128.

Gathercole, V. C. (1985). More and more and more about more. *Journal of Experimental Child Psychology, 40*, 73–104.

Gathercole, V. C. M., & Min, H. (1997). Word meaning biases or language-specific effects? Evidence from English, Spanish and Korean. *First Language, 17*(49, Pt 1), 31–56.

Gathercole, V., C. M, Thomas, E. M., & Kim, S. (1999). Cue coordination: An alternative to word meaning biases. In L. A. Michaelis, B. A. Fox, & D. Jurafsky (Eds.), *Cognition and Function in Language*. Stanford: CSLI.

Goldiamond, I. (1966). Perception, language, and conceptualization rules. In B. Kleinmuntz (Ed.), *Problem solving*. New York: Wiley.

Golinkoff, R., Bailey, L., Wenger, N., & Hirsh-Pasek, K. (1989, April). *Conceptualizing constraints: Why and how many?* Paper presented at the Biennial Meeting of the Society for Research in Child Development, Kansas City, MO.

Gopnik, A., & Choi, S. (1990). Do linguistic differences lead to cognitive differences? A cross-linguistic study of semantic and cognitive development. *First Language, 10*, 199–215.

Gopnik, A., & Choi, S. (1992). Early acquisition of verbs in Korean: A cross-linguistic study. *Journal of Child Language, 22*, 497–529.

Gopnik, A., Choi, S., & Baumberger, T. (1996). Cross-linguistic differences in early semantic and cognitive development. *Cognitive Development, 11*, 197–227.

Gopnik, A., & Meltzoff, A. N. (1984). Semantic and cognitive development in 15 to 21-month-old children. *Journal of Child Language, 11*, 495–513.

Gopnik, A., & Meltzoff, A. N. (1986). Relations between semantic and cognitive development in the one-word stage: The specificity hypothesis. *Child Development, 57*, 1040–1053.

Gopnik, A., & Meltzoff, A. N. (1987). The development of categorization in the second year and its relation to other cognitive and linguistic developments. *Child Development, 58*, 1523–1531.

Gopnik, A., & Meltzoff, A. N. (1992). Categorization and naming: Basic-level sorting in eighteen-month-olds and its relation to language. *Child Development, 63*, 1091–1103.

Gray, H. (1978). Learning to take an object from the mother. In A. Locke (Ed.), *Action, gesture and symbol: The emergence of language* (pp. 159–182). New York: Academic Press.

Green, G. (1990). Differences in development of visual and auditory-visual equivalence relations. *American Journal on Mental Retardation, 95*, 260–270.

Green, G., & Saunders, R. R. (1998). Stimulus equivalence. In K. A. Lattal & M. Perone (Eds.), *Handbook of research methods in human operant behavior: Applied clinical psychology* (pp. 229–262). New York: Plenum Press.

Greer, R. D. (1997). The Comprehensive Application of Behavior Analysis to Schooling (CABAS®). *Behavior & Social Issues, 7*, 59–63.

Hall, G. A., & Chase, P. N. (1991). The relationship between stimulus equivalence and verbal behavior. *Analysis of Verbal Behavior, 9*, 107–119.

Harnad, S. (1990). The symbol grounding problem. *Physica D, 42*, 335–346.

Harris, F. D. A., Randle, R. L., Horne, P. J., & Lowe, C. F. (2000). *Naming, stimulus classes and categorisation*. Paper presented at the 4th European Meeting for the Experimental Analysis of Behaviour, Amiens, France.

Harris, J. R. (1998). *The nurture assumption: Why children turn out the way they do*. London: Bloomsbury.

Harris, M., Jones, D., & Grant, J. (1983). The nonverbal context of mothers' speech to infants. *First Language, 4*, 21–30.

Harris, M., Yeeles, C., Chasin, J., & Oakley, Y. (1995). Symmetries and asymmetries in early lexical comprehension and production. *Journal of Child Language, 22*, 1–18.

Hayes, S. C. (1989). *Rule-governed behavior: Cognition, contingencies, and instructional control.* New York: Plenum.

Hayes, S. C. (1991). A relational control theory of stimulus equivalence. In L. J. Hayes & P. N. Chase (Eds.), *Dialogues on verbal behavior* (pp. 19–40). Reno, NV: Context Press.

Hayes, S. C. (1992). Verbal relations, time, and suicide. In S. C. Hayes & L. J. Hayes (Eds.), *Understanding verbal relations* (pp. 109-118). Reno, NV: Context Press.

Hayes, S. C. (1994). Relational frame theory: A functional approach to verbal events. In S. C. Hayes, L. J. Hayes, M. Sato, & K. Ono (Eds.), *Behavior analysis of language and cognition* (pp. 9–30). Reno, NV: Context Press.

Hayes, S. C., & Hayes, L. J. (1989). The verbal action of the listener as a basis for rule-governance. In S. C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 153–190). New York: Plenum Press.

Hayes, S. C., & Hayes, L. J. (1992). Verbal relations and the evolution of behavior analysis. *American Psychologist, 47*, 1385–1392.

Hayes, S. C., Gifford, E. V., & Wilson, K. G. (1996). Stimulus classes and stimulus relations: Arbitrary relational responding as an operant. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus class formation in humans and animals: Advances in psychology, 117*. Amsterdam: Elsevier.

Hayes, S. C., & Wilson, K. G. (1996). Criticisms of relational frame theory: Implications for a behavior analytic account of derived stimulus relations. *The Psychological Record, 46*, 221–236.

Hearst, E. (1989). Backward associations: Differential learning about stimuli that follow the presence versus the absence of food in pigeons. *Animal Learning & Behavior, 17*, 280–290.

Hirsh-Pasek, K., Golinkoff, R. M., & Reeves, L. (1994). Constructivist explanations for language acquisition may be insufficient: The case for language-specific principles. In W. F. Overton & D. S. Palermo (Eds.), *The nature and ontogenesis of meaning*.

Hogan, D. E., & Zentall, T. R. (1977). Backward associations in the pigeon. *American Journal of Psychology, 90*, 3–15.

Horne, P. J., & Lowe, C. F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 185–241.

Horne, P. J., & Lowe, C. F. (1997). Toward a theory of verbal behavior. *Journal of the Experimental Analysis of Behavior, 68*, 271–296.

Horne, P. J., & Lowe, C. F. (in press). Putting the naming account to the test: Preview of an experimental program. To appear in J. C. Leslie & D. Blackman (Eds.), *Issues in experimental and applied analysis of human behaviour*. Reno, NV: Context Press.

Hull, C. L. (1939). The problem of stimulus equivalence in behavior theory. *Psychological Review, 46*, 9–30.

Huttenlocher, J., & Smiley, P. (1987). Early word meanings: The case of object names. *Cognitive Psychology, 19*, 63–89.

Jenkins, J. J. (1963). Mediated associations: Paradigms and situations. In C. N. Cofer (Ed.), *Verbal behavior and learning: Problems and processes* (pp. 210–245). New York: McGraw-Hill.

Jones, S. S., Smith, L. B., & Landau, B. (1991). Object properties and knowledge in early lexical learning. *Child Development, 62*, 499–516.

Katz, N., Baker, E., & Macnamara, J. (1974). What's in a name? A study of how children learn common and proper names. *Child Development, 45*, 469–473.

Kazdin, A. E. (1982). *Single-case research designs: Methods for clinical and applied settings*. New York: Oxford University Press.

Kazdin, A. E. (1989). *Behavior modification in applied settings*. Belmont, CA: Brooks/Cole Publishing.

Knapp, T. J. (1990). Verbal behavior and the history of linguistics. *The Analysis of Verbal Behavior, 8*, 151–153.

Knapp, T. J. (1992). Verbal behavior: The other reviews. *The Analysis of Verbal Behavior, 10*, 87–95.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago, IL: University of Chicago Press.

Landau, B. (1994). Object shape, object name, and object kind: Representation and development. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 31, pp. 253–304). San Diego, CA: Academic Press.

Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3*, 299–321.

Langer, J. (1982). From prerepresentational to representational cognition. In G. Forman (Ed.), *Action and thought* (pp. 37–63). New York: Academic Press.

Leaf, R., & McEachin, J. (1999). *A work in progress: Behavior management* *strategies and a curriculum for intensive behavioral treatment of autism.* New York: DRL Books, L.L.C.

Lee, V. L. (1984). Some notes on the subject matter of Skinner's *Verbal Behavior. Jounal of the Experimental Analysis of Behavior, 12*, 29–40.

Lieberman, D. A. (1990). *Learning: Behavior and cognition.* Belmont, CA: Wadsworth Publishing Company.

Lipkens, R., Hayes, S. C., & Hayes, L. J. (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology, 56*, 201–239.

Lipkens, R., Kop, P. F., & Matthijs, W. (1988). A test of symmetry and transitivity in the conditional discrimination performances of pigeons. *Journal of the Experimental Analysis of Behavior, 49*, 395–409.

Lowe, C. F. (1979). Determinants of human operant behavior. In P. Harzem & M. D. Zeiler (Eds.), *Advances in the analysis of behavior (*Vol. 1, pp. 159–192). New York: Wiley.

Lowe, C. F. (1986, May). *The role of verbal behavior in the emergence of equivalence relations.* Paper presented at the meeting of the Association of Behavior Analysis, Milwaukee, WI.

Lowe, C. F., & Beasty, A. (1987). Language and the emergence of equivalence relations: A developmental study. *Bulletin of the British Psychological Society, 40*, 42.

Lowe, C. F., & Horne, P. J. (1996). Reflections on naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 315–340.

Lowe, C. F., Horne, P. J., & Higson, P. J. (1987). The hiatus between theory and practice in clinical psychology. In H. J. Eysenck & I. Martin (Eds.), *Theoretical foundations of behavior therapy* (pp. 153–165). New York: Plenum.

Manabe, K., Kawashima, T., & Staddon, J. E. R. (1995). Differential vocalization in budgerigars: Towards an experimental analysis of naming. *Journal of the Experimental Analysis of Behavior, 63*, 111–126.

Mandell, C., & Sheen, V. (1994). Equivalence class formation as a function of the pronounceability of the sample stimulus. *Behavioural processes, 32*, 29–46.

Mandler, J. M. (1996). Preverbal representation and language. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), *Language and space: Language, speech, and communication* (pp. 365–384). Cambridge, MA: MIT Press.

Markman, E. M. (1989). *Categorization and naming in children: Problems of induction.* Cambridge, MA: MIT Press.

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science, 14*, 57–77.

Markman, E. M. (1991). The whole object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings. In J. P. Byrnes & S. A. Gelman (Eds.), *Perspectives on Langauge and Cognition: Interrelations in Development* (pp. 72–106). Cambridge: Cambridge University Press.

Markman, E. M. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity. In M. Gunnar & M. Maratsos (Eds.), *Modularity and constraints in language and cognition: The Minnesota Symposia of Child Psychology* (Vol. 25, pp. 59–101). Hillsdale, NJ: Erlbaum.

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology, 16*, 1–27.

Matthews, B. A., Shimoff, E. H., Catania, A. C., & Sagvolden, T. (1977). Uninstructed human responding: Sensitivity to ratio and interval contingencies. *Journal of the Experimental Analysis of Behavior, 27*, 453–467.

McIlvane, W. J., & Dube, W. V. (1996). Naming as a facilitator of discrimination. *Journal of the Experimental Analysis of Behavior, 65*, 267–272.

McIlvane, W. J., Kledaras, J. B., Munson, L. C., King, K. A., & de Rose, J. C. (1987). Controlling relations in conditional discrimination and matching by exclusion. *Journal of the Experimental Analysis of Behavior, 48*, 187–208.

Mead, G. H. (1934). *Mind, self and society*. Chicago: University of Chicago Press.

Messer, D. J. (1978). The integration of mothers' referential speech with joint play. *Child Development, 49*, 781–787.

Moerk, E. L. (1983). The mother of Eve as a first language teacher. *Monographs on Infancy, Mono 3*, 158.

Moerk, E. L. (1992). *A first language taught and learned*. Baltimore, Maryland: Paul H. Brookes Publishing Co.

Morris, E. K. (1992). ABA Presidential address: The aim, progress and education of behavior analysis. *The Behavior Analyst, 1*, 3–30.

Mowrer, O. H. (1958). Hearing and speaking: An analysis of language learning. *Journal of Speech Disorders, 23*, 143–152.

Murphy, C. M., & Messer, D. J. (1977). Mothers, infants and pointing: A study of gesture. In H. R. Schaffer (Ed.), *Studies in mother-infant interaction* (pp. 325-354). New York: Academic Press.

Namy, L. L., Smith, L. B., & Gershkoff-Stowe, L. (1997). Young childrens' discovery of spatial classification. *Cognitive Development, 12*, 163–184.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development, 38*, 1–136.

Nelson, K. (1974). Concept, word and sentence: Interrelations in acquisition and development. *The Psychological Review, 81*, 267–285.

Newport, E. L., Gleitman, H. R., & Gleitman, L. R. (1977). Mother I'd rather do it myself: Some effects and non-effects of maternal speech style. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 109–150).

Osgood, C. E. (1958). Review of *Verbal Behavior*. *Contemporary Psychology, 3*, 209–212.

Palmer, D. C. (1996). Achieving parity: the role of automatic reinforcement. *Journal of the Experimental Analysis of Behavior, 65*, 289–290.

Piaget, J. (1962). The stages of the intellectual development of the child. *Bulletin of the Menninger Clinic, 26*, 120–128.

Pilgrim, C., & Galizio, M. (1995). Reversal of baseline relations and stimulus equivalence: I. Adults. *Journal of the Experimental Analysis of Behavior, 63*, 225–238.

Pilgrim, C., & Galizio, M. (1996). Stimulus equivalence: A class of correlations or a correlation of classes. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus Class Formation in Animal and Humans: Advances in Psychology, 117*. (pp. 173–195). Amsterdam: Elsevier.

Pinker, S. (1994). *The language instinct*. Cambridge, MA: MIT Press.

Poulson, C. L., Kymissis, E., Reeve, K. F., Andreatos, M., & Reeve, L. (1991). Generalized vocal imitation in infants. *Journal of Experimental Child Psychology, 51*, 267–279.

Quine, W. V. (1960). *Word and object*. Cambridge: MIT Press.

Randell, T. D. W. (2000). Stimulus equivalence and naming. Unpublished Ph.D. Thesis, University of Southampton.

Randell, T., & Remington, B. (1999). Equivalence relations between visual stimuli: The functional role of naming. *Journal of the Experimental Analysis of Behavior, 71*, 395–415.

Randle, V. R. L. (1999). *Naming and categorisation*. Unpublished Ph.D. Thesis, University of Wales, Bangor.

Reese, H. W. (1968). *The perception of stimulus relations: Discrimination learning and transposition*. New York: Academic Press.

Remington, B. (1991). Behavior analysis and severe mental handicap: The dialogue between research and application. In B. Remington (Ed.), *The challenge of severe mental handicap: A behaviour analytic approach*. Chichester: Wiley.

Remington, B. (1996). The evolution of naming-just so! *Journal of the Experimental Analysis of Behavior, 65*, 243–245.

Rescorla, R. A. (1966). Predictability and number of pairings in Pavlovian fear conditioning. *Psychonomic Science, 4*, 383–384.

Ristau, C. A., & Robins, D. (1984). Language in the great apes: A critical review. *Advances in the study of behavior, 12*, 142–247.

Roberts, K. (1988). Retrieval of a basic-level category in prelinguistic infants. *Developmental Psychology, 24*, 21–27.

Roche, B., & Barnes, D. (1997). A transformation of respondently conditioned stimulus function in accordance with arbitrarily applicable relations. *Journal of the Experimental Analysis of Behavior, 67*, 275–301.

Rosch, E., Mervis, C., Gray, W., Johnson, D., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*, 382–439.

Ross, R. T., & LoLordo, V. M. (1987). Evaluation of the relation between Pavlovian occasion-setting and instrumental discriminative stimuli: A blocking analysis. *Journal of Experimental Psychology: Animal Behavior Processes, 13*, 3–16.

Saunders, K. J. (1989). Naming in conditional discrimination and stimulus equivalence. *Journal of the Experimental Analysis of Behavior, 51*, 379–384.

Saunders, K. J., & Spradlin, J. E. (1989). Conditional discrimination in mentally retarded adults: The effect of training the component simple discriminations. *Journal of the Experimental Analysis of Behavior, 52*, 1–12.

Saunders, K. J., & Spradlin, J. E. (1996). Naming and equivalence relations. *Journal of the Experimental Analysis of Behavior, 65*, 304–308.

Saunders, R. R. (1996). From review to commentary on Roche and Barnes: Toward a better understanding of equivalence in the context of relational frame theory. *Psychological Record, 46*, 477–487.

Saunders, R. R., & Green, G. (1992). The nonequivalence of behavioral and mathematical equivalence. *Journal of the Experimental Analysis of Behavior, 57*, 227–241.

Saunders, R. R., & Green, G. (1996). Naming is not (necessary for) stimulus equivalence. *Journal of the Experimental Analysis of Behavior, 65*, 312–314.

Saunders, R. R., Saunders, K. J., Kirby, K. C., & Spradlin, J. E. (1988). The merger and development of equivalence classes by unreinforced conditional selection of comparison stimuli. *Journal of the Experimental Analysis of Behavior, 50*, 145–162.

Scaife, M., & Bruner, J. S. (1975). The capacity for joint visual attention in the infant. *Nature, 253*, 265–266.

Schusterman, R. J., & Kastak, D. (1993). A California sea lion (Zalophus californianus) is capable of forming equivalence relations. *The Psychological Record, 43*, 823–839.

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research, 14*, 5–13.

Sidman, M. (1986). Functional analysis of emergent verbal classes. In T. Thompson & M. D. Zeiler (Eds.), *Analysis and integration of behavioral units* (pp. 213–245). Hillsdale, NJ: Erlbaum.

Sidman, M. (1990). Equivalence relations: Where do they come from? In D. E. Blackman & H. Lejeune (Eds.), *Behaviour analysis in theory and practice: Contributions and controversies* (pp. 93–114). Hove: Lawrence Erlbaum Associates.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston, MA: Authors Cooperative, Inc.

Sidman, M., & Cresson, O. (1973). Reading and crossmodal transfer of stimulus equivalences in severe retardation. *American Journal of Mental Deficiency, 77*, 515–523.

Sidman, M., Rauzin, R., Lazar, R., Cunningham, S., Tailby, W., & Carrigan, P. (1982). A search for symmetry in the conditional discriminations of rhesus monkeys, baboons and children. *Journal of the Experimental Analysis of Behavior, 37*, 23–44.

Sidman, M., & Tailby, W. (1982). Conditional discrimination vs. matching to sample: An expansion of the testing paradigm. *Journal of the Experimental Analysis of Behavior, 37*, 5–22.

Siemann, M., Delius, J. D., Dombrowski, D., & Daniel, S. (1996). Value transfer in discriminative conditioning with pigeons. *The Psychological Record, 46*, 707–728.

Simner, M. L. (1971). Newborn's response to the cry of another infant. *Developmental Psychology, 5*, 136–150.

Skinner, B. F. (1935). The generic nature of the concepts of stimulus and response. *The Journal of General Psychology, 12*, 40–65.

Skinner, B. F. (1938). *The behavior of organisms*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.

Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton Century Crofts.

Skinner, B. F. (1969). *Contingencies of reinforcement: A theoretical analysis*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1974). *About behaviorism*. New York: Knopf.

Smeets, P. M., Schenk, J. J., & Barnes, D. (1994). Establishing transfer from identity to arbitrary matching tasks via complex stimuli under testing conditions: A follow-up study. *The Psychological Record, 44*, 521–558.

Smith, L. B. (1995). Self-organizing processes in learning to learn words: Development is not induction. In C. A. Nelson (Ed.), *Basic and applied perspectives on learning, cognition, and development: The Minnesota Symposia on Child Psychology* (Vol. 28, pp. 1–32). Mahwah, NJ: Lawrence Erlbaum Associates.

Smith, T. L. (1994). *Behavior and its causes: Philosophical foundations of operant psychology*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Soja, N. N., Carey, S., & Spelke, E. S. (1991). Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition, 38*, 179–211.

Steele, D., & Hayes, S. C. (1991). Stimulus equivalence and arbitrarily applicable relational responding. *Journal of the Experimental Analysis of Behavior, 56*, 519–555.

Stemmer, N. (1995). Do we need an alternative theory of verbal behavior? A reply to Hayes and Wilson. *Behavior Analyst, 18*, 357–362.

Stern, D. N., Spieker, S., & MacKain, K. (1982). Intonation contours as signals in maternal speech to prelinguistic infants. *Developmental Psychology, 18*, 727–735.

Stromer, R., & Mackay, H. A. (1996). Naming and the formation of stimulus classes. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus class formation in humans and animals: Advances in psychology, 117*. (pp. 221–252). Amsterdam: Elsevier.

Stromer, R., Mackay, H. A., & Remington, B. (1996). Naming, the formation of stimulus classes, and applied behavior analysis. *Journal of Applied Behavior Analysis, 29*, 409–431.

Stromer, R., & Osborne, J. G. (1982). Control of adolescents' arbitrary matching-to-sample by positive and negative stimulus relations. *Journal of the Experimental Analysis of Behavior, 37*, 329–348.

Sugarman, S. (1983). *Children's early thought: Developments in classification*. Cambridge: Cambridge University Press.

Sundberg, M. L., & Partington, J. W. (1998). *Teaching language to children with autism or other developmental disabilities*. Pleasant Hill, CA: Behavior Analysts, Inc.

Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development, 57*, 1454–1463.

Tonneau, F., & Sokolowski, M. B. C. (1997). Standard principles, nonstandard data, and unsolved issues. *Journal of the Experimental Analysis of Behavior, 68*, 266–270.

Urcuioli, P. J. (1996). Acquired equivalences and mediate generalisation. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus class formation in humans and animals: Advances in psychology, 117* (pp. 15–34). Amsterdam: Elsevier.

Urcuioli, P. J., & Lionello-DeNolf, K. (in press). A test of the anticipatory mediated generalization model of acquired sample equivalence in pigeons' many-to-one matching.

Urcuioli, P. J., Zentall, T. R., & DeMarse, T. (1995). Transfer to derived sample-comparison relations by pigeons following many-to-one versus one-to-many matching with identical training relations. *Quarterly Journal of Experimental Psychology: Comparative & Physiological Psychology, 48B*, 158–178.

Vaughan, M., & Michael, J. L. (1982). Automatic reinforcement: An important but ignored concept. *Behaviorism, 10*, 217–227.

Vaughan, W. (1988). Formation of equivalence sets in pigeons. *Journal of Experimental Psychology: Animal Behavior Processes, 14*, 36–42.

Vihman, M. M. (1996). *Phonological development: The origins of language in the child*. Oxford: Blackwell.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language*. Cambridge, MA: MIT Press.

Wulfert, E., Dougher, M. J., & Greenway, D. E. (1991). Protocol analysis of the correspondence of verbal behavior and equivalence class formation. *Journal of the Experimental Analysis of Behavior, 56*, 489–504.

Wulfert, E., & Hayes, S. C. (1988). Transfer of a conditional ordering response through conditional equivalence classes. *Journal of the Experimental Analysis of Behavior, 50*, 125–144.

Zentall, T. R. (1996). An analysis of stimulus class formation in animals. In T. R. Zentall & P. M. Smeets (Eds.), *Stimulus class formation in humans and animals: Advances in psychology, 117* (pp. 15–34). Amsterdam: Elsevier.

Zentall, T. R., Sherburne, L. M., & Urcuioli, P. J. (1993). Common coding in a many-to-one delayed matching task as evidenced by facilitation and interference effects. *Animal Learning & Behavior, 21*, 233-237.

Zentall, T. R., Sherburne, L. M., Steirn, J. N., Randall, C. K., Roper, K. L., & Urcuioli, P. J. (1992). Common coding in pigeons: Partial versus total reversals of one-to-many conditional discriminations. *Animal Learning & Behavior, 20*, 373–381.

Zentall, T. R., Sherburne, L. M., Roper, K. L., & Kraemer, P. J. (1996). Value transfer in a simultaneous discrimination appears to result from within-event Pavlovian conditioning. *Journal of Experimental Psychology: Animal Behavior Processes, 22*, 68–75.

Zentall, T. R., Steirn, J. N., Sherburne, L. M., & Urcuioli, P. J. (1991). Common coding in pigeons assessed through partial versus total reversals of many-to-one conditional discriminations. *Journal of Experimental Psychology: Animal Behavior Processes. 17*, 194–201.