THE RELATIONSHIP BETWEEN PARENT'S COMPARISONS OF NOUNS AND CHILDREN'S NOUN LEARNING

by

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ABSTRACT

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The Relationship between Parent's Comparisons of Nouns and Children's Noun Learning

Thesis directed by Assistant Professor Eliana Colunga

Previous literature shows that language input is related to the language that children produce. Less is known about how the input provided to children relates to the way that they process language. In this study, this question was explored by looking at the relationships between children's word learning ability and the kinds of names provided by parents for objects. Whether these relationships varied with age and vocabulary size was also investigated. Children from five age groups at 12-, 16-, 20-, 24-, and 28-months participated in two types of tasks. First, to characterize the amount and type of labels used by parents, parents and children were videotaped in a naturalistic play in which they played with four sets of familiar and unfamiliar toys. Second, to characterize the children's ability to learn new labels, children were taught and tested on their learning of new words for familiar and unfamiliar objects either directly or indirectly (i.e. by inference). A factor analysis of parent's contrasts of multiple labels for the same object showed that the input was consistent with several factors suggested to influence children's successful learning of labels including the taxonomic level of the label, whether the name is for a whole object or a part, and whether the label is for a familiar or unfamiliar object. In the word learning task, children learned labels for familiar and unfamiliar objects equally well following direct teaching, but learned labels for unfamiliar objects easier following indirect teaching. The types of contrasts provided by parents were related to children's abilities to learn multiple names for objects such that parents' use of taxonomic contrasts was related to children learning more multiple names. Age and vocabulary size could not account for these relationships. These results suggest that the input provided by parents is related to several word learning principles put forth in previous literature. In addition, this input is related to children's performance in a word learning task. The implications for understanding several word learning processes are discussed.

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CHAPTER 1: INTRODUCTION

The ease with which young children learn language can seem astonishing. The goal of research in language development is to explore the mechanisms and processes that allow children to pick up this complex system of communication. Explanations of how children learn words range from pre-determined learning mechanisms inherent to the child to information provided in the input that children take in during language learning. As such, most research focuses on either factors related to the ways in which children learn words or factors related to the environment in which those words are learned. However, several important relationships have also been identified between aspects of the input (e.g. syntax complexity, verb use, or conversation style) and aspects of the output (e.g. vocabulary size, syntax usage). The question at hand is whether or not the language input is related to *mechanisms* of language learning, not merely the content of the language output. In the current study, I explore the relationship between the *amount* and *kind* of input provided by parents and *how* children learn new words.

The Relationship between Parental Input and Language Acquisition

In general, parents that use more complex language and are more responsive to their children's use of language have children with more developed language abilities (e.g. Hoff & Naigles, 2002; Paavola, Kunnari, Moilanen, & Lehtihalmes, 2005). For example, Hart and Risley's (1995) study showed that vocabulary growth in one- and two-year-olds was related to the frequency of interaction between parent and child. This in turn was also highly related to socioeconomic status (SES). Moreover, vocabulary growth was also related to the type of interaction style of the parents (e.g. how responsive the parents were and how they corrected their children). Although parental input is clearly related to language *use*, less is known about how parental input relates to children's *processing* and *learning* of language itself.

As a separate area of study, substantial research has also been conducted on the way that children learn language. In particular, research shows that children have certain expectations about how words are used and how they map to objects, action, properties, and so on. One good example of such an expectation is the fact that children often have an easier time learning basic-level terms (e.g. *dog*) than superordinate terms (e.g. *animal*), suggesting that they expect nouns to name whole objects at a basic level of specificity, not at a highly general or specific level (e.g. Au & Glusman, 1990). A second example is that children expect objects to have one name, not multiple names (e.g. Liittschwager & Markman, 1994; Markman & Wachtel, 1988).

Though little to no research has been done to look at how the way that parents talk to their children is related to such language processes, preliminary data do suggest that parents supplement their language use to provide their children extra support when using more difficult constructions like superordinate terms (Callanan, 1985) and when using multiple labels for an object (Callanan & Sabbagh, 2004; Masur, 1997). The study reported here explored the idea that there is a connection between the way that parents name objects and how children process new names for objects. Before turning to the larger background, I first describe what is already known about the relationship between parental input and language acquisition.

Language Input

For the purpose of reviewing the range of areas that have been suggested to be related to language learning, I define linguistic input very broadly as "any aspect of the word learning context that is available to children as they learn language". This definition leaves open the scope that input can take – from differences in phoneme distribution (e.g. Saffran, Aslin, & Newport, 1996), use of specific word classes (e.g. Callanan, 1985; Durkin, Rutter, & Tucker, 1982) or syntactic structures (e.g. Hoff & Naigles, 2002; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Ringler, 1981) to the style of parent interaction (e.g. Hart & Risley, 1995) and how responsive parents are to their child's speech (e.g. Baumwell & Tamis-LeMonda, 1997; Hart & Risley, 1995; McDuffie & Yoder, 2010). The language input context at all levels is related to the language that children produce. Moreover, the overall context in which input happens is often related to the way that parents use language. For example, SES is often related to the number of words that parents say and the complexity of their speech, which in turn is related to children's vocabulary size and the complexity of their syntactic structures (Hoff & Tian, 2005).

Accordingly, the context in which words are learned can be separated into two types. First are the general context level aspects such as the number of languages spoken, parent responsiveness, and the simplification of language structures by speakers to the child. The second type of input is the specific structures of the language(s) spoken. This type of input includes the development of proper phoneme segmentation, specific syntactic structures, and learning of words and their proper classes. I review each type separately.

At the general context level, several types of input "style" are related to child language outcomes, including the number of word tokens and type used (Hoff, 2003), mean length of utterance (MLU), (e.g. Hoff, 2003), the use of "sophisticated words" (Weizman & Snow, 2001), and the use of several syntactic structures such as multi-clause sentences and noun phrases (e.g. Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002). Another example of general language context being related to language learning has to do with the number of languages that are spoken to the child. Children growing up in a bilingual environment have often been shown to accept second labels for familiar objects more often than monolingual children, particularly when those two labels clearly come from two different languages (Davidson, Jergovic, Imami, &

Theodos, 1997; Davidson & Tell, 2005; Diesendruck, 2005; Merriman & Kutlesic, 1993). It is not yet clear what aspect of the bilingual environment relates to this difference in word learning between monolingual and bilingual children. Several aspects of the bilingual environment may be responsible including the phonology differences between the languages, bilingual children receiving more pragmatic cues that indicate multiple labels, or the mere frequency with which objects get multiple labels. Each of these explanations has in common that the style of language use by parents in a bilingual environment is different than the style of language use in a monolingual environment. And this difference in overall language style is thought to be related to the degree to which children accept multiple labels for one object. This relationship is tested directly in the current study in monolingual children.

At the other level of input, the specific level, particular word learning situations are thought to be related to the development of the particular language structures produced by the child. This means that children learn the phonemes, words, and syntactic structures that are used by their parents. For example, the language(s) that a child hears will determine the phonemes that they are able discriminate (Werker & Tees, 1984). There is a long line of research showing that the number of words and types of words used (i.e. relative number of nouns, verbs, and adjectives) are related to the language produced by children (e.g. Brent & Siskind, 2001; Rollins, 2003; Sandhofer, Smith, & Luo, 2000). It is important to note that these language-specific input effects often interact with the larger context; bilingual environments have been shown to slow down the ability to learn to distinguish words that sound alike, for example (Fennell, Byers-heinlein, & Werker, 2007).

Acquisition of Word Knowledge via Input

Although a large area of research on the relationship between input and language acquisition has focused on the way that input is related to the development of phonology and the syntax of a language, this study focuses on a third important area – the acquisition of the lexicon. In the current study, I focused on how children learn new words and the relationship between this and how parents use words in a naturalistic play task.

Research shows that parental input is related to the number and type of words in children's vocabulary (e.g. Huttenlocher, Haight, Bryk, & Seltzer, 1991; Rollins, 2003). The specific words and categories that are used by parents tend to be those words and categories used by children (e.g. Brent & Siskind, 2001; Huttenlocher, et al., 2002; Pine, Lieven, & Rowland, 1997). In addition, children are more likely to learn words at the basic-level (e.g. "dog") of category description than the super- (e.g. "animal") or subordinate (e.g. "poodle") levels. This finding is congruent with research showing that parents provide input that includes extra support for children to learn superordinate words (Callanan, 1985) and extra information about the object attributes that distinguish a subordinate category as such (C. B. Mervis, Johnson, & Mervis, 1994). In addition, the frequency with which parents use particular words has been shown to be related to the frequency with which children use those same words (Moerk, 1980; van Veen, Evers-Vermeul, Sanders, & van den Bergh, 2009).

The type of interaction in which words are presented may be more important than overall frequency of input. Parents who demonstrated that words can be combined flexibly with many other words have children that combine noun phrases in a more flexible way (Pine, et al., 1997). Brent and Siskind (2001) also showed that using words in isolation rather than in a syntactic frame (i.e. in a sentence) was more important than the frequency with which the word was used.

For any given word, it was more likely to be learned and used by the child if the parent used the word in isolation. Moreover, the diversity of the words used have been shown to predict greater vocabulary production by the child (Pan, Rowe, Singer, & Snow, 2005). In the current study, I focus on a similar type of measure that investigates the interaction between parent and child; namely, how parents contrast multiple labels for an object.

Overall, the input – "aspects of the word learning context that are available to children as they learn language" – are varied and are highly related to the frequency and types of words that children produce and the syntactic structures that they form. However, as can be seen throughout the above review, and to the best of my knowledge, all of the research investigating the way that parents talk to their children has focused on the output that children produce rather than the ways in which children learn and process language itself. In the current study, I look at how parent's contrasts of multiple labels for objects are related to the way that children learn new words.

Goals of the Study

There were four goals at the outset of this study. The first goal was to understand how parents use multiple labels when talking to their children about the same object. I was interested in the way that parents contrast names for objects, not merely the amount of times that they named objects. As such, I looked at parents' use of multiple names for the same object and how those names were compared and contrasted by parents. In a naturalistic play task, parents talked about several sets of objects with their children. I then looked at the number of objects given multiple names and how parents contrasted those names with each other.

The second goal was to understand more precisely how children learn names for objects. It is not adequate to merely look at one word learning situation to understand how children learn words. And it seems likely given previous research that input shares different relationships with some word learning situations than others; different cognitive processes may be employed under different conditions. Indeed, research shows that the conditions under which children's word learning is evaluated can have a profound impact on whether or not children are successful word learners (Brandon, Prahlad, & Naveen, 2008; Diesendruck & Bloom, 2003; Mareschal & Quinn, 2001; Samuelson & Horst, 2004). In order to fully understand how children learn words, it was necessary to get a complete picture of how these processes relate to word learning. Thus, in this study children were asked to learn new words under four different conditions – learning new words for familiar or unfamiliar objects either directly or indirectly. These tasks have been employed numerous times in the literature but never in the same study (Au & Glusman, 1990; Haryu, 1994; Littschwager, 1994; Markman & Wachtel, 1988; Markman, Wasow, & Hansen, 2003; Merriman & Bowman, 1989; Merriman & Schuster, 1991; Merriman & Stevenson, 1997). A well-rounded picture of word learning must include all four conditions.

The third goal was to investigate the relationship between the way that parents use names and the way that children learn names for objects. To understand this relationship, parent's naming of objects in the naturalistic play task was correlated with their children's abilities to learn new names for objects under the four different conditions. It should be noted that any significant relationship found could indicate one of two directions. It may be that they way that parents name objects impacts how children learn words, but it may also be that the way that children learn words causes parents to adjust the way that they name objects for their children. These two possibilities could not be distinguished given the design of this study.

The fourth, and final, goal of the study was to understand the relationship between input and the process of word learning *in light of* the child's age and vocabulary level. Past research shows that both of these factors are very important in predicting word learning ability (e.g. Gershkoff-Stowe & Hahn, 2007; Morrison & Ellis, 1995; Samuelson & Smith, 1999; Stokes & Klee, 2009) and, as with the task, it was necessary to include these factors in the current study to get a complete picture of the relationship between input and the word learning process as it develops across time.

Characterizing the way that parental input is related to word learning has important implications for how we understand the word learning process in general. By exploring the way that parents use and compare names for objects and how children learn words, we can begin to understand the relationship between word learning and the word learning context. For example, knowing whether aspects of the input are related to children's learning may begin to explain how input influences children's word learning, which will help to clarify how children bootstrap their word learning capabilities as they "learn how to learn". It will also provide researchers a better understanding of how word learning proceeds given different experiences with language.

Overview

The general question addressed by this project is how language input is associated to language learning in children as it relates to learning multiple labels for objects and how this changes with age. To ask this question, a cross-sectional sample of 12- to 28-month-old children participated. In each of two identical sessions, children and parents participated in two separate tasks, including 1) a task to evaluate the amount and type of first and second labels used by parents and 2) a task to test children's learning of multiple labels for objects. Together, these two tasks provided data on both the context in which language has been used in children's experience and how children learn new words in different contexts in the lab. After careful examination of the current literature, it was decided to test samples of children from five different age groups, 12-, 16-, 20-, 24- and 28-months. Children have been shown to complete a simple multiple-labeling or mutual exclusivity task as early as 10 months (Liittschwager & Markman, 1994; Mather & Plunkett, 2010). Research also shows that parents do produce multiple labels for children as young as 11-months (Callanan & Sabbagh, 2004).

The first task, the parental input task, was designed to be similar to a task previously used to evaluate the use of second labels by parents in which parents were asked to help their children play with sets of objects (Callanan & Sabbagh, 2004, Study 2). In the current study, this naturalistic setting allowed the experimenter to observe how the parent and child interact on an everyday basis. This contrasts with experimental lab tasks, like the second task in this study, in which experimenters ask the child, without the parent’s help, to identify which objects can have multiple labels (Hollich, Hirsh-Pasek, & Golinkoff, 2000; Jaswal & Hansen, 2006; Liittschwager & Markman, 1994; Markman, et al., 2003).

The second task, the word learning task, was used to test children’s ability to learn nouns in four different conditions. In general, tasks used to measure word learning can be separated into two groups. They either 1) measure the child’s ability to learn names for an object directly or they 2) require the child to infer by exclusion to which object a name applies. This difference

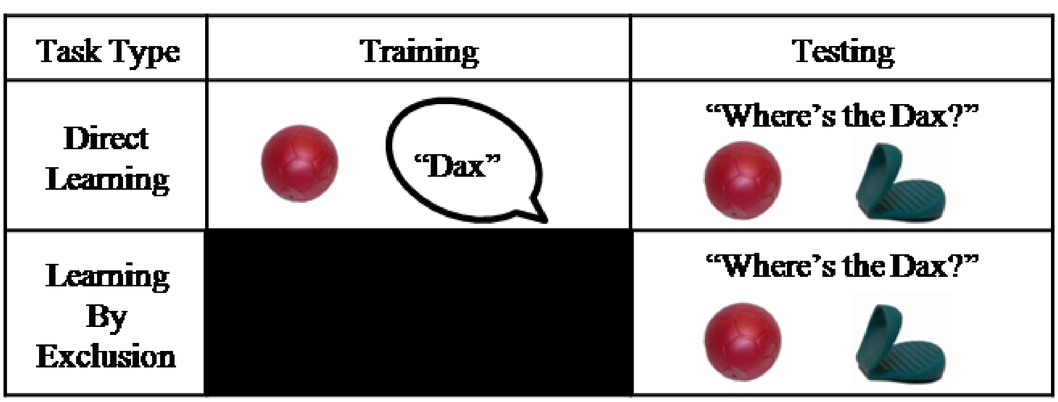

Figure 1. Examples of tasks used to test label learning

in task is often confounded with age in the literature such that older children are often taught words indirectly or by exclusion and younger children are taught words directly (Liittschwager & Markman, 1994; Markman, et al., 2003).

As shown in Figure 1, in direct learning children are presented with a familiar object (e.g. a ball) and told that it is a “dax”. They are then asked to identify the “dax” among one or more distractors. In this way, children are required to directly map the word “dax” to an object (Liittschwager & Markman, 1994; Carolyn B. Mervis, Golinkoff, & Bertrand, 1994). Tasks requiring indirect learning, on the other hand, require that children infer the referent of a name without being told explicitly the name for that object. For instance, children would have to infer the new name by reasoning by exclusion. They may be shown two objects – one that they already have a name for and one that is unfamiliar. They are then simply asked to choose the “dax”. Experimenters never directly label the unfamiliar object as “dax”. Thus, children must infer that the novel word should refer to the unfamiliar object (Hollich et al., 2000; Markman, Wasow, & Hansen, 2003).

In sum, these two tasks allow for several valuable contributions to the literature. First, this is the first time that a comprehensive analysis has been done to evaluate parent’s contrasts of multiple labels for a single object. In addition, looking at these contrasts across a wide range of ages will be an important contribution to understanding how parent’s labeling styles change with their child’s age and vocabulary level. Second, although children’s abilities to learn multiple labels has been tested extensively in previous literature, this will be the first study to compare directly the different situations in which multiple labels can be learned and compare that to learning single labels for objects. Finally, previous research has not been conducted to look at the relationships between the way that parents use multiple labels for objects and how their children learn multiple labels. Therefore, this study, by investigating both the way that parents use labels and how children learn labels, contributes to several important areas in the word learning literature.

In the next chapter, I review previous research looking both at how parents use labels in everyday speech and how children learn labels, giving particular emphasis to the types of parent input that have been shown to be important previously and the different word learning processes that underlie children's word learning in different situations. Following this, in Chapter 3, I detail the methods used in the current study. Chapters 4 through 6 will report the results of each task separately – the input task in Chapter 4 and the word learning task in Chapter 5 – and the results of the relationships between the two tasks in Chapter 6. Finally, Chapter 7 is devoted to situating the results of each task and the relationship between the two tasks in the current literature and showing how it extends our knowledge of how parents label objects and how children learn labels for objects.

CHAPTER 2: LITERATURE REVIEW

The ease with which young children learn language is incredible. As newborns, infants can distinguish familiar linguistic sounds from unfamiliar linguistic and other structured non-linguistic sounds, such as music (Colombo & Bundy, 1981; Glenn, Cunningham, & Joyce, 1981; Vouloumanos & Werker, 2004). By around 18 months, children can learn a new word for a new object after having only heard the word once or twice, an ability often called fast mapping (Carey, 1978; Carey & Bartlett, 1978; Heibeck & Markman, 1987). By their second birthday children have, on average, around 300 words in their vocabulary (Fenson et al., 1993).

How do children acquire language, and, in particular, words, so rapidly? Accounts of word learning have suggested that factors related to both the way that children learn news words and the way that parents introduce new words is important in predicting children's word learning success. Factors related to how parents name objects for their children are sometimes referred to as sociopragmatic, which simply means any aspect of the way in which parents present new words (or language in general) to their children. On the other hand, the ways in which children learn words are often indexed by domain-general cognitive processes. These processes are measured by carefully manipulating the conditions under which children learn new words in laboratory tasks. Inevitably, understanding both factors completely will be required to adequately explain word learning. Indeed, although discussed and analyzed separately in this study (and others), these two factors are completely dependent on each other and are not separable in the real-world task of word learning.

First, the way that parents learn words can be thought of as context factors describing the social situations in which children learn words. In particular, children are thought to understand the intention of other speakers and use this information to help guide their word learning. It is important to investigate factors related to the context in which children learn new words, including the input provided by their parents. In the current study, because we were interested in how parental input relates to word learning *processes* and not simply language use per se, we focused on the kind or type of input provided by parents (e.g. how parents related multiple labels to each other in the input) rather than simply the quantity of the input available (e.g. how many labels parents used), although this information was collected as well. In addition, as a way to include factors related to the larger overall context in which children were learning words, we also collected information on SES and exposure to print material.

Second, the ways in which children learn new words is often, though not always, thought to be a product of or built out of more general cognitive capacities such as attention, association, memory capacity, and inference-making, to name a few. In the current study I manipulated the conditions under which children learned new words in order to engage these domain-general processes to different degrees. The contribution of each of these cognitive processes to children's word learning success was evaluated. Specifically, the task used to test children's word learning required that, to differing degrees, they attend to the correct object when learning a new name, that they associate new words and objects,that they remember these words at test, and that they infer names for objects.

In the current study, both how parents introduce new words and how children learn new words was measured. As a way to review the word learning literature, it will be useful to examine each of these two factors separately; researchers generally take a very different approach when exploring the two factors. Each one can be studied by focusing on a different set of aspects of the word learning context said to relate to the ease with which children learn words.

How Parents Label Objects

Research on factors relating to how parents name objects suggests that infants are driven to discover what adults are referring to in their environment. To do this children use their knowledge of how adults *intend* to use words to understand their meaning. For example, if a child knows that an adult knows the name for a cup but asks instead for a "dax", the child will assume that if the adult had meant to refer to a cup, they would have asked for a "cup" and not a "dax". Hence, the adult must not be referring to the cup (Bloom, 2000; Clark, 1997). In this way, children infer the meaning of the word "dax".

What changes during word learning is children's knowledge about naming conventions; for example, children learn that words are used to refer to objects. They also learn that it is social convention to only use only one socially-accepted word for each object (Clark, 1997; Diesendruck & Markson, 2001) and to name objects at the basic level instead of at the sub- or superordinate level (Callanan, 1985; Callanan & Markman, 1982). Evidence that social and pragmatic cues are important in word learning comes from several different sources. First, a series of studies by Baldwin and her colleagues (Baldwin, 1993; Baldwin & Baird, 2001; Baldwin, Bill, & Ontai, 1996; Baldwin et al., 1996) has shown that children will only map labels to objects when the pragmatic situation supports this interpretation. For example, children will only map a novel label to a novel object when the speaker intentionally labels the object in front of the child, is present in the room (and not on the phone in another room) (Baldwin, Markman, et al., 1996), and is sharing in attending to the object, called joint attention (Baldwin, 1991).

Pragmatic cues have also been shown to be important for learning multiple labels. For example, children can learn two labels for one object when a speaker explicitly states that there is a relationship between the two labels – such as one label being more specific than the other label (Clark & Grossman, 1998) or asking for an apple using the word “dax” by suggesting that the speaker is hungry (Haryu, 1998). This tendency to only accept second labels under certain pragmatic conditions is likely related to previous experience with the way adults use multiple labels for objects. Several researchers have suggested that the difference in the extent to which children learn and use multiple labels stems from differences in parental language input (Callanan, 1985; Callanan & Sabbagh, 2004; Hall, Waxman, & Hurwitz, 1993). In particular, some parents may simply use more multiple labels when talking about objects and object categories. They may also provide differing degrees of socio-linguistic cues or explicit “bridging information” as to how the two labels that they are using are related (e.g. one thing is a kind of another). This “bridging information” in the parent’s speech may train children to accept multiple labels to a greater degree.

In one of the only studies to directly address the question of whether variability in parental input for multiple labels truly exists, Callanan and Sabbagh (2004) showed that parents rarely used two words for one object in a naturalistic play session (for about 15% of the objects). However, when they did use two words for the same object, parents provided clear clues that the two words labeled the same object. They also provided cues as to how the two words contrasted in meaning (e.g. “A seal is a kind of animal”). Moreover, children with larger vocabularies had parents that used more second labels for objects. These children also initiated more instances of second labeling themselves. These results suggest that parental language input is an important variable in determining how children become biased to learn words. Unfortunately, this study did not directly test children’s processing and learning of second labels. Instead, it was assumed that all children would reject a second label for an object. Additionally, this study did not investigate the developmental time course of the parental input, though they did show that vocabulary size may be a better predictor of parental input than age (in months).

In the current study, like in the Callanan and Sabbagh (2004) study, I was less interested in the quantity of the input, but more the type of input. This means that rather than looking at simple pointing and eye gaze measures as measures of sociopragmatic support for word learning, I looked at the kind of interaction between parent and child. Importantly, this was done so that I could ask whether the type of interaction between parent and child in a word learning situation was related to subsequent word learning processes.

In order to look at the type of interaction, I measured how often and in what manner parents contrasted labels for the same object in a naturalistic play setting. Parent and child were asked to play as they would at home with four sets of objects for four minutes each. Each four-minute segment was then coded and each instance of labeling by the parent was recorded. For those instances in which the parent provided more than one label for the same object, we looked at how the parent contrasted those two labels (i.e. “bridging information”). The amount of each type of contrast made by parents was then compared to their children’s performance in the word learning task.

How Children Learn New Words

Several authors have recently made the case that differences in how children learn words is dependent on domain-general cognitive processes (for a review see Deák, 2000; Goldstone & Landy, 2010). These domain-general processes include a flexible attentional mechanism (e.g. Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002), an associative mechanism (e.g. Colunga & Smith, 2005), memory capacity (e.g. Gathercole, Frankish, Pickering, & Peaker, 1999) and the ability to make inferences (e.g. Gelman & Markman, 1986). The expression of these mechanisms are influenced by the task used to evaluate word learning ability; children learn words differently depending on what captures attention, the memory load required, and so on.

Research suggesting that word learning is supported by these domain-general mechanisms comes from both experimental studies and modeling efforts. Experimental studies, for example, show that children learn other types of information in the same way that they learn words. For example, children learn facts just as easily as words – after only one instance. Moreover, they can remember these facts at least as long as they can remember a new word for the same category (Markson & Bloom, 1997). However, it should be noted that children do not always extend facts in the same manner as words to other category instances (Waxman & Booth, 2000). This may mean that not all word learning abilities are domain-general or that other domain-general processes, such as an attentional mechanism or inference process, are responsible for other aspects of word learning. Modeling efforts also show that general associative mechanisms can give rise to more complex fast mapping abilities and the ability to extend words correctly (Colunga & Smith, 2005; Mayor & Plunkett, 2010).

Together, these domain-general cognitive mechanisms and task constraints combine to give rise to what are thought of as domain-specific word learning biases (Mayor & Plunkett, 2010). These biases guide word learning and make it easier for children to correctly identify the object to which a given label refers in a word learning situation (e.g. Au & Glusman, 1990; Markman & Wachtel, 1988). It is likely that not one, but several, domain-general mechanisms are responsible for children's word learning biases. Below, I outline each of the domain-general mechanisms mentioned above. I then describe the task features that influence the expression of these mechanisms. Finally, I provide an overview of the word learning biases that have been studied extensively in the literature and suggest how they relate to the four broader domain-general cognitive mechanisms.

Flexible Attentional Mechanisms

When learning a new name for an object it is important to attend to the correct object, but even more important to attend to the properties of that object that cause it to have that name. In most cases, this property is shape. For example, a cup is a cup because it is concave and has a handle, not because it is brown or made of plastic. Children have been shown to correctly attend to shape when learning a new category of objects by the time they are three years of age. This propensity to attend to shape is often called the shape bias. It is likely that this shape bias is learned and supported by a domain-general attentional mechanism (Smith, et al., 2002).

Children do not only attend to shape as a way to learn words, but have been shown to attend to the entire word learning context. Indeed, previous research shows that changing the context (e.g. change of location) in which children play with an object will highlight that object over others; children will be more likely to give a new word to the highlighted object (Akhtar, Carpenter, & Tomasello, 1996; Samuelson & Smith, 1998). Other important context factors that have been shown to shift children's attention include whether a speaker is present or absent and how many languages are being spoken (Au & Glusman, 1990; Diesendruck, 2005). Thus, domain-general processes like attention may help children map a novel word to the correct novel object. However, it should also be noted that attending to highlighted objects may interact with sociopragmatic processes. For example, only intentional changes may highlight an object (Diesendruck, Markson, Akhtar, & Reudor, 2004).

Another more recent area of research suggesting that attentional mechanisms are at play focuses on cross-situational learning. Research suggests that children can learn words by attending to how they are used over time in multiple situations (Blythe, Smith, & Smith, 2010; Frank, Goodman, & Tenenbaum, 2009; Siskind, 1996; Smith & Yu, 2008; Yu & Ballard, 2007). Much of this work has come from modeling efforts showing that, computationally, it is possible to learn an entire lexicon from an environment in which the mapping from word to object is not perfect (Blythe, et al., 2010; Siskind, 1996). Experimental research also shows that presenting adults and children with ambiguous pairing of words can lead to learning multiple word meanings as long as the mappings are unambiguous *across* trials (Smith & Yu, 2008; Yu & Smith, 2007).

Associative Mechanism

At the beginning of word learning, children have been shown to have a domain-general mechanism that allows them to associate things in their environment that systematically co-occur together; objects in categories are often labeled in such a way that a label for one category always tends to co-occur with that category and not at other times or with other categories of objects (Colunga & Smith, 2005). For example, in the category *animal*, things that look like dogs are often labeled "dog" and not "cat", just like cats are labeled "cat" and not "dog". Over time, the associations between words and objects that co-occur frequently are strengthened and the associations for words and objects that don't co-occur are weakened or disappear. Research shows that children are very good at making these associations (Houston-Price, Plunkett, & Harris, 2005; Robinson, Howard, & Sloutsky, 2005). They make these mappings very quickly, even after just one example (Carey & Bartlett, 1978). It becomes easier for children to make these associations as they get older, but even as young as 18 months they are able to make an association between a word and an object after only three pairings – and they do so even if the object is in motion (Houston-Price, et al., 2005).

These mechanisms have also been formulized in computational models that are based on associationist and competition principles. For example, the Competition, Attention, and Learned Lexical Descriptions (or CALLED) model by Merriman (1999) and the Competition Model by MacWhinney (1989), suggest that competition between labels and the similarity of objects make it more or less difficult to associate two labels for the same object. More recent models, such as the Lexicon as Exemplars (LEX) model by Regier (2005) and the associative model by Colunga and Smith (2005) show that taking into account how the associations are strengthened over time to build up the lexicon can explain several word learning patterns seen in development including the increase of rejection of multiple labels for the same object over time, the increasing bias to attend to shape, and the ease with which labels are added to vocabulary at older ages as compared to younger ages. A final model based on associative mechanisms takes into account prior evidence and the probability that an object will be given a particular label (Tenenbaum & Xu, 2000; Xu & Tenenbaum, 2007). This model accounts for empirical research showing that adults and children will extend a novel word to familiar objects differently depending on prior experience with different examples of the familiar category. Overall, this domain-general associative mechanism is an important part of how children learn words. It is through this mechanism that children learn to correctly map words to their meanings.

Memory

The role of memory in the learning of new words has been less often studied than the other mechanisms. However, it has been shown that memory processes are very important for the learning of new words (Gathercole, Hitch, E., & Martin, 1997). By two years of age children can fast map objects easily but still have a difficult time retaining that mapping after a five minute retention period (Cuevas, Rovee-Collier, & Learmonth, 2006; Horst & Samuelson, 2008).

By three to four years of age children are much better at retaining these mappings (Merriman, Lipko, & Evey, 2008). Memory mechanisms have been shown to help children make associations between objects that are not physically present (Cuevas, et al., 2006), remember causal properties of named objects better than non-causal properties (Booth, 2009), remember more frequently heard words, and remember words over non-words (Gathercole, et al., 1999).

How exactly does memory support word learning? Research suggests a very important role for phonological short-term memory in the learning of new words. Phonological working-memory can be defined as the short-term memory for speech (Baddeley, 2003). Both phonological short-term memory and rehearsal of speech has been shown to aid children and adults in learning a word that they have never heard before (Baddeley, Papagno, & Vallar, 1988; Gathercole & Adams, 1993; Gathercole & Baddeley, 1989; Gathercole, et al., 1999; Merriman, et al., 2008; Papagnoa & Vallarb, 1992) . The ability to rehearse words and non-words is also related to vocabulary size (Gathercole & Adams, 1993). Young children that have a good phonological short-term memory seem to base their judgments of word familiarity on the word form. Those with good semantic memory but poor phonological memory base their judgments on the meaning of the word instead (Merriman, et al., 2008). It should also be noted that phonological short-term memory is less important when using already familiar words than when learning new words (Gathercole, et al., 1999; Horst & Samuelson, 2008; Papagnoa & Vallarb, 1992).

Inference-making

The final mechanism to be discussed has been studied extensively in the literature and is likely highly related to all three of the other mechanisms. This mechanism allows children to learn words when the mapping between word and object is not ostensive or clearly pointed out.

Instead, in much of word learning, children must pick up the meaning of a word from a stream of input; they must infer the meaning of the word. Within the language acquisition literature, one of the most often cited examples of this mechanism comes from a scenario suggested by Quine (1960) in which a traveler encounters a group of people who do not speak his language. One of these individuals points to a rabbit and says “gavagai”. How does the traveler figure out (or infer) what the speaker means? Does the speaker mean rabbit or does he mean furry thing, the foot of a rabbit or the color gray? In recent decades the answer to Quine’s question has given rise to explanations of how adults (and children) understand the meaning of a new word.

Children have been shown to make inferences about word meaning in several different ways including inferring properties of categories at different taxonomic levels (with superordinate category properties being the hardest to transfer to the lower levels) (e.g. Deneault & Ricard, 2005), generalizing the name of a category to other instances of that category by shape or function (e.g. Landau, Smith, & Jones, 1998), inferring properties of category members that are perceptually dissimilar to other members (e.g. Gelman & Markman, 1986), and inferring the type of word being used such as a proper versus a common name (e.g. Jaswal & Markman, 2001).

Several different features of the input may help guide children’s inferences. Having a word for a category is particularly important (Balaban & Waxman, 1997; Fulkerson & Waxman, 2007; Graham & Kilbreath, 2007) , but other types of communication, such as gestures, may also benefit inferences (Graham & Kilbreath, 2007; Namy & Waxman, 2000). Similarity between items in the category, though not compulsory, also help inference-making (Heit & Rubinstein, 1994) as does prior knowledge of how categories and words co-occur (Colunga & Smith, 2005; Xu & Tenenbaum, 2007). Finally, the type of input that parents provide to their children may support the inferences that children make (Callanan, 1990; Kobayashi, 1999). For instance, parents talk differently about superordinate categories than basic or subordinate categories; they are more likely to tell children the abstract properties that define the former than the latter (Callanan, 1990).

Task Factors used to Measure Word Learning Ability

Each of the mechanisms outlined above is at play the moment that a child hears a new word. However, it is not just the combination of these mechanisms that determine whether the child learns the new word and, if so, whether the new word will be mapped to the correct referent. The mechanisms outlined above work together with the context in which a word is presented to determine whether a new word is learned or not. In the research domain, this context boils down to the laboratory task used to measure children's word learning abilities. Three general task factors can be said to index how children learn new words. These factors include: 1) the type of learning required (direct or indirect), 2) the familiarity of the objects, and 3) the type of word presented. These task factors are each outlined below.

Learning Type

The different tasks used to test children's ability to learn new words often come in one of two types. The simplest type of learning is direct. Here children learn a new word by simply being told the meaning of the word (i.e. what object is being labeled). These tasks are most often used with young children who cannot overtly tell you to which object they have mapped the new word or cannot make inferences about the new word. The most popular type of direct learning task is the preferential looking task or interactive intermodal preferential looking task (Mather & Plunkett, 2010). In this task young infants are tested on their ability to learn new words for objects based on the amount of time that they look at pictures of objects matching the labels.

The labels are often spoken through a speaker device. The amount of time that children spend looking at pictures that match the label is compared to the amount of time looking at pictures that do not match the label. Even young infants have been shown to successfully map words to the correct object picture in this direct learning task (Hollich, et al., 2000; Houston-Price, et al., 2005). Research with slightly older children (1- to 3-year-olds) using tasks that require simple pointing shows that they too can easily map new words to objects (Au & Glusman, 1990; Liittschwager & Markman, 1994).

A more difficult word learning task is the indirect task. Learning words indirectly is a much harder task because it often requires making one or more inferences about the way that the word maps to a new object. These tasks preferentially engage the inference mechanism and to some extent memory. In these tasks, in order to correctly map a word to an object category, children must be able to extend a word to other members of a new category based on perceptual or conceptual features of the object (Booth, Waxman, & Huang, 2005; Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995; Landau, et al., 1998), determine which referent among distractors is the correct referent based on the social context (Akhtar, et al., 1996; Diesendruck, et al., 2004), determine which object is the most novel (Markman & Wachtel, 1988; Samuelson & Smith, 1998), and identify the type of word that is being used based on the syntactic frame in which it is used (Hall, 1994; Jaswal & Markman, 2001). Although both types of tasks, direct and indirect, have been used in the literature extensively, learning in these two tasks has not been directly compared. This direct comparison was one sub-goal of the current study.

Object Familiarity

The extent to which the familiarity of an object influences how easily a child learns a word for that object has a long history in the word learning literature. It has been shown both in direct and indirect learning paradigms (though not compared directly within the same study) that children have a much more difficult time learning words for familiar than unfamiliar objects. This is true for young infants (Mather & Plunkett, 2010) to older children and adults (e.g. Au & Glusman, 1990; Markman & Wachtel, 1988). The opposite pattern also seems likely in that novel labels preferentially highlight unfamiliar over familiar objects (Mather & Plunkett, 2010). It has often been suggested that it is more difficult to learn a name for a familiar object because any new label will be a *second* label for that object. New labels for unfamiliar objects are *first* labels (Markman & Wachtel, 1988; Markman, et al., 2003). This way of denoting the difference in object familiarity will be used interchangeably for the remainder of this paper. Another sub-goal of this paper was to directly compare children's abilities to learn first and second labels under different conditions.

Word Type

In addition to the task and object familiarity determining learning of a new word, the type of word to be learned is also important. For example, children learn part names (e.g. Banigan & Mervis, 1988; Saylor, Sabbagh, & Baldwin, 2002), proper names (e.g. Gelman & Taylor, 1984; Katz, Baker, & Macnamara, 1974), names for properties (e.g. Imai & Gentner, 1997), and names at different taxonomic levels (e.g. Markman, Wasow, & Hansen, 2003; Waxman & Senghas, 1992) differently. In general, when children are learning a second label for a familiar object, they are likely to interpret that second label as a name for a different taxonomic level than the already familiar label (Gelman, Wilcox, & Clark, 1989; Haryu & Imai, 1999; Ishida, Kosugi, & Itakura, 2003; Waxman & Senghas, 1992). However, this tendency is somewhat diminished when an alternative interpretation for the second label such as a proper name (Taylor & Gelman, 1989) or a part name (Carolyn B. Mervis, et al., 1994) is possible.

It has been suggested that children have an easier time learning two names at different hierarchical levels for the same object because the input that parents provide support this interpretation (Callanan & Sabbagh, 2004). Indeed, prior research shows that parents do tend to explain the relationship between words when teaching labels at different taxonomic levels (Callanan, 1985; Callanan & Markman, 1982; Callanan & Sabbagh, 2004). For example, a parent might say “What kind of whale is it?... It’s a baby beluga” (Callanan & Sabbagh, 2004, p. 750) as a way to distinguish the words *whale* and *beluga.* This type of “bridging information” between two taxonomically-related labels for the same object is the most often kind of contrast parents make when teaching children multiple labels (Callanan & Sabbagh, 2004) In the current study, we investigate the “bridging information” that parents use when contrasting these different types of words for the same object and compare that to children’s learning of novel labels.

Word Learning Biases

The sum result of the mechanisms brought to the task by the child and the task constraints themselves are biases that children show when learning new words. In general, children are said to expect words to label whole objects before parts (the whole-object assumption), label objects at the basic level of taxonomy rather than a more or less specific level, such as “dog” rather than “poodle” or “animal” (the taxonomic bias), and label objects in a mutually exclusive way with one word paired to one object (the mutual exclusivity bias) (Markman & Wachtel, 1988). The word learning literature suggests that children do map words to objects according to these biases in most situations, though pragmatic and other context cues can sometimes lead children to suspend these biases (Callanan & Markman, 1982; Clark & Grossman, 1998; Diesendruck & Markson, 2001). These biases are often thought of as default assumptions that are only adhered to when available evidence doesn't contradict this interpretation, as opposed to hard and fast rules.

The most relevant bias for the current study is the mutual exclusivity bias, one of the most highly discussed word learning biases in the literature (Heibeck & Markman, 1987; Huntley & Ghezzi, 1993; Markman & Wachtel, 1988; Markman, Wasow, & Hansen, 2003; Merriman, Bowman, & MacWhinney, 1989). This bias refers to children's general preference for objects to be labeled with a single label. In particular, when shown two objects, one familiar and one unfamiliar, and asked to "find a *dax",* children find it difficult to give this novel label to the already familiar object and most often choose the unfamiliar object (Littschwager & Markman, 1994; Markman & Wachtel, 1988). Additionally, the degree to which children are biased to give novel labels to familiar objects is related to their vocabulary size such that having more vocabulary words makes it easier for children to learn multiple labels for objects (Mervis & Bertrand, 1994).

In the current study, children's mutual exclusivity bias was tested by systematically varying the familiarity of the object to the child (unfamiliar object/first label and familiar object/second label). This was manipulated in addition to the condition under which children had to learn these new labels (i.e. direct and indirect learning). Children's ability to learn new labels under these different conditions was compared to the way that parents use different types of words – specifically, how they qualitatively contrasted more than one label for the same object.

Research Design Summary

The design of this study takes into account factors related to both how parents contrast multiple labels for the same object and how children learn multiple labels for objects. A cross-sectional sample of children at 12-, 16-, 20-, 24-, and 28-months-old participated in the study. These ages span the most relevant developmental period. In particular, it spans the vocabulary spurt around 18 months and key points of development for many of the domain-general cognitive mechanisms. First, how parents contrast multiple labels for objects was investigated by documenting the input that children hear. In particular, parents were asked to play with their child in a naturalistic play setting and then their speech was coded and analyzed regarding their use of multiple labels for objects. Second, how children learn new words, as indexed by the task conditions outlined above, was studied using an experimental task. Specifically, children were asked to learn words directly and indirectly for both unfamiliar objects (i.e. first labels) and familiar objects (i.e. second labels).

This design allowed us to do four things: 1) characterize the input that parents provide to their children in terms of both how much they name objects and how they contrast names for objects, 2) look at how task demands influence children's abilities to learn new names for objects, 3) look at the relationship between how parents label objects and how children learn labels – whether there were any specific relationships between the type of interaction provided in the parent input and the way that children learn words and 4) investigate whether this relationship would be mediated by age and vocabulary size. These four questions were explored in depth in the current study.

CHAPTER 3: METHOD

Participants

One-hundred and twenty children from five age groups (n=24 for each age group) at 12-, 16-, 20-, 24- and 28-months-old and one of their parents were recruited from the Boulder and Denver, Colorado, communities to participate in this experiment.[1] Approximately equal numbers of male and female children were recruited for each age group. Children that were within 7-weeks or 48-days of the age group listed above were recruited for the study. The average ages for each age group are shown in Table 1. An additional 32 children were excluded from the study for failure to complete the second session (n=12 with 3 12-month-olds, 3 16-month-olds, 1 20-month-old, 1 24-month-old, and 4 28-month-olds), equipment failure (n=1 for a 12-month-old), inability to complete the task (n=13 with 2 12-month-olds, 7 16-month-olds, 2 20-month-olds, and 2 24-month-olds), and for not speaking English as their primary language (n=6 with 1 12-month-old, 1 20-month-old, 2 24-month-olds, and 2 28-month-olds).

Participants were primarily middle- and upper-class Caucasian families. Of the 68 percent of families who reported education levels for at least one parent, 45 percent reported that at least one parent had a post-graduate degree. Of those families, 48 percent reported that both parents held post-graduate degrees. In the remaining 23 percent of families, at least one parent held a 4-year degree with both parents holding a 4-year degree in 81 percent of those families. None of the families reported that both parents had less than a 4-year-degree and only 11 percent reported that one parent had less than a 4-year-degree. We decided to limit the languages that participants speak to English for inclusion in this study as coding of the videotape data requires a fluent speaker of the language. However, it should be noted that, as we are studying the

[1] Recruitment of 120 participants allowed for enough power to have at least a 95% chance of finding a significant difference between the five age groups for either task with a small to medium effect size (cohen's *d*=.35).

Table 1. Statistics for age (in months) separated by age group.

	Average	St. Dev.	Minimum	Maximum
12 month-olds	12.2	0.77	11.25	13.77
16 month-olds	16.44	0.53	15.57	17.41
20 month-olds	20.6	0.47	19.64	21.57
24 month-olds	24.17	0.56	23.15	25.08
28 month-olds	28.48	0.63	27.28	29.64

relationship between parental input by one parent and their own child's word learning biases, the choice of language should not affect the results.

Recruitment of participants for this study consisted of contacting families that had previously signed up to participate in projects at the University of Colorado. Contact Information was stored in a database housed at the psychology department on the university campus. Only those children and parents that spoke English as their primary language were recruited for the project. For additional demographic variables, including child vocabulary size, parent vocabulary score, number of known objects in the play task, and degree of print exposure, see Appendix D.

Measures

Several different measures were collected from each parent/child dyad in order to gain a complete picture of vocabulary and second label use. First, each child's age and gender and parent's socio-economic status (education level) were recorded. Second, the MacArthur Communicative Development Inventories (MCDI) was used to determine the level of productive vocabulary for the children. Third, a vocabulary test was completed by the parent to estimate the relative vocabulary size of each parent that participated in the project with their child. This information was collected to account for individual differences between parent's uses of second labeling with their children. Fourth, in order to account for any variability children's learning of first and second labels, parents were asked to complete a short questionnaire about their children's exposure to print. Finally, children and parents were asked to complete two short tasks twice, once at each of two sessions. These two tasks were designed to test both parental use of second labeling and children's learning of first and second labels. Each measure will be described in more detail below.

Productive Vocabulary

Productive vocabulary size was evaluated in all children at all five age groups using the English version of the MacArthur Communicative Development Inventories (MCDI) (Fenson et al., 1993). Parents completed the form either before or at the first testing session (Fenson et al., 1993). This measure determines the total productive vocabulary size for children 8 to 30-months-old. These data were collected to allow for grouping the final sample by vocabulary size in addition to age. This test consists of a paper and pencil checklist of words that children might now. The words are subdivided into smaller subsections, including lists of nouns such as animals, clothing, household items and lists of action words and adjectives. Parents were asked to fill out the form using their best guess as to whether or not they have heard their child use each word, regardless of whether pronunciation was correct.

Two separate versions of this form are available. The two forms differ according to the age group with which it can be used. In terms of vocabulary, the forms differ in the number of words that are included. The "words and gestures" form contains 384 words and can be used from 8- to 18-months, whereas the "words and sentences" form contains 652 words and can be used from 16- to 30-months. Parents of the 12- and 16-month-old children completed the former whereas parents of the older groups completed the latter. The total number of words from each form were compared directly as this measure intends to reflect the total vocabulary size of children in each age group.

Both of these tests have high reliability (.85 and .90 test-retest reliability, respectively) and high concurrent validity with other productive vocabulary measures (.73 and .72, respectively).

Parent Vocabulary

Parent's relative level of vocabulary size was tested using a subtest from the Kit of Factor-referenced Cognitive Tests (Ekstrom, French, Harman, and Dermen, 1976). This test is a two-page, eight-minute task in which participants identify synonyms of difficult vocabulary words. They are given five choices to choose from – one correct and four distractors. There are a total of 36 items. Participants are given four minutes to answer each half or 18 items. Participants are told not to answer questions that they are not sure of the answer. Scoring is

Table 2. Questions asked to determine children's exposure to print and rating system.

Question	Available Responses	Ratings
In a typical week, how often do you, or other members of the family, read to your child at bedtime?	Never to 7 times	0-7
In a typical week, how often do you, or other members of the family, read to your child at other times?	Never to 7 times	0-7
Please estimate the number of children's books per child available in your household	Increments of 10 from 0-90	0-9
When being read a story, how interested does your child appear to be?	don't know, not, slightly, quite, very	0-4
In a typical week, how often do you, or another family member, go to the library?	N/A, never, rarely, sometimes, often, very often	0-5
In a typical week, how often do you, or another family member, teach your children to learn the alphabet letters?	N/A, never, rarely, sometimes, often, very often	0-5
In a typical week, how often do you, or another family member, teach your children to write their own name?	N/A, never, rarely, sometimes, often, very often	0-5
In a typical week, how often do you, or another family member, teach your children to read words?	N/A, never, rarely, sometimes, often, very often	0-5

based on the number correct minus one fourth of the number incorrect. Unanswered items are ignored.

Print Exposure

A short questionnaire was taken from Hood, Conlon, and Andrews (2008) to assess children's exposure to print. It was possible that children with more exposure to print, like having larger vocabularies, would be more likely to learn second labels easily. Parents were asked to respond to several questions regarding their use of books at home and outside of the home (see the questions and scoring details presented in Table 2). These questions were multi-faceted so that they asked about exposure to books, interest in books, and direct teaching related to books.

For each question asked, a closed set of responses were available. Each response for each question was given a score. To determine children's overall print exposure, the number corresponding to the response of each question was determined
and the total was summed. Children's print exposure score could range from 0 to 47.

Observational and Experimental Tasks

Participants completed two separate sessions within two weeks of each other. At each session they completed two tasks, an observational task and an experimental task. The first task, the observational task, was used to record how many and what type of second labels parents use with their children. This task consisted of a simple play session in which parents and children were videotaped playing with sets of toys. The second task, the experimental task, was used to test children's ability to learn first and second labels directly and indirectly. In this task children were taught two new words for familiar objects (session 1) and two new words for unfamiliar objects (session 2) and their comprehension of these and other new words were tested. The overall material list and procedure for each task is outlined below.

Parental Input Task

Materials. The goal of this task was to observe the extent to which parents use second labels and the types of second labels that they use for objects. Children and parents were asked to play with 4 sets of 14 objects each for a total of 56 objects. The four sets selected for this task included a sea animals set, a construction vehicles set, a fruits and vegetables set, and a kitchen utensils set (see Appendix A for a full list of objects). The parent/child dyads played with two sets during their first session and two sets during their second session.

Parents were asked to complete a form to identify which objects were familiar for their child and which were unfamiliar (see Appendix B). This form asked them to supply the name that they would use for each object and whether their child would call the object something different than they would call it. The purpose of this form was to help identify for each child individually which objects were familiar and unfamiliar, so that the input results could be analyzed according to each child's specific knowledge rather than as a whole group.

The object sets that children played with were chosen very carefully and conformed to the following set of four criteria (see Appendix B for pictures):

1) Twelve objects within each set belonged to one subordinate-level category (e.g. all sea animals, rather than all animals). Two additional objects were added to each set such that one matched taxonomically at the superordinate level (e.g. swan) and one matched thematically (e.g. boat).

2) Approximately half of the objects were familiar and half of the objects unfamiliar to a 20-month-old (our middle age group) according to the norms for the MCDI vocabulary test.
3) It was possible to categorize each set into at least two categories that made sense (e.g. mammals vs. fish and walks on land vs. doesn't walk on land)
4) The objects were real objects that were colorful enough to hold the child's attention while not being distracting. Every effort was made to keep the objects within a set as equal in saliency as possible.

Design and Procedure. Throughout the task, the parent and child were seated comfortably on the floor of a play room. They were given a set of objects and a set of small plastic bins and told to play with the objects. They were also told that they could categorize the objects by putting them into the bins if they wished or they could just play with the objects. After four minutes of playing with the toys, the experimenter retrieved the first set of objects. The parent and child were then handed a second set of objects that they played with for an additional four minutes. This task lasted for approximately 10 minutes. Participants played with different sets at each session – either the sea animal and kitchen utensil sets or the construction trucks and fruits and vegetables sets. The two sets that they played with were counterbalanced across the sessions.

The entire procedure was videotaped with a high quality camera that produced high quality video clips that could easily be stored on a computer. Although the video camera recorded audio, a small digital hand-held device was also used separately to record parent's speech. These video and audio clips were then used for coding purposes at a later date. An experimenter remained in the room with the parent and child to keep careful watch on the time and to ensure that the parent and child played with each object set. The experimenter made every effort not to interrupt the play session and made it clear to the parent prior to beginning the task that they were not to be consulted during the 10 minute task.

Coding. First, each videotape was reviewed and each instance of labeling for each object was identified and recorded. After coding, a total of 5 general measures were calculated in a similar manner to Callanan and Sabbagh (2004). These five general measures were of two types (see Appendix C): 1) the number of times that each object was labeled and 2) the number of label instances for each object. For the number of times each object was labeled, three sub-measures were calculated including: 1) the average number of objects labeled, 2) the average number of objects labeled with more than one label, and 3) the proportion of labeled objects labeled with more than one label. Each of these measures was also calculated as a proportion for familiar and unfamiliar objects separately. For the total number of labeling instances per object, two sub-measures were calculated including: 1) the average number of labeling instances for labeled objects and 2) the average number labeling instances only for those objects that were given more than one label. Again, each of these measures was calculated separately as a proportion for familiar and unfamiliar objects.

After the instances of second labeling had been identified, videotapes were reviewed again in order to classify words that were used for the same object (i.e. for objects that had two or more labels). Each word pair for each object was categorized according to the type of contrast that parents used for the words. For objects where more than two words were used, more than one code was potentially assigned to that object. It was determined that ten codes were sufficient to categorize the types of contrasts that were made between pairs of words. One or the following ten contrast codes were used when parents: 1) made no relation or labels were separated in time

(NR), 2) indicated that one label was "not" correct (NT), 3) didn't know which of two labels were correct (DK), 4) stated that an object could be named using one label "or" another label (OR), 5) stated that an object could be named using one label "and" another label (AND), 6) stated that one label was not correct but that the object looked like another object (LK), 7) indicated that the label was a type of object from a hierarchically superordinate category (HR), 8) indicated only one part of a larger object (PT), 9) used one label as a proper name and one as a common name (PP), and 10) used one label as a shortened version of the other (e.g. "crab" and

Table 3. Examples of parent contrasts used for labels of objects in input task

Code	Description	Example
NR	Parent made no relation or labels were separated in time	N/A
NT	Parent indicated that one label was "not" correct	"That's not a *rutabaga*. That's a *cutie*."
DK	Parent didn't know which of two labels were correct	"I can't tell. Maybe it's an *onion*. I don't know if it's a *peach*."
OR	Parent stated that an object could be named using one label "or" another label	"It's a *garlic* or a maybe a *peach."*
AND	Parent stated that an object could be named using one label "and" another label	"It's a *crane*. It's a *picker-upper* right?"
LK	Parent stated that one label was not correct but that the object looked like another object	"That does look like a *crab*. That's a *stingray*."
HR	Parent indicated that the label was a type of object from a hierarchically superordinate category	"*Carrot*. That's a *vegetable*."
PT	Parent indicated only one part of a larger object	"That's a *watermelon*. It has *seeds* in it."
PP	Parent used one label as a proper name and one as a common name	"See the *crab*. *Mr. Crabs*."
SV	Parent used one label as a shortened version of the other	"Look at the *crab*. It's a *crabby*."

"crabby") (SV) (see Table 3 for examples of each code).

Videotapes from all participants were coded by one experimenter. In addition, as a check on the reliability of coding, a random 20 percent of the participant data were coded by a second experimenter. The inter-rater agreement was 93.5% for the number of labeling instances identified. This is similar to previous studies also showing a high reliability for this type of coding scheme (Cohen's kappa averaged .85) (Callanan & Sabbagh, 2004).

Word Learning Task

Materials. Children also participated in a more formal task used to test how easily children learn first and second labels for objects. For this task, 2 sets of 11 objects were needed for training and testing (see Figure 2 for full list). One set (the *familiar* set) was used to test children's ability to learn second labels for two already familiar objects (i.e. a ball and a spoon). The other set (the *unfamiliar* set) was used to test children's ability to learn first labels for two unfamiliar objects (i.e. a honey dipper and rubber pot holder).

Each of the sets contained two target objects that were labeled in training and then used later in testing. For the familiar set, the two target objects were familiar and for the unfamiliar set, the two target objects were unfamiliar. Each set also contained an additional six familiar objects and three unfamiliar objects that were used in training and testing as distractor objects (see Figure 2). Children saw both sets of objects, one during session 1 and the other during session 2 in a counterbalanced order. During the testing phase, the experimenter also employed the use of a stuffed toy frog to help those children that became distracted to stay focused on the task while they answered the "frog's questions". This was especially useful for the younger children.

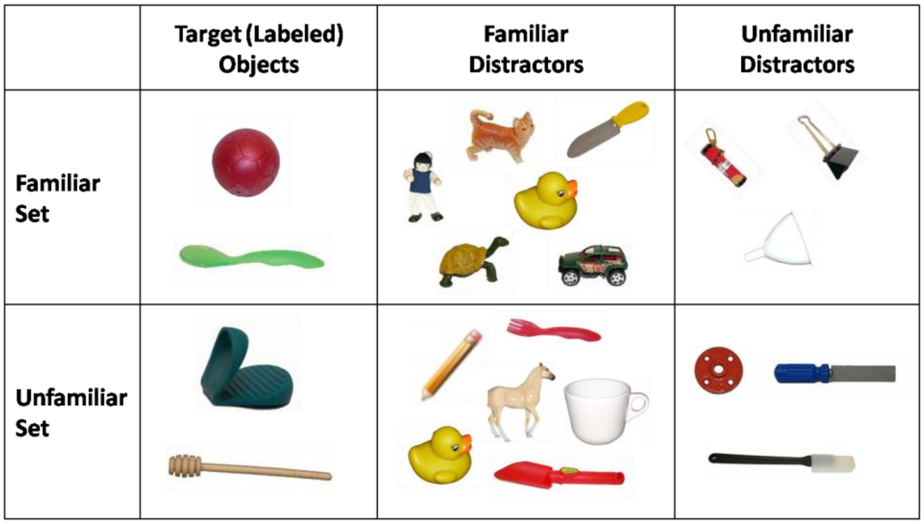

Figure 2. Summary of stimuli for word learning task.

In addition to object stimuli, linguistic stimuli were also necessary. Specifically, at each session, children learned two new words for two target objects (e.g. “mido” and “lep”). These two words were used in both training and testing. In addition, during testing, children were tested on two additional new words that they had not heard before. Thus, eight new words were created, four for each session, two at training and two additional at testing. These words were created such that they were short and easy to hear phonetically. They were made up of phonemes that are the first to appear in children’s productive language including /b/, /p/, /d/, /t/, /m/ and /n/ where possible. The eight words that were chosen included “lep”, “mela”, “mido”, “nupa”, “pamo”, “tobe”, “toma”, and “zolt”. The order in which children learned these words was counterbalanced within and across sessions. In addition, each word was used equally as often as a training word and as a testing word.

Design and Procedure. The purpose of the experimental task was to test the degree to which children learn labels for familiar and unfamiliar objects directly and indirectly. Three separate variables were investigated: 1) age (between-subjects factor), 2) label type (first labels,

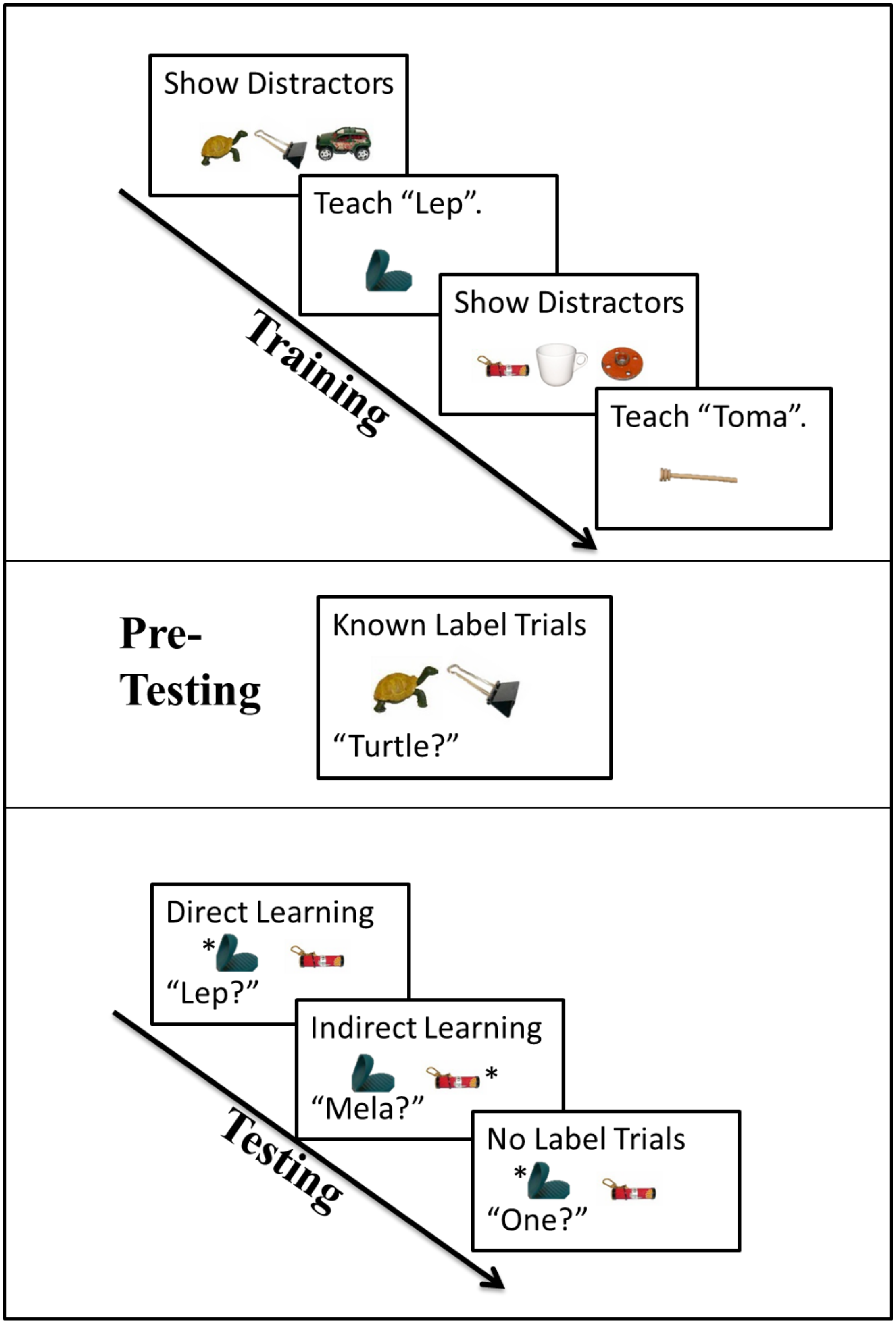

Figure 3. Summary of procedure for the word learning task.

second labels – within-subjects factor), and 3) learning type (direct learning, indirect learning – within-subjects factor). The dependent variable for this task was the number of times that the correct object was chosen. All children received the same procedure at both sessions except that they saw a different set of objects each time. Half of the children saw the familiar object set first and half saw the unfamiliar object set first. All children were tested in English.

The task or "game" that the children were asked to complete included three phases, the training phase, the pre-testing phase and the testing phase (see Figure 3).

Training Phase. In the training phase, two target familiar or unfamiliar objects were labeled and six distractor items were shown to the children. Distractor items were shown to the children during training to ensure that these objects were familiar to the children before testing. The objects were presented to children in this order: 1) three distractor objects in a pre-determined random order, 2) one target object, 3) three additional distractor objects in a pre-determined random order, and 4) the second target object. For the first three distractor objects, the experimenter simply drew attention to each distractor object one at a time without naming them (e.g. "See this. Look at this."). The target object was then presented and named at least three times (e.g. "Look at the *mido*. See the *mido*? This one is the *mido*."). Before showing the additional three distractors and second target object, the experimenter repeated steps one and two, so that each object was presented twice and the target object was named a total of six times with the novel label. Steps three and four were also repeated a second time. Each target object was labeled with a different novel label. By the end of the training phase children had been presented with six distractors (three familiar and three unfamiliar) and been taught two new names for two separate target objects. The order in which the two sets were presented at each session was counterbalanced.

Pre-Testing Phase. Following the training phase, children moved immediately to the pre-testing phase. The goal of this phase was to ensure that children were engaged in the task and could correctly identify known objects. In this phase, children were introduced to the toy frog, when necessary, and asked to choose three familiar objects one at a time from a choice of two objects. For example, they might be shown a cup and a funnel and asked to choose the "cup" or asked to give the frog a "cup". Children were provided encouragement during this phase to ensure correct responses.

Testing Phase. Immediately following the pre-testing phase, children entered the testing phase. The goal of testing was three-fold: 1) to test whether children had learned the two new words for the target objects in training, 2) to test whether children could learn two new words for non-target objects indirectly, and 3) to test whether children would choose the target objects in general, even without labels. To this end, children were asked 12 separate questions, including four each of three types corresponding to the goals outlined above. One of each question type was presented per block for four blocks with the order of questions within a block being presented in a fixed random order. For each of the 12 questions, children were shown two objects and asked to "find something" by the experimenter, with or without the aid of the small stuffed toy frog. The following three types of questions are outlined below:

1) Direct learning questions: children were asked to identify the referent of one of the new words used in training. They were given a choice between the corresponding target object that was labeled in training and a distractor object from training. Two of the target-label questions included a familiar distractor and two included an unfamiliar distractor.

2) Indirect learning questions: children were asked to identify the referent of a new word not presented in training. The set-up of these questions was identical to the target label questions except that the correct answer was now the familiar or unfamiliar distractor from training that had not previously been labeled.
3) No label questions: children were asked to "find one" while being presented with a target object and a distractor object. Again, there were two no label questions for each target object/distractor pair from training, one with a familiar distractor and one with an unfamiliar distractor. The target labeled object was considered the correct choice.

For each type of question, subsequent to the experimenter asking the child to "find the…", the two objects were presented on a tray designed to keep the two objects at an equal distant from the child and from each other. Experimenters did not look at or touch either object while asking children to choose.

Overall Procedure

This study required that both tasks be completed at each session. Both sessions were identical except that parents completed the consent forms, demographic information and productive vocabulary MCDI form before or at the beginning of the first session and they complete the parent vocabulary test at the beginning of the second session. After the initial forms/tests were completed at each session, children and parents proceeded to the first task, the parental input task. After playing with the toys for eight minutes, parents and children were taken to a separate room to complete the experimental task. At the end of the second task, parents were asked to complete the form asking about the familiarity of the parental input task objects for their child. They were then presented with $5.00 for travel and children were given a small book as a prize. Parents were also debriefed after the experimental task at the second session.

CHAPTER 4: PARENTAL INPUT RESULTS

General Input Measures

For the parental input task, parent speech was coded, as described in Appendix C, for five separate measures. These five measures were of two types – number of labels given to objects and number of labeling instances for each object (see Table 4). For the former, the following three sub-measures were calculated: 1) the number of objects given a label, 2) the number of objects given multiple labels, and 3) the proportion of labeled objects given multiple labels. For the latter, the following two sub-measures were calculated: 1) the number of labeling instances for all labeled objects and 2) the number of labeling instances only for those objects that were given multiple labels. In addition to these five measures, each measure was also calculated separately as a proportion for familiar objects and unfamiliar objects separately. Each of the five raw measures was submitted to a 2 (familiarity of object) by 5 (age group) mixed-factorial ANOVA separately. Each analysis is reported below (see Figure 4).

Table 4. Summary of raw parent input measures.

Measure Types	Description
1. Number of Labeled Objects	
a. Objects Labeled	Average number of objects labeled
b. Objects given multiple labels	Average number of objects (out of 56) given two or more different labels
c. Labeled objects given multiple labels	Average proportion of *labeled* objects given two or more different labels
2. Number of Labeling Instances	
a. All Objects	Average number of labeling instances per labeled object
b. Objects given multiple labels	Average number of labeling instances per labeled object given multiple labels

Proportion of Objects Labeled

Results of the overall ANOVA showed that a higher proportion of familiar objects were labeled than unfamiliar objects, $F(1,115)=27.33$, $\eta^2=.19$, $p<.001$. This interacted with age, $F(4,115)=4.46$, $\eta^2=.13$, $p<.01$, such that a higher proportion of familiar objects were labeled than unfamiliar objects at all age levels, all p's<.01, except for the 12-month-olds, $t(23)=3.33$, n.s. Note that this non-significant effect is not due to 12-month-olds knowing fewer objects given that this measure was calculated as the proportion of objects known. The overall proportion of

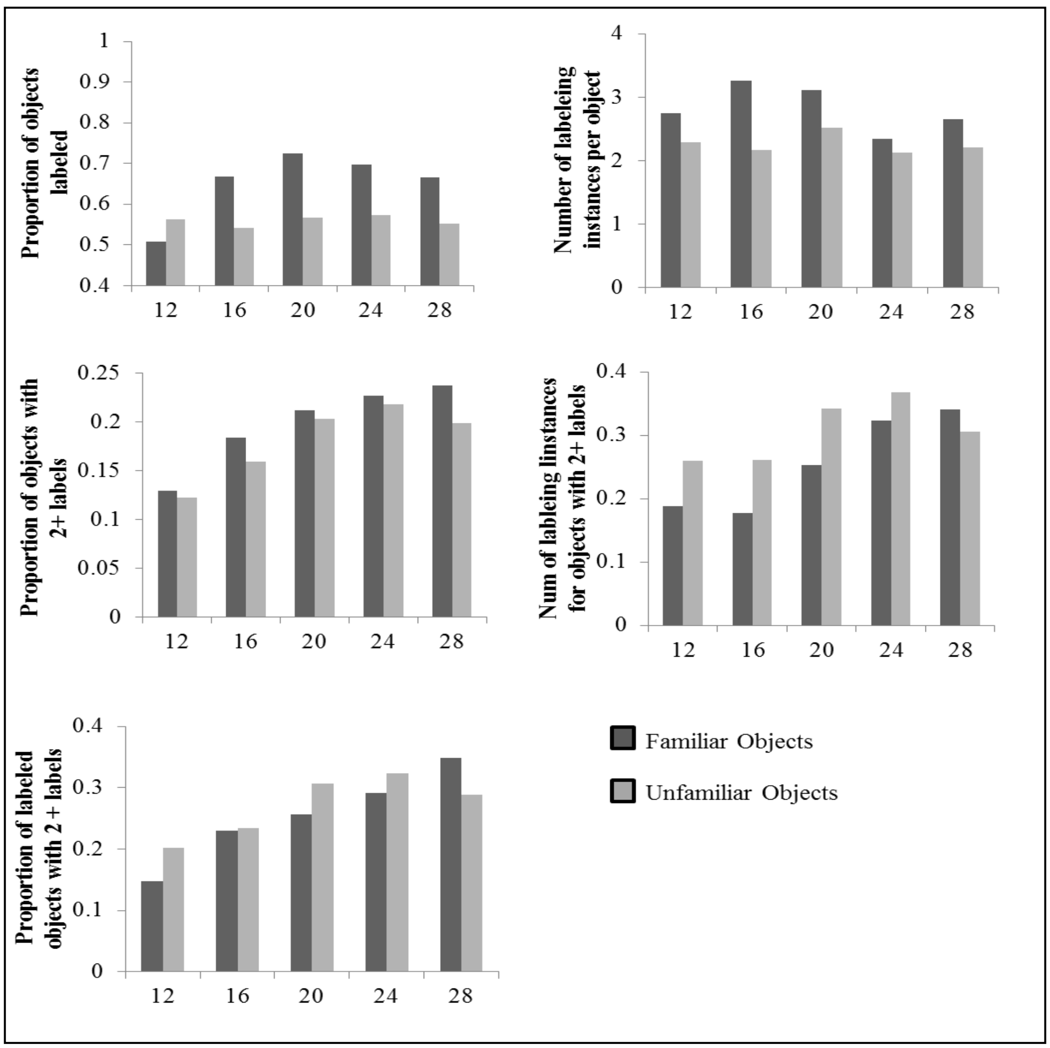

Figure 4. Means for 15 raw measures of parental input

labeled objects did not change with age, $F(4,115)=1.53$, $\eta^2=.05$, n.s. This result is unsurprising given that this measure is a simple count of the nouns that parents used and not a measure of language complexity such as MLU or syntax structures. If we had collected data on a measure sensitive to overall complexity of language use, a across age would be expected. Grouping participants by vocabulary size instead of age group did not change the interpretation of the main effects or interactions.

The mixed-factorial ANOVA reported above was conducted a second time with three demographic variables added as covariates. These variables included child vocabulary size, parent vocabulary score and print exposure score. Adding these covariates eliminated the effect of object familiarity seen in the overall ANOVA conducted without these covariates, $F(14,115)=1.82$, $\eta^2=.02$, n.s. Like the previous ANOVA, there was still no main effect of age group, $F(4,115)=.46$, $\eta^2=.03$, n.s. However, these two effects did still show a significant interaction, $F(4,115)=1.53$, $\eta^2=.05$, n.s., suggesting that these demographic variables could not

Table 5. Correlations between raw input measures and demographic variables.

Measure	Age	Child Vocabulary	Objects Known	Parent Vocabulary	Print Exposure
Number of objects named	0.10	0.09	0.14	0.21*	0.15
Proportion of objects with 2 or more labels	0.32**	0.25**	0.29**	0.42**	0.14
Proportion of labeled object with 2 or more labels	0.36**	.29**	0.32**	0.43**	0.12
Number of labeling instances	-0.04	-0.06	0.06	0.26**	0.03
Proportion of labeling instances for objects with 2 or more labels	0.37**	0.35**	0.35**	0.41**	0.10

*$p<.05$, **$p<.01$

completely explain the change the lack of difference in labeling familiar and unfamiliar objects for 12-month-olds as compared to the four older age groups.

In addition to being added as covariates, correlations between the demographic variables and the five raw measures were also investigated (see Table 5). Demographic variables included children's age, children's vocabulary size, number of objects that children knew in the input task, parent's vocabulary score, and print exposure. The number of objects that parents labeled was related to parent vocabulary but none of the other demographic variables, suggesting that parent's own vocabulary was a better predictor of how often parents label objects than variables related to their child. Again, this result is unsurprising given that this measure simply measures noun use and not language complexity. This interpretation was also supported by a stepwise regression performed to model how well these demographic variables predicted the number of objects labeled by parents. Only one model was reliable – the model that included parent vocabulary, $F(1,118)=5.60$, $r^2=.05$, $p<.05$ (see Table 6). Child's age, vocabulary level, and print exposure did not explain a significant proportion of the variability above and beyond parent vocabulary.

Table 6. Regression model of demographic variables predicting number of labeled objects by parents.

Model	B	SE of B	β
(Constant)	29.52	2.26	
Parent Vocabulary	.26	.11	.21*

*$p<.05$

Proportion of Objects Labeled with Two or More Labels

Results of an overall ANOVA showed that a higher proportion of objects were labeled with multiple labels as the age of the child increased, $F(4,115)=3.53$, $\eta^2=.12$, $p<.01$. The overall proportion did not change based on the familiarity of the object, $F(1,115)=2.26$, $\eta^2=.02$, n.s., nor did this interact with age, $F(4,115)=.28$, $\eta^2=.01$, n.s. Grouping participants by vocabulary size instead of age group did not change the interpretation of the main effects or interactions.

The mixed-factorial ANOVA reported above was conducted a second time with child vocabulary size, parent vocabulary score and print exposure score added as covariates. Adding these variables eliminated all effects. There was no effect of object familiarity, $F(1,115)=.48$, $\eta^2<.01$, n.s., age group, $F(4,115)=1.31$, $\eta^2=.05$, n.s., or an interaction between the two, $F(4,115)=1.07$, $\eta^2=.04$, n.s. The fact that adding these demographic variables as covariates eliminates all the effects seen in the previous ANOVA suggests that these demographic variables could explain the fact that parents use more multiple labels as children grow older.

Correlation tests between these demographic variables and the number of objects given multiple labels showed that all of the demographic variables (i.e. age, child's vocabulary, number of objects known, and parent vocabulary) were positively related to parent's use of multiple labels. The exception was print exposure (see Table 5). This suggests that variables related to both the child and the parents are responsible for the difference in proportion of second labels for familiar and unfamiliar objects. Regression analyses showed, however, that of these correlated variables, parent vocabulary was the best predictor of second label use, followed by child's age, $F(1,118)=17.60$, $r^2=.23$, $p<.001$. This is similar to what was found in the analysis

Table 7. Regression model of demographic variables predicting number of objects given two or more labels by parents.

Model	B	SE of B	β
(Constant)	4.41	1.32	
Parent Vocabulary	.32	.07	.42**
(Constant)	.23	1.90	
Parent Vocabulary	.28	.06	.37**
Child's Age	.24	.08	.25**

**$p<.01$

for the overall number of objects labeled. Number of known objects and print exposure did not explain a significant proportion of the variability above and beyond parent vocabulary and child's age (see Table 7).

Proportion of Labeled Objects Labeled with Two or More Labels

The proportion of objects given multiple labels was also calculated for only those objects that were labeled, as opposed to all objects seen by the parent/child dyads. The results of this two analyses were nearly identical. Specifically, results showed that a higher proportion of labeled objects were given multiple labels as the age of the child increased, $F(4,115)=4.87$, $\eta^2<.15$, $p<.01$. The overall proportion of labeled objects given two or more labels did not change based on the familiarity of the object, $F(1,115)=1.01$, $\eta^2<.01$, n.s., nor did this interact with age, $F(4,115)=1.70$, $\eta^2<.06$, n.s. Grouping participants by vocabulary size instead of age group did not change the interpretation of the main effects or interactions. Additionally, adding child vocabulary size, parent vocabulary score and print exposure score as covariates eliminated all effects. There was no effect of object familiarity, $F(1,115)=1.81$, $\eta^2=.02$, n.s., age group, $F(4,115)=1.75$, $\eta^2=.06$, n.s., or an interaction between the two, $F(4,115)=1.88$, $\eta^2=.06$, n.s.

Correlation tests between these demographic variables and the number of labeled objects given multiple labels showed that all of the demographic variables (i.e. age, child's vocabulary, number of objects child knew, and parent vocabulary) were positively related to parent's use of second labels except for print exposure (see Table 5). Regression analyses showed that of these correlated variables, parent vocabulary was again the best predictor of multiple labeling, followed by child's age, $F(1,118)=21.72$, $r^2=.52$, $p<.001$. The number of known objects and print exposure did not explain a significant proportion of the variability above and beyond parent vocabulary and child's age (see Table 8).

Table 8. Regression model of demographic variables predicting number of labeled objects given two or more labels by parents.

Model	B	SE of B	β
(Constant)	.13	.03	
Parent Vocabulary	.01	.001	.44***
(Constant)	.02	.04	
Parent Vocabulary	.01	.001	.39***
Child's Age	.01	.002	.28***

****p*<.001

Number of Labeling Instances

Results of the overall ANOVA showed that familiar objects, when labeled, were, on average, labeled a higher number of times than unfamiliar objects, $F(1,115)=20.27$, $\eta^2<.15$, $p<.01$. The number of labeling instances did not change with age, $F(4,115)=1.42$, $\eta^2<.05$, n.s., This is not surprising given that this is only a measure of the number of nouns given to objects rather than a language complexity measure. Age also did not interact with the familiarity of the objects, $F(4,115)=1.37$, $\eta^2<.05$, n.s. Grouping participants by vocabulary size instead of grouping by age did not change the interpretation of the main effects or interactions.

The mixed-factorial ANOVA reported above was conducted a second time with child vocabulary size, parent vocabulary score and print exposure score added as covariates. Adding these variables eliminated all effects, such that there was no effect of object familiarity, $F(1,115)=1.01$, $\eta^2<.01$, n.s., effect of age group, $F(4,115)=1.75$, $\eta^2=.06$, n.s., or an interaction between the two, $F(4,115)=.83$, $\eta^2=.03$, n.s. This suggests that parent vocabulary could explain the fact that familiar objects were labeled more times than unfamiliar objects.

Correlation tests showed that only parent vocabulary score was related (positively) to the average number of labeling instances per object (see Table 5). Age, child's vocabulary, number of objects child knew, and print exposure were not related to the number of labeling instances. Regression analyses further supported this connection as parent vocabulary score was the only significant predictor of average labeling instances (see Table 9), $F(1,118)=8.21$, $r^2=.07$, $p<.01$, again suggesting that parent's own vocabulary was a better predictor of their labeling of objects than variables related to their child.

Table 9. Regression model of demographic variables predicting average number of labeling instances per object

Model	B	SE of B	β
(Constant)	2.10	.16	
Parent Vocabulary	.2	.01	.26**

$^{**}p<.01$

Number of Labeling Instances for Objects Given More than One Label

Although *familiar* objects were given a greater number of labels each overall, when looking only at objects that were given multiple labels, *unfamiliar* objects were given more labels, $F(1,115)=8.51$, $\eta^2=.07$, $p<.01$. The number of labeling instances for objects with multiple labels did not change with age, $F(4,115)=1.27$, $\eta^2=.04$, n.s., nor did this interact with the familiarity of the object, $F(4,115)=1.70$, $\eta^2=.06$, n.s. Grouping participants by vocabulary size instead of grouping by age did not change the interpretation of the main effects or interactions.

The mixed-factorial ANOVA reported above was conducted a second time with child vocabulary size, parent vocabulary score and print exposure score added as covariates. Adding these variables eliminated all effects. There was no effect of object familiarity, $F(1,115)=.37$, $\eta^2<.01$, n.s., effect of age group, $F(4,115)=.97$, $\eta^2=.03$, n.s., or an interaction between the two, $F(4,115)=.48$, $\eta^2=.02$, n.s. This suggests, again, that parent vocabulary could explain the fact that unfamiliar objects given multiple labels were labeled more times than familiar objects given multiple labels.

Correlation tests showed that all of the demographic variables (i.e. age, child's vocabulary, number of objects child knew, and parent vocabulary) were positively related to the number of labels per object given more than one label except for print exposure (see Table 5). Regression analyses showed that of these correlated variables, parent vocabulary was again the best predictor of the number of labeling instances for objects given multiple labels, followed by child's age, $F(1,118)=19.81$, $r^2=.25$, $p<.001$. Number of known objects and print exposure did not explain a significant proportion of the variability above and beyond parent vocabulary and child's age (see Table 10).

Table 10. Regression model of demographic variables predicting average number of labeling instances for objects given two or more labels by parents.

Model	B	SE of B	β
(Constant)	.26	.04	
Parent Vocabulary	.01	.002	.41***
(Constant)	.19	.06	
Parent Vocabulary	.01	.002	.35***
Child's Age	.01	.002	.30***

***$p<.01$

Summary

In general, parents overall labeling of objects was more heavily influenced by the familiarity of the object that they were labeling than the age of their child. In particular, parents were more likely to label objects familiar to their child than objects unfamiliar to their child. Additionally, this labeling pattern was related to parent vocabulary size, but not demographics related to the child (i.e. age and child vocabulary size). On the contrary, for multiple labeling, the number of objects that parents gave more than one label to was more heavily related to the age of the child than the familiarity of the object. And, in addition to parent vocabulary, the child demographics of age and vocabulary size were related to multiple labeling, suggesting that both parent and child variables were related to the way that parents used second labels. This result is consistent with previous research on parent's use of multiple labels with their children (Callanan & Sabbagh, 2004)

Second Label Relations in Parental Input

After each object that was given two or more labels had been identified, a second pass of coding was conducted to assign one or more "bridging" or "contrast" codes to each of these objects. These codes were used to categorize the relationship between the two labels used for the same object depending on how the parent did (or did not) contrast the two labels. There were 10 possible codes for every label pair (see Table 3). Because some objects were given more than two labels, each object could receive more than one code. For each code separately, the percentage of objects that received that code was calculated. This was done for all objects together and for familiar objects and unfamiliar objects separately (see Table 11).

The percent of objects given multiple labels that received each code varied from 14.56% (receiving a part name and whole name for the same object) to only 0.61% (receiving a common name and a proper name for the same object). Overall, part name relations, "and" relations (i.e. an object received two basic-level names for the same object), and hierarchical relations (i.e. one name was at the basic-level and the other at a superordinate level), were the most common types of relations. Proper names were by far the least likely relation with shortened versions (i.e. parents used two versions of the same word) being the second least likely relation. The codes for "not" relations (i.e. parents indicated that one name was correct and the other incorrect), no

Table 11. Mean percent use of each second label relationship code for objects with more than one label for each age group

	Second Label Relation Codes									
Age Groups	PT	AND	HR	NT	NR	DK	LK	OR	SV	PP
12-month-olds										
Familiar	3.33	4.75	10.33	2.08	5.29	0.71	4.17	0.00	0.71	0.46
Unfamiliar	9.96	15.08	12.92	11.21	16.96	4.75	6.00	4.29	3.08	3.00
All Objects	6.65	9.92	11.63	6.65	11.13	2.73	5.08	2.15	1.90	1.73
16-month-olds										
Familiar	4.08	5.54	7.58	4.25	4.21	2.08	2.13	1.71	2.54	0.00
Unfamiliar	13.08	10.21	17.63	8.71	7.08	8.50	4.25	3.58	1.67	0.00
All Objects	8.58	7.88	12.60	6.48	5.65	5.29	3.19	2.65	2.10	0.00
20-month-olds										
Familiar	12.54	12.46	6.17	5.83	6.83	4.25	2.67	1.29	3.88	0.00
Unfamiliar	10.33	11.54	6.96	11.33	9.33	5.88	6.96	5.13	1.08	0.33
All Objects	11.44	12.00	6.56	8.58	8.08	5.06	4.81	3.21	2.48	0.17
24-month-olds										
Familiar	11.83	12.08	11.67	8.17	9.00	3.46	4.96	3.71	2.42	0.33
Unfamiliar	17.29	9.92	8.21	7.92	6.25	3.67	3.54	2.25	2.17	0.92
All Objects	14.56	11.00	9.94	8.04	7.63	3.56	4.25	2.98	2.29	0.63
28-month-olds										
Familiar	17.63	14.92	12.38	14.04	11.58	7.04	4.17	2.13	1.08	0.33
Unfamiliar	6.88	6.96	6.13	9.54	6.04	3.46	0.87	1.88	0.71	0.71
All Objects	12.25	10.94	9.25	11.79	8.81	5.25	2.52	2.00	0.90	0.52
All age groups										
Familiar	9.88	9.95	9.63	6.88	7.38	3.51	3.62	1.77	2.13	0.23
Unfamiliar	11.51	10.74	10.37	9.74	9.13	5.25	4.33	3.43	1.74	0.99
All Objects	10.70	10.35	10.00	8.31	8.26	4.38	3.97	2.60	1.93	0.61

relations (i.e. parents did not relate the two labels), “don’t know” relations (i.e. parents didn’t know which word was correct), “like” relations (i.e. parents indicated that the object was “like” another object) and “or” relations (i.e. parents stated that either of two labels could be correct) all fell in the middle range of usage.

Effects of Object Familiarity

An overall 5 (age group) by 2 (object familiarity) by 10 (code) mixed-factorial ANOVA was conducted to investigate the differences in usage of the 10 types of second label relations by parents. A greater number of labels per object were used with increasing age, $F(4,115)=2.98$, $\eta^2=.09$, $p<.05$, and for unfamiliar objects over familiar objects, $F(1,115)=6.05$, $\eta^2=.05$, $p<.05$. This means that more second labels were used per object at older age groups and for unfamiliar objects overall, which is consistent with the earlier analysis of the quantity of labels used. There was also an interaction between these two variables. Unfamiliar objects received more labels per object at 12-months, $t(23)=3.94$, $p<.01$, and 16-months of age, $t(23)=4.49$, $p<.01$. This effect disappeared at 20-months, $t(23)=1.07$, n.s., and 24-months, $t(23)=.54$, n.s. By 28-months, the effect had reversed such that familiar objects received more labels per object, $t(23)=4.40$, $p<.01$. This pattern is likely because 28-month-olds (and the other older age groups, in general) were familiar with more of the objects than the younger groups.

There was also a significant main effect of code, $F(9,115)=33.39$, $\eta^2=.23$, $p<.001$. As described above, there was a large variability in the percent of objects that received each code. This effect did not interact with age alone, $F(36,115)=1.43$, $\eta^2=.05$, n.s., but did interact with age and object familiarity, $F(4,115)=1.67$, $\eta^2=.06$, $p<.05$. In order to investigate this significant

Table 12. Post-hoc results for each second label relation coded separately.

	Main Effect of Familiarity		Main Effect of Age Group		Interaction	
Measure	F (1,115)	η^2	F (4,115)	η^2	F (4, 115)	η^2
PT	1.04	0.01	3.19*	0.10	5.16**	0.15
AND	0.28	<.01	0.82	0.03	4.34**	0.13
HR	0.13	<.01	1.11	0.04	1.91	0.06
NT	4.47*	0.04	1.32	0.04	2.85*	0.09
NR	1.53	0.01	1.84	0.06	4.34**	0.13
DK	2.98	0.03	1.22	0.04	2.85*	0.09
LK	0.58	0.01	0.86	0.03	2.13	0.07
OR	5.55*	0.05	0.47	0.02	2.53*	0.08
SV	0.37	<.01	0.73	0.03	1.70	0.06
PP	5.41*	0.05	3.84**	0.12	1.89	0.06

** $p<.01$, *$p<.05$

three-way interaction, a series of post- hoc analyses were run. Specifically, for each code separately, a 5 (age group) x 2 (object familiarity) ANOVA was conducted (see Table 12).

Overall, three codes showed a significant main effect of object familiarity – "not" relations (NT), "or" relations (OR), and proper name relations (PP). In each case, unfamiliar objects received a higher number of labels per objects. Only part names and proper names showed a main effect of age group. The part name relations (PT) were used more often with increasing age. The increase in usage of proper name relations (PP) across age may have been spurious given that this type of contrast was used only for the 12-month-olds and only for 1.7% of the objects.

The majority of the codes showed the same interaction between age and object familiarity. Six of the 10 codes showed a significantly higher percentage of usage for unfamiliar objects at younger ages and familiar objects at older age groups. The hierarchical (HR) relations and "like" (LK) relations did not show significant interaction effects but did show the same trend as the six codes that did, though to a lesser extent. The final two codes, proper names (PP) and shortened version (SV), did not show this interaction, though this is likely due to the fact that both showed a very low incidence of use. Again, this overall pattern of interaction was likely due to the older age groups being more familiar with a greater number of objects than the younger groups. Grouping the participants by vocabulary size instead of age group did not change the interpretation of any of the main effects of interactions of the overall ANOVA. Adding covariates to the overall model showed that only the main effect of familiarity, $F(1,115)=14.25$, $\eta^2=.11$, $p<.001$, and the main effect of code, $F(9,115)=2.80$, $\eta^2=.02$, $p<.01$, continued to be significant. All other effects were eliminated, suggesting that child vocabulary, parent vocabulary, and print exposure explained a large portion of the variability contributing to the age related effects significant in the overall ANOVA.

Factor Analysis

Because it was likely that the ten second label relations coded for in the parental input were heavily interrelated, a factor analysis was conducted using PCA (principal components analysis) to look for contrasts that loaded onto similar factors or components. It should be noted that the ten codes were not added to the model separately by familiar and unfamiliar objects as this resulted in several codes with low commonality values – i.e. the components/factors extracted by the model explained very little of the variability of these codes. This was due to the fact that not all codes were used by all parents at every age group. In addition, once codes with low common values were removed from the model, the model was incomplete and the extracted components were difficult to interpret. Likewise, when using the 10 overall codes, both the shortened version (SV) code and the proper name (PP) code showed very low commonality scores and did not load on to any factors. This is likely due, again, to the fact these two relations were rarely used by parents. Adding only the eight relations that were commonly used by parents provided a much cleaner picture of second label relations in parental input. Additionally, adding age (in months) and vocabulary size to the model showed that age had a very low commonality and no loadings on any components. Vocabulary size showed a low commonality but did load onto the fifth and final component (the part names component) (see below).

The final factor analysis passed several common criteria for use. First, with 15 cases per variable entered into the model, the factor analysis was reliable. Second, Bartlett's test of sphericity was significant, $\chi^2(28)=95.48$, $p<.001$. Finally, the diagonals of the anti-image matrix and the commonalities between the relations were all at or above .60. The principal components analysis produced five components with Eigen values above 1.0 that were retained in the model. The first component explained 17.84% of the variance, the second 16.91%, the third 15.75%, the fourth 14.72%, and the fifth 12.67% for a total variance explained of 77.88%. Three other components had Eigen values less than 1.0 and were excluded from the model. Rotation of the solution was utilized to facilitate interpretation of the three components. For this rotation, the verimax solution was used, though no difference in interpretation was obtained using an oblimin solution.

Interpretation of Extracted Components

Upon inspection of the rotated solution and using component loading values greater than .6 (positive or negative) (see Table 13), it was possible to interpret the five significant components. The first component (henceforth called Specificity) can be interpreted as having higher values for parents using the "like" or LK code (i.e. gave objects two basic-level names using the word "like") and lower values for parents using the taxonomic contrast or HR code (i.e. gave objects one basic-level name and one superordinate name). The second component (henceforth called Contrast) can be interpreted as having higher values for parents using the "and" or AND code (i.e. accepting two labels for one object) and lower values for parents using

Table 13. Rotated Solution for second label relation factor analysis

	Component				
Code	Specificity	Contrast	Ambiguous	No Relation	Part Names
NT	.237	**-.821**	.160	.021	-.053
DK	-.158	-.013	**.612**	.529	-.200
LK	**.796**	.028	-.245	.247	-.143
OR	.027	-.014	**.789**	-.107	.057
AND	.273	**.801**	.135	-.005	-.033
PT	.001	.017	-.002	.145	**.957**
HR	**-.723**	.006	-.379	.306	-.291
NR	-.098	.021	.078	**-.871**	-.213

the “not” or NT code (i.e. accepting only one label for an object). The “don’t know” or DK and “or” or OR codes both loaded (positively) onto the third component (henceforth called Ambiguous Relations) with a higher score indicating a greater use of relations that are ambiguous toward rejecting or accepting second labels. The no relation or NR code loaded (negatively) onto the fourth component (henceforth called No Relations) with a lower score indicating that parents made no clear relations between two labels for one object. Finally, the fifth component (henceforth called Part Names) showed a high (positive) loading for the part names or PT code such that higher values were given to parents who were more likely to relate two labels as names for the whole and a part of an object.

Changes with Age and Vocabulary of Children

A series of ANOVA’s were conducted to look for changes in the component values by age group and vocabulary size. There were no significant changes across age groups or vocabulary size for any of the five components with the exception of the part name component changing with age such that parents were more likely to use part name relations for older children than younger children, $F(4,115)=2.66$, $\eta^2=.09$, $p<.05$. However, adding the three demographic variables of child vocabulary size, parent vocabulary score and print exposure eliminated this effect, $F(9,115)=1.39$, $\eta^2=.05$, n.s. Adding these covariates to the other analyses had no impact on the lack of change across age or vocabulary size.

Correlations with Demographics

The relationships between the five components extracted from the factor analysis and five demographic variables were investigated using correlation analyses (see Table 14).   The specificity, contrast, and no relation components were not related to any of the demographic variables. The ambivalence component was positively related to parent vocabulary such that parents with higher vocabulary scores were more likely to say that they "didn't know" which of two labels were correct or say that either label could be correct. The part name component was related to the three child-centered demographic variables of age (in months), child vocabulary size and number of objects known in the play task. As children got older and knew more words, their parents labeled more part names of objects.

Table 14. Correlation analyses between factor analysis components and demographic variables

Component	Age	Child Vocabulary	Objects Known	Parent Vocabulary	Print Exposure
Specificity	0.02	-0.01	0.04	0.02	-0.11
Contrast	-0.06	-0.04	-0.07	-0.09	0.05
Ambivalence	0.12	0.11	0.13	0.30**	0.13
No Relation	0.05	-0.03	0.10	0.10	0.17
Part Names	0.24**	0.20*	0.18*	0.07	0.01

Step-wise regression analyses were largely consistent with the correlation analyses. None of the demographic variables significantly predicted parent's use of the specificity relations, contrast relations, or when parents made no relation. Parent's use of ambiguous relations was significantly predicted by parent vocabulary, $F(1,118)=11.90$, $\eta 2=.09$, $p<.01$. None of the other variables significantly predicted ambiguous relations above and beyond parent vocabulary. Part name relations was significantly predicted by child's age, $F(1,118)=7.10$, $\eta 2=.06$, $p<.01$. None of the other variables significantly predicted part name relations above and beyond the child's age.

Chapter 5: Word Learning Results

In the word learning task, children were tested on their ability to learn first and second labels directly and indirectly in four respective types of trials. Additionally, in two types of control trials, they were tested 1) on their ability to identify known objects (i.e. known label trials) and 2) on their preference for choosing previously labeled objects over non-labeled objects when asked to "find one" (i.e. no label trials). This chapter is devoted to analyzing children's performance on this task.

Word Learning across Development

Control Trials

Children's ability to choose a known object (rather than a distractor) changed with age such that older children were more likely to choose the requested object than younger children, $F(4,109)=11.94$, $\eta^2=.31$, $p<.001$ (see Table 15). Participants were also able to correctly identify known objects above chance when given a choice between that object and one distractor, $t(109)=21.45$, $p<.001$. This was true at all age groups, all p's<.001.

Children's preference to choose the labeled object from training when asked to "get one" in the no label trials did not change with age, $F(4,115)=.80$, $\eta^2=.03$, n.s. (see Table 15). Participants chose the labeled objects from training more than the distractor in the no label trials

Table 15. Statistics and comparisons to chance for control trials

	Known Label Trials		No Label Trials	
	Mean	Std Dev.	Mean	Std. Dev.
Entire Sample	.84*	.17	.57*	.19
12-month-olds	.66*	.19	.63*	.16
16-month-olds	.84*	.13	.55	.16
20-month-olds	.85*	.14	.55	.24
24-month-olds	.91*	.23	.57	.19
28-month-olds	.92*	.12	.54	.17

*$p<.001$

significantly greater than chance, $t(119)=3.44$, $p<.001$. However, separately, only the 12-month-old participants showed a preference to choose the labeled object more than chance, $t(23)=3.67$, $p<.001$. All of the other age groups chose the labeled object at chance rates, all p's>.1.

Learning First and Second Labels Directly and Indirectly

A 2 (label type: first label, second label) x 2 (learning type: direct, indirectly) x 5 (age group) mixed-factorial ANOVA showed that there was no overall difference in the average number of times that children chose the target object when learning directly or indirectly, $F(1,115)=.02$, $\eta^2<.01$, n.s., nor did this interact with age, $F(1,115)=2.28$, $\eta^2=.07$, n.s.

Participants did, however, make more correct choices when learning first labels than second labels, $F(1,115)=25.52$, $\eta^2=.18$, $p<.001$. This effect did not change with age, $F(1,115)=.52$, $\eta^2=.02$, n.s., but did interact with the type of learning, $F(1,115)=16.05$, $\eta^2=.12$, $p<.001$, such that participants made more correct choices with first than second labels when learning indirectly, $t(119)=6.43$, $p<.001$, but showed no difference in correct choices for first and

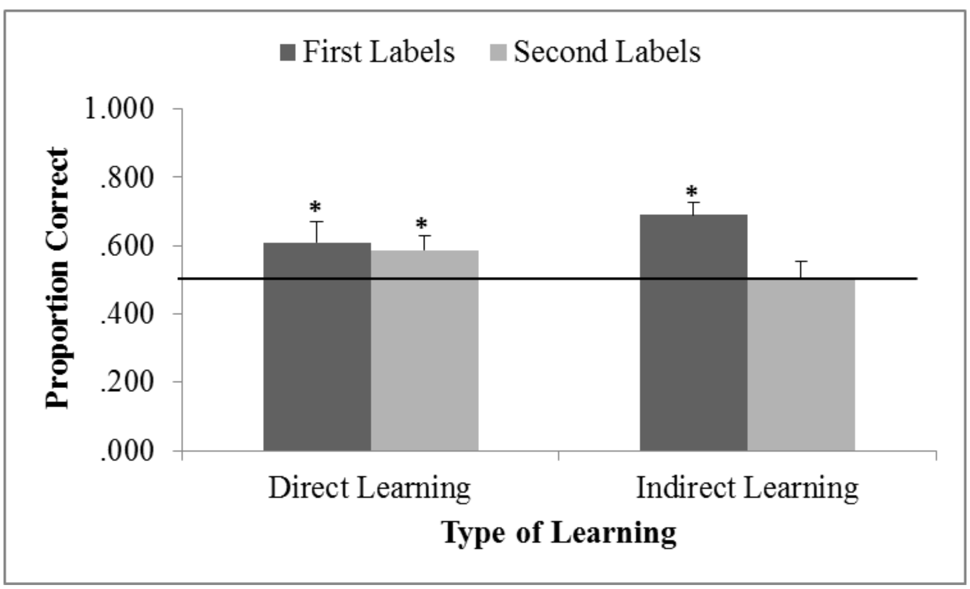

Figure 5. Percent correct choices on word learning task. Significant comparisons to chance indicted by asterisk.

second labels when learning labels directly, $t(119)=.74$, n.s. Put another way, children made more correct choices when learning first labels *indirectly* than *directly*, $t(119)=.74$, $p<.001$, and made more correct choices when learning second labels *directly* than *indirectly*, $t(119)=.74$, $p<.001$ (see Figure 5).

Overall, participants also made more correct choices with increasing age group, $F(4,115)=2.91$, $\eta^2=.09$, $p<.05$, though this effect interacted with label type and learning type, $F(4,115)=4.81$, $\eta^2=.14$, $p<.001$, suggesting that the interaction of learning first versus second labels better under indirect learning than direct learning was different for different age groups (see Figure 5). In order to examine this 3-way interaction more closely, the effect of label type and learning type is analyzed separately below for each age group.

Object Familiarity

Further analyses were conducted on each condition separately to investigate any effect of distractor familiarity (direct learning conditions) and training object familiarity (indirect learning conditions). There was no significant difference between familiar distractors and unfamiliar distractors when learning first labels directly, $t(119)=.70$, n.s., or when learning second labels directly, $t(119)=1.48$, n.s. Additionally, there was no difference between learning second labels indirectly with familiar and unfamiliar target objects from training, $t(119)=1.25$, n.s.

There was, however, a significant difference when learning first labels indirectly, $t(119)=2.43$, $p<.05$, such that learning first labels was easier when the target object labeled earlier in training was unfamiliar than when it was familiar. This suggests that having two names for the non-target distractor object, for example a ball that is called "lep" in training, made it more difficult for children to learn a second label indirectly for the target object than if the non-target object was only known by one label (e.g. "lep"). This may be because children had a hard time attaching “lep” to the already familiar ball than to an unknown object. This would mean that the word “lep” was not as easily attached to the *familiar* non-target distractor object in training as to the *unfamiliar* non-target distractor object in training. If the familiar non-target object was not clearly a “lep”, it would be harder to infer that the second new word (e.g. “toma”) should be given to the target object in testing. On the contrary, when the unfamiliar non-target object was clearly a “lep”, it is easy to infer that it is not also a “toma”.

Development of Label Learning

12-month-olds. The overall effect of label type and learning type was investigated for each age group separately in order to investigate the three-way interaction between label type, learning type, and age group found in the initial ANOVA. Results of a 2 (label type: first, second) by 2 (learning type: direct, indirect) within-subjects ANOVA showed that 12-month-

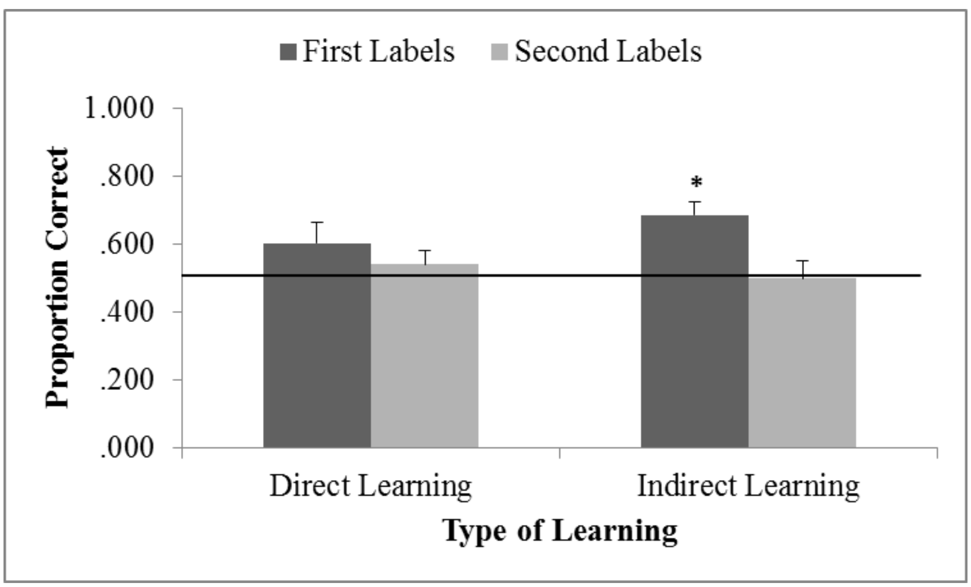

Figure 6. Percent correct choices on word learning task for 12-month-olds. Significant comparisons to chance indicted by asterisk.

olds learned first labels easier than second labels, $F(1,23)=5.87$, $\eta^2=.20$, $p<.05$ (see Figure 6). This was true regardless of type of learning, $F(1,23)=.72$, $\eta^2=.01$, n.s. There was no interaction between the two variables, $F(1,23)=.18$, $\eta^2=.07$, n.s. However, post-hoc analyses showed that 12-month-olds fit the general pattern seen for the overall group. They learned first and second labels directly equally well, $t(23)=.88$, n.s., but learned first labels better than second labels when learning indirectly, $t(23)=.2.84$, $p<.01$.

16-month-olds. A within-subjects ANOVA showed that 16-month-olds did not learn first or second labels better, $F(1,23)=1.38$, $\eta^2=.06$, n.s., nor did they learn better directly or indirectly, $F(1,23)=.85$, $\eta^2=.04$, n.s (see Figure 7). However, there was a significant interaction between the two variables, $F(1,23)=15.12$, $\eta^2=.40$, $p<.01$, such that when learning directly, 16-month-olds learned first and second labels equally well, $t(23)=1.48$, n.s. When learning indirectly, they learned first labels better than second labels, $t(23)=3.84$, $p<.01$. This is the same pattern seen for the 12-month-olds and for the group as a whole.

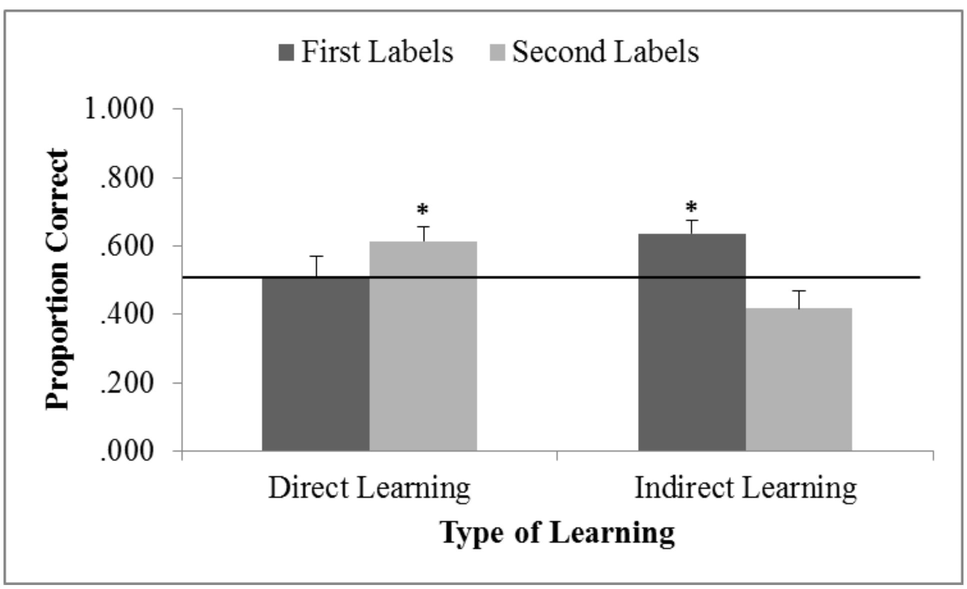

Figure 7. Percent correct choices on word learning task for 16-month-olds. Significant comparisons to chance indicted by asterisk.

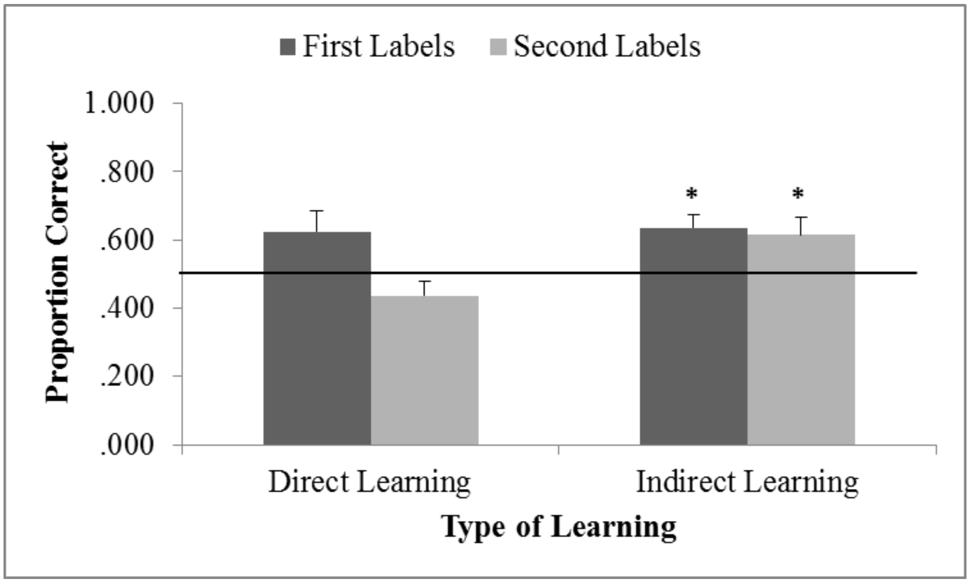

Figure 8. Percent correct choices on word learning task for 20-month-olds. Significant comparisons to chance indicted by asterisk.

20-month-olds. The within-subjects ANOVA showed that 20-month-olds learned first labels easier than second labels, $F(1,23)=6.05$, $\eta^2=.21$, $p<.05$. This was true regardless of type of learning, $F(1,23)=2.54$, $\eta^2=.10$, n.s. (see Figure 8). There was no interaction between the two variables, $F(1,23)=2.88$, $\eta^2=.11$, n.s. This age group did not show the same pattern as the overall group. Instead, both types of labels were learned equally well indirectly, $t(23)=.36$, n.s., but first labels were easier to learn directly, $t(23)=2.64$, $p<.05$. As discussed below, the pattern seen for this age group does not fit the pattern for the children as a whole. However, these effects were non-significant trends and, as discussed below, adding demographic variables as covariates eliminated the effects.

24-month-olds. The within-subjects ANOVA showed that 24-month-olds learned first labels better than second labels, $F(1,23)=9.24$, $\eta^2=.29$, $p<.01$ (see Figure 9). And although they did not learn better directly or indirectly, $F(1,23)=.28$, $\eta^2=.01$, n.s., there was a significant interaction between the two variables, $F(1,23)=12.59$, $\eta^2=.35$, $p<.01$, such that when learning

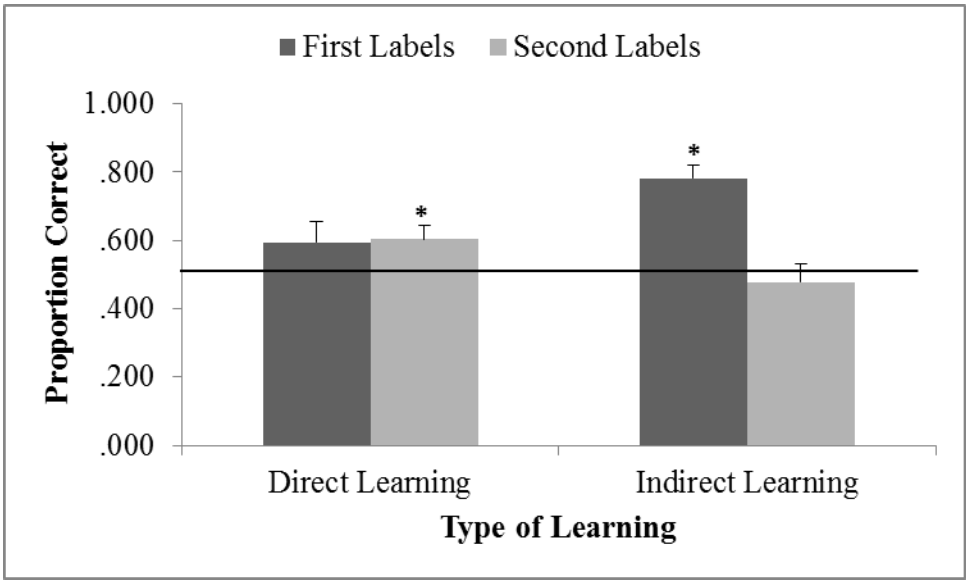

Figure 9. Percent correct choices on word learning task for 24-month-olds. Significant comparisons to chance indicted by asterisk.

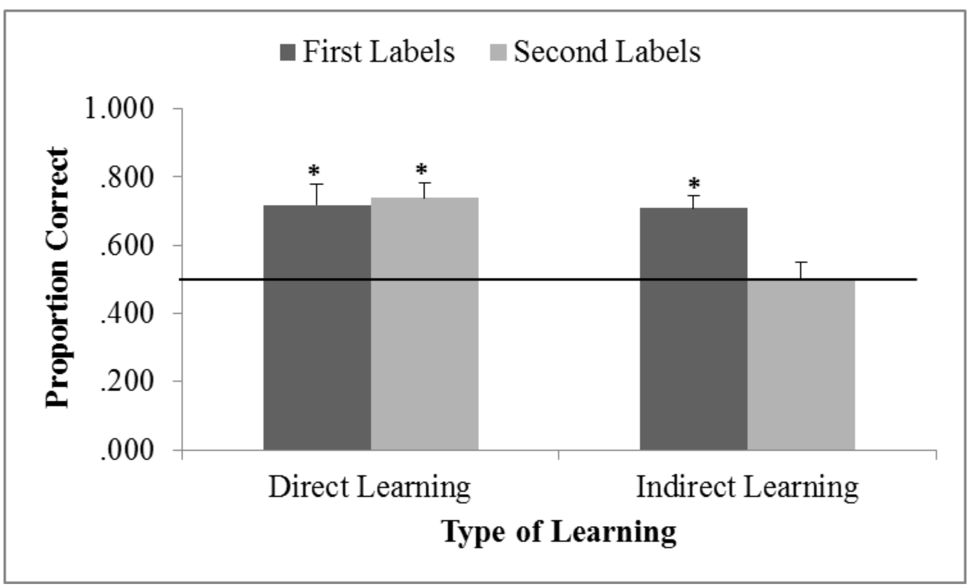

Figure 10. Percent correct choices on word learning task for 28-month-olds. Significant comparisons to chance indicted by asterisk.

directly, 24-month-olds learned first and second labels equally well, $t(23)=.17$, n.s. When learning indirectly, they did learn first labels better than second labels, $t(23)=4.38$, $p<.01$. Again, this pattern is consistent with the two youngest age groups and the overall group.

28-month-olds. By 28-months, children were learning first labels better than second labels, $F(1,23)=5.13$, $\eta^2=.18$, $p<.05$, and learning better by direct means than indirect means, $F(1,23)=5.21$, $\eta^2=.18$, $p<.05$ (see Figure 10). There was a significant interaction however, $F(1,23)=5.04$, $\eta^2=.19$, $p<.05$, suggesting that like the 12-, 16- and 24-month-olds, the 28-month-olds learned first and second labels equally well directly, $t(23)=.34$, n.s., but learned first labels significantly better than second labels when learning indirectly, $t(23)=3.12$, $p<.01$.

All of the age groups except the 20-month-olds conformed to the overall pattern of word learning such that they learned first and second labels by direct means equally well but learned first labels better indirectly than second labels. Though the 20-month-olds do not show this pattern, and even appear to show the opposite pattern, this trend was not significant. A discussion of this age group is provided in the following section.

Demographic Covariates

The initial ANOVA with participants grouped by age was conducted a second time with demographic variables as covariates. Three demographic variables were added as covariate including child vocabulary size, parent vocabulary, and print exposure. Adding these as covariates for the overall ANOVA eliminated all of the significant effects except for the three-way interaction between label type, learning type and age group, $F(4,115)=4.58$, $\eta^2=.14$, $p<.01$. This three-way interaction is likely due to the fact that 20-month-olds did better when learning first labels than second labels directly, an effect that also goes away when adding age as a covariate, $F(1,20)=.63$, $\eta^2=.03$, n.s. None of the other main effects or interactions were significant when ANOVAs were conducted separately for each age group. This pattern suggests that these three demographic variables together accounted for a large portion of the variability in children's ability to learn first and second labels directly and indirectly. In particular, it is likely that vocabulary accounted for these effects, at least for the direct learning conditions. This interpretation is supported by regression analyses reported below.

Grouping of Participants by Vocabulary Size

In addition to grouping participants by age, participants were also grouped by vocabulary size. Participants were sorted by total vocabulary size (and by percentile rank in case of ties). Means are shown in Table 16. Five groups of 24 participants each were created and these groups were submitted to a similar 2 (label type: first label, second label) x 2 (learning type: direct, indirect) x 5 (vocabulary size group) mixed-factorial ANOVA. Correct choices on the four word learning tasks were evaluated for each group separately. The main effects and interactions of label type and learning type remained the same as the overall age group ANOVA reported above as these variables were not different from that analysis. Although correct choices increased overall with larger vocabularies, $F(4,115)=27.02$, $\eta^2=.19$, $p<.001$, no interactions with vocabulary size were significant including the word type by vocabulary size interaction,

Table 16. Average correct choices for each condition grouped by vocabulary size

	Direct		Indirect	
	1st Labels	2nd Labels	1st Labels	2nd Labels
Vocabulary Size Groups				
0-9 words	0.60	0.50	0.66	0.48
9-56 words	0.51	0.51	0.71	0.50
57-180 words	0.55	0.57	0.57	0.55
187-430 words	0.66	0.59	0.77	0.47
445-651 words	0.73	0.76	0.74	0.51

$F(4,115)=2.23$, $\eta^2=.07$, n.s., the learning type by vocabulary size interaction, $F(4,115)=1.94$, $\eta^2=.06$, n.s., and the three-way interaction, $F(4,115)=1.06$, $\eta^2<.04$, n.s.

Comparisons to Chance

Comparisons to Chance for Entire Sample

Overall, participants easily learned the labels directly when compared to chance, whether they were first labels, $t(119)=4.26$, $p<.001$, or second labels, $t(119)=3.71$, $p<.001$. When learning indirectly, participants learned the first labels greater than chance, $t(119)=9.06$, $p<.001$. They did not, however, learn second labels greater than chance, $t(119)=.10$, n.s. This pattern is once again consistent with the pattern seen in the overall ANOVA analyses.

Comparisons to Chance by Age Group

The pattern of learning labels greater than chance in all conditions, except when learning second labels indirectly, was replicated in the two oldest age groups, but was more variable in the three youngest age groups. Specifically, participants found it difficult to consistently and correctly identify referents of both first and second labels learned directly until 24-months-old. They did, however, find it very easy to correctly identify referents of first labels learned indirectly at all five age groups. Only the 20-month-olds identified referents of second labels learned indirectly above chance.

These results are consistent with the repeated-measures ANOVA reported above, suggesting that second labels are not harder to learn than first labels when learning by direct means, but are harder to learn indirectly. This is true for every age group except the 20-month-olds that showed no difference or possibly the opposite pattern.

Regressions and Correlations

Correlation analyses suggested that responding in the four conditions was not inter-related, $p>.05$. The one significant correlation was between learning first labels directly and second labels directly, $r(120)=.23$, $p<.05$ (see Table 17). This is further evidence that learning labels directly is similar regardless of the type of label, whereas learning labels indirectly is very different for first and second labels.

Table 17. Correlations between word learning and demographics

	Direct		Indirect	
	1st Labels	2nd Labels	1st Labels	2nd Labels
2nd Label Direct	0.23 *			
1st Label Indirect	0.10	0.09		
2nd Label Indirect	-0.03	-0.16	0.07	
Age	0.16 ±	.22 *	0.11	0.05
Child Vocabulary	0.23*	.35 **	.17 ±	-0.01
Play Objects Known	0.28 **	.28 **	0.1	0.06
Parent Vocabulary	0.03	-0.03	0.12	0.08
Print Exposure	0.09	0.08	.21 *	-0.04

**$p<.01$, *$p<.05$, ±$p<.1$

In addition, correlation analyses were conducted between the four conditions and several demographic factors including age, child vocabulary size, number of known objects in the play task, parent vocabulary and print exposure (see Table 17). Age and child's vocabulary size were highly positively related to both learning first labels and second labels directly. These variables were not related to learning either label type indirectly. Additionally, overall, parent vocabulary and print exposure were not related to any of the four conditions.

CHAPTER 6: RELATIONSHIPS BETWEEN PARENT'S LABELING AND CHILDREN'S WORD LEARNING

In this chapter, I explore the relationships between the way that parents label objects and how children learn new labels. A series of step-wise linear regressions were conducted to investigate any relationship between the four word learning conditions (i.e. learning first and second labels directly and indirectly) and the input measures including the general measures of amount of label use and the five measures of input type found in the earlier factor analysis. Specifically, these regressions explored whether each word learning condition could be predicted by any (or several of) the input measures. Each analysis was done for the sample as a whole and for each age and vocabulary group separately. Correlation analyses were also conducted to confirm the regression results and explore non-significant trends in the data. Adding age (in months) and child's vocabulary size as covariates did not change the interpretation of any of the following results.

Only those participants that correctly identified at least six out of the eight known objects across both sessions were included in the sample. This was done to ensure that children understood and were fully engaged with the task. The final sample included in these analyses were 98 participants (n=12 at 12-month-olds, n=21 at 16-month-olds, n=21 at 20-month-olds, n=22 at 24-month-olds, and n=22 at 28-month-olds).

General Input Measure Relationships to Word Learning

In the first series of step-wise regression analyses, parents' use of first and second labels were used to predict each of the four word learning conditions separately (see Table 18 and Table 19). Only those input measures that significantly predicted word learning were entered into the model; when more than one input measure was a significant predictor they were added according to which input measure was the best predictor and so on. Each step-wise regression is reported below for the sample as a whole, for each age group separately and for each vocabulary

Table 18. Correlation values between general input measures and word learning in children at each age group.

Word Learning Condition	Labels per Object	Two or more Labels per Object	Two or More Labels per Labeled Object	Labeling Instances	Second Labeling Instances
First Direct					
All participants	-0.02	0.01	0.08	-0.16	0.16
12-month-olds	-0.32	0.06	0.22	-0.03	0.24
16-month-olds	0.17	0.03	0.08	0.01	0.08
20-month-olds	0.16	0.03	-0.09	-0.16	0.14
24-month-olds	0.14	0.26	0.15	0.02	0.23
28-month-olds	**-.72****	-0.54	-0.26	-0.69	-0.24
Second Direct					
All participants	0.01	0.05	0.07	-0.05	0.13
12-month-olds	-0.12	-0.25	-0.02	0.12	-0.03
16-month-olds	0.16	0.09	0.07	-0.14	0.01
20-month-olds	-0.14	-0.15	-0.16	0.23	-0.01
24-month-olds	0.00	0.00	0.08	0.09	0.11
28-month-olds	-0.01	0.03	0.01	-0.13	0.27
First Indirect					
All participants	0.16	0.09	0.10	-0.13	0.07
12-month-olds	-0.12	0.25	0.12	0.28	0.26
16-month-olds	0.26	0.29	**0.49±**	0.04	**0.21**
20-month-olds	0.15	-0.21	-0.30	**-0.46***	-0.29
24-month-olds	0.12	-0.06	-0.17	-0.14	-0.12
28-month-olds	0.30	0.20	0.22	0.08	0.22
Second Indirect					
All participants	0.07	0.04	0.05	-0.02	0.04
12-month-olds	0.20	0.03	-0.02	0.32	-0.16
16-month-olds	0.20	0.25	0.20	0.08	0.27
20-month-olds	-0.19	-0.19	-0.24	-0.31	-0.14
24-month-olds	0.10	0.03	0.11	-0.14	0.11
28-month-olds	-0.25	-0.12	-0.05	-0.21	-0.19

Bolded values signify significant predictors.
±, p<.10, *p<.05, **p<.01

Table 19. Correlation values between general input measures and word learning in children at each vocabulary group. Bolded values signify significant predictors.

Word Learning Condition	Labels per Object	Two or more Labels per Object	Two or More Labels per Labeled Object	Labeling Instances	Second Labeling Instances
First Direct					
0-9 words	-0.05	0.06	0.17	-0.10	0.17
9-56 words	-0.09	-0.01	0.07	-0.19	0.10
57-180 words	0.25	0.22	0.09	-0.07	0.19
187-430 words	-0.39	-0.36	-0.16	-0.27	-0.18
445-651 words	-0.19	0.08	0.04	-0.14	0.19
Second Direct					
0-9 words	-0.15	-0.42	-0.33	-0.15	-0.31
9-56 words	-0.22	0.01	0.07	-0.28	0.12
57-180 words	0.20	-0.10	-0.23	0.42	-0.31
187-430 words	0.06	0.37	0.28	0.24	0.25
445-651 words	-0.13	-0.04	0.03	-0.05	0.22
First Indirect					
0-9 words	0.15	-0.03	-0.15	0.00	-0.11
9-56 words	0.26	0.25	**0.48***	0.07	0.27
57-180 words	-0.07	-0.30	-0.40	-0.24	-0.30
187-430 words	0.24	0.24	0.17	-0.07	0.38
445-651 words	0.12	-0.09	-0.18	-0.20	-0.14
Second Indirect					
0-9 words	0.03	-0.13	-0.13	0.03	-0.18
9-56 words	0.26	0.29	0.18	0.18	0.24
57-180 words	0.29	0.17	0.22	0.12	0.09
187-430 words	0.02	0.06	0.04	0.07	0.61
445-651 words	3.65	0.16	0.02	0.11	-0.17

Bolded values signify significant predictors.
*p<.10

group separately. Correlations for each age group and vocabulary group can be seen in Table 18 and Table 19. Bonferroni corrections for multiple comparisons have been made.

Learning First Labels Directly

A step-wise regression analysis showed that none of the five general input measures significantly predicted children's ability to learn first labels directly for the group as a whole.

Nor were these correlations significant when conducted separately for familiar labeled objects and unfamiliar labeled objects. Conducting regression analyses for each age group separately showed that the number of objects that parents labeled was a significant predictor of first label learning directly for the 28-month-old group only, $F(1,20)=21.58$, $r^2=.52$, $p<.001$ (see Table 20). In particular, the more objects that parents labeled, the less likely their children were to learn the first labels directly. Inspection of the correlation values showed that there were no similar trends for the other age groups. Conducting these same regression analyses for each vocabulary group separately showed that none of the general input measures significantly predicted learning of first labels directly for any of the five groups.

Table 20. Step-wise regression results for parent input predicting 28-month-old's learning of first labels directly.

Model	B	SE of B	β
(Constant)	1.74	.22	
Number of Objects Labeled	-.03	.01	-.72**

$^{**}p<.01$

Learning Second Labels Directly

A step-wise regression analysis showed that none of the five general input measures significantly predicted children's ability to learn second labels directly. Nor were these correlations significant when conducted separately for familiar labeled objects and unfamiliar labeled objects. This was true both for the group as a whole, for each age group separately and for each vocabulary group separately.

Learning First Labels Indirectly

A step-wise regression analysis showed that none of the five general input measures significantly predicted children's ability to learn first labels indirectly for the group as a whole.

Table 21. Step-wise regression results for parent input predicting 16-month-old's learning of first labels indirectly.

Model	B	SE of B	β
(Constant)	.48	.09	
Number of Labeled Objects Labeled given 2+ Labels	.78	.32	.49*
(Constant)	.58	.09	
Number of Labeled Objects Labeled given 2+ Labels	1.91	.57	1.19**
Number of second labeling instances	-1.06	.46	-.82*

*p<.05, **p<.01

Nor were these correlations significant when conducted separately for familiar labeled objects and unfamiliar labeled objects. Conducting regression analyses for each group separately showed that at 16 months both the number of labeled objects that parents gave two or more labels and the number of second labeling instances were significant predictors of indirect first label learning, $F(1,19)=6.32$, $r^2=.41$, $p<.01$ (see Table 21). In particular, children learned first labels indirectly better when parents gave more labeled objects second labels (step one). When controlling for this variable (i.e. when parents gave zero labeled objects second labels), children learned first labels indirectly better when their parents used fewer second labeling instances (step two). This second step can be explained by the fact that when parents did not give any objects two labels, the number of instances of second labeling was by default zero. Inspection of the correlation values showed that there were no similar trends for the other age groups.

When grouping by vocabulary a similar pattern was seen for the second vocabulary group (9-56 words), such that the more second labels that parents gave to labeled objects, the easier it was for their children to learn first labels indirectly, $F(1,18)=5.03$, $r^2=.22$, $p<.05$. The number of second labeling instances was no longer a significant predictor. Additionally, at 20 months, the number of labels that parents used per object predicted learning first labels indirectly such that children learned first labels indirectly better when parents used *fewer* labels per object, $F(1,19)=5.00$, $r^2=.21$, $p<.05$ (see Table 22). Inspection of the correlation values showed that there were no similar trends for the other age groups.

Table 22. Step-wise regression results for parent input predicting 20-month-old's learning of first labels indirectly.

Model	B	SE of B	β
(Constant)	1.10	.22	
Number of Labels per Object	-.17	.08	-.46*

***p*<.05

Learning Second Labels Indirectly

A step-wise regression analysis showed that none of the five general input measures significantly predicted children's ability to learn second labels indirectly. Nor were these correlations significant when conducted separately for familiar labeled objects. This was true both for the group as a whole, for each age group separately, and for each vocabulary group separately.

Summary

Overall, results showed that the parental input measures only predicted conditions in which children learned first labels and not second labels. By 28 months children's ability to learn first labels directly was significantly negatively correlated with the number of labels parents gave to each object. Additionally, children's ability to learn first labels indirectly was positively related to parents giving a greater number of labeled objects multiple labels at 16 months and negatively related to the number of labels that parents used per object at 20 months. Together, these results suggest that learning first labels indirectly is related to input earlier than learning first labels directly.

Relationships between Second Label Relations and Word Learning

In the second series of step-wise regression analyses, parents' comparisons or contrasts of multiple labels were used to predict each of the four word learning conditions separately for each

Table 23. Correlation values between second label relation components and word learning in children at each age group.

	Specificity	Contrast	Ambivalence	No Relation	Part Names
1st Direct					
All participants	-0.01	**0.18**	0.04	-0.01	**0.22***
12-month-olds	0.05	0.25	0.04	0.24	0.25
16-month-olds	0.01	0.50	0.34	0.24	0.05
20-month-olds	-0.25	-0.16	0.22	-0.02	**0.61****
24-month-olds	0.02	0.36	-0.34	0.01	-0.12
28-month-olds	0.24	**0.46***	-0.17	-0.23	0.23
2nd Direct					
All participants	0.09	0.05	-0.04	-0.17	0.20
12-month-olds	0.46	0.37	-0.05	0.04	0.40
16-month-olds	0.08	-0.04	0.23	**-0.43±**	0.31
20-month-olds	0.24	0.23	-0.10	-0.18	0.20
24-month-olds	0.24	0.20	-0.31	-0.35	-0.34
28-month-olds	-0.11	-0.24	0.07	-0.08	0.23
1st Indirect					
All participants	-0.14	-0.11	**0.20***	0.02	0.10
12-month-olds	0.06	-0.35	-0.21	0.33	0.48
16-month-olds	**-0.28**	-0.21	**0.44±**	0.30	0.05
20-month-olds	-0.09	0.06	0.09	-0.11	0.03
24-month-olds	-0.28	-0.08	0.40	-0.20	0.16
28-month-olds	0.13	-0.10	0.10	0.02	-0.15
Second Indirect					
All participants	**0.19**	-0.10	0.11	-0.07	-0.07
12-month-olds	0.31	-0.23	-0.21	0.11	-0.33
16-month-olds	0.17	-0.13	0.25	-0.30	-0.06
20-month-olds	0.11	0.13	-0.22	-0.03	-0.06
24-month-olds	0.14	-0.17	**0.49***	0.15	0.00
28-month-olds	0.10	-0.12	-0.04	-0.12	-0.08

±p<.10, *p<.05, **p<.01

Bolded values signify significant predictors.

Table 24. Correlation values between second label relation components and word learning in children at each vocabulary group.

	Specificity	Contrast	Ambivalence	No Relation	Part Names
1st Direct					
0-9 words	-0.19	0.07	0.25	0.26	0.31
9-56 words	-0.07	-0.14	-0.01	-0.02	0.16
57-180 words	0.03	0.43	0.08	0.35	0.27
187-430 words	0.27	**0.40**	-0.26	-0.16	-0.04
445-651 words	-0.10	0.24	0.01	-0.09	0.38
2nd Direct					
0-9 words	0.42	0.30	0.05	0.18	0.10
9-56 words	-0.05	-0.09	-0.24	0.14	0.22
57-180 words	0.13	0.14	0.05	**-0.65****	-0.34
187-430 words	0.01	0.16	-0.25	-0.19	-0.17
445-651 words	0.19	-0.26	0.14	-0.10	0.19
1st Indirect					
0-9 words	-0.26	-0.49	0.11	0.10	0.44
9-56 words	-0.13	-0.07	0.40	0.00	-0.03
57-180 words	-0.03	-0.02	0.16	-0.03	0.12
187-430 words	**-0.42**	-0.23	-0.01	-0.02	0.31
445-651 words	0.06	0.20	0.08	0.06	-0.04
Second Indirect					
0-9 words	0.33	-0.16	-0.31	0.13	-0.39
9-56 words	0.23	-0.04	0.25	**-0.49±**	-0.08
57-180 words	-0.12	-0.07	0.42	0.19	-0.18
187-430 words	0.14	-0.25	0.16	-0.16	0.16
445-651 words	0.27	-0.08	0.20	0.03	-0.06

±p<.10, **p<.01
Bolded values signify significant predictors.

age group and each vocabulary group. Only those input measures that significantly predicted word learning were entered into the model; when more than one input measure was a significant predictor they were added according to which the best predictor was and so on. Correlations for each age group and vocabulary group can be seen in Table 23 and Table 24. Bonferroni corrections for multiple comparisons have been made.

Learning First Labels Directly

A step-wise regression analysis showed that for participants as a whole, the part names and contrast components together significantly predicted first label learning directly, $F(2,95)=4.06$, $r^2=.08$, $p<.05$ (see Table 25) . Specifically, contrasting part names with whole-object names was related to children being better able to learn first labels directly. When controlling for the use of part names, first label learning directly was still marginally predicted by a greater use of "and" relations and a lesser use of "not" relations.

Table 25. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels directly.

Model	B	SE of B	β
(Constant)	.62	.3	
Part Names	.06	.03	.22*
(Constant)	.62	.03	
Part Names Component	.06	.03	.22*
Contrast Component	.05	.03	.18

*$p<.05$

Looking at each age group separately revealed that the use of part names only predicted learning first labels directly at 20 months, $F(1,19)=11.48$, $r^2=.34$, $p<.01$ (see Table 26). None of the other age groups showed a correlation that reached significance. Although none of the vocabulary groups show a correlation between part names and direct first label learning, they each show a strong trend towards a positive correlation for every vocabulary group but the second highest.

Table 26. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels directly.

Model	B	SE of B	β
(Constant)	.65	.05	
Part Names Component	.18	.05	.61**

**$p<.01$

Unlike the part names component for which only the 20-month-old group showed a significant correlation to first label learning directly, a trend for large positive correlations between the contrast component and learning first labels directly was found at all age groups except for the 20-month-olds and at the three largest vocabulary groups. This relationship was only significant at 28 months, $F(1,20)=5.35$, $r^2=.21$, $p<.05$ (see Table 27). There was only a marginal relationship for the second to largest vocabulary group, $F(1,20)=3.83$, $r^2=.16$, $p=.06$, though, again, there was a trend at each of the three largest vocabulary groups. Together, these relationships suggest that learning first labels directly is related to parents using more "and" comparisons and less "not" contrasts, especially at the oldest ages and highest vocabulary levels, whereas part names are generally related to first label learning directly throughout the age groups and vocabulary levels.

Table 27. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels directly.

Model	B	SE of B	B
(Constant)	.76	.05	
Part Names Component	.13	.06	.46*

*$p<.05$

Learning Second Labels Directly

A step-wise regression analysis showed that none of the five component measures significantly predicted children's ability to learn second labels directly as a whole group. However, when looking at each age group separately, the No Relation component significantly predicted learning second labels directly at 16 months, $F(1,19)=4.38$, $r^2=.19$, $p=.05$ (see Table 28) such that children learned second labels directly better when parents were *less* likely to make no relation between the two labels. Inspection of the correlations for each age group showed that there were also non-significant trends in the same direction at 20 and 24 months old.

Table 28. Step-wise regression results for parent's use of second label relations predicting children's learning of second labels directly.

Model	B	SE of B	β
(Constant)	.67	.05	
Part Names Component	-.11	.05	-.43*

*p=.05

Looking at each vocabulary group separately showed a similar relationship between learning second labels directly better and fewer No Relation codes at the middle vocabulary group (57-180 words), $F(1,16)=11.49$, $r^2=.42$, $p<.01$.

Learning First Labels Indirectly

A step-wise regression analysis showed that for participants as a whole, the Ambiguous component significantly predicted first label learning indirectly, $F(1,96)=4.09$, $r^2=.04$, $p<.05$, such that the more that parents used the "don't know" and "or" relations, the easier their children learned first labels indirectly (see Table 29).

Table 29. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels indirectly.

Model	B	SE of B	β
(Constant)	.67	.05	
Ambiguous Component	-.11	.05	-.43*

*p<.05

When looking at each group separately, the Ambiguous component significantly predicted learning first labels indirectly only at 16 months, $F(1,19)=4.53$, $r^2=.19$, $p<.05$ (see Table 30) and not at all for any of the vocabulary groups. Additionally, on top of the positive correlation with ambiguous relations at 16 months, the specificity component was also a significant predictor of learning first labels indirectly at this age, *F*(2,18)=6.11, r^2=.40, p<.01, such that children who learned first labels indirectly better had parents that used more taxonomic relations and fewer "like" relations at the basic-level. A similar pattern was seen for the fourth largest vocabulary group as well (187-430 words), *F*(2,18)=6.11, r^2=.40, p<.01.

Table 30. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels indirectly at 16 months.

Model	B	SE of B	Β
(Constant)	.66	.05	
Ambiguous Component	.10	.05	.44*
(Constant)	.63	.05	
Ambiguous Component	.13	.04	.61**
Specificity Component	-.10	.04	-.49*

*p<.05, **p<.01

Learning Second Labels Indirectly

Finally, a step-wise regression analysis showed that for participants as a whole, the Specificity component marginally predicted indirect second label learning, *F*(1,96)=3.60, r^2=.04, p=.06, such that children learned second labels indirectly better when their parents used more "like" relations and less taxonomic relations (see Table 31). And although the correlations did not reach significance, there was a similar positive correlation at all five age groups that were particularly large at the youngest age groups and smallest vocabulary levels.

Table 31. Step-wise regression results for parent's use of second label relations predicting children's learning of first labels indirectly.

Model	B	SE of B	β
(Constant)	.50	.03	
Specificity Component	.05	.03	.19*

*p=.06

There was a different predictor of indirect second label learning at 24 months. The strongest and only significant predictor of indirect second label learning was the Ambiguous component, $F(2,18)=6.11$, $r^2=.40$, $p<.01$, such that the more ambiguous relations (i.e. “don’t know” and “or”) that parents used, the more correct choices their children made when learning second labels indirectly (see Table 32).

Table 32. Step-wise regression results for parent’s use of second label relations predicting children’s learning of second labels indirectly.

Model	B	SE of B	B
(Constant)	.50	.04	
Specificity Component	.10	.04	.50*

*$p<.05$

Finally, when grouping by vocabulary size, there was a significant relationship between learning second labels indirectly and fewer No Relation codes for the second vocabulary size group (9-56 words), $F(1,18)=5.75$, $r^2=.24$, $p<.05$ (see Table 33).

Table 33. Step-wise regression results for parent’s use of second label relations predicting children’s learning of second labels indirectly for vocabulary group 2.

Model	B	SE of B	B
(Constant)	.52	.05	
Specificity Component	-.13	.06	-.50*

*$p<.05$

Summary

Overall, results showed that there were direct relationships between the quantity and type of parental input and child’s ability to learn words. *First labels* were learned *directly* when parents labeled fewer objects, gave those objects more part names as second labels, and gave more objects one correct label and one incorrect label. *Second labels* were learned *directly* best when parents were less likely to use multiple labels for the same object and, likewise, when they made few label contrasts. *First labels* were learned *indirectly* best when parents gave labeled objects more than one label, gave fewer labels per objects, and used more ambiguous and taxonomic relations between multiple labels. *Second labels* were learned *indirectly* best when parents gave more basic-level contrasts than taxonomic contrasts, more ambiguous relations, and when parents used fewer multiple labels for objects and did not contrast them in any way. These patterns also changed with age. These changes are discussed in the following chapter.

CHAPTER 7: GENERAL DISCUSSION

The goal of the current study was to explore how parents *use* multiple names for objects and how children *learn* multiple names for objects. Specifically, both the input that parents provide to their children as they name objects and the way that children learn new names were explored. The relationship between how parents name objects and the process by which children learn new names was also investigated. Additionally, any changes seen across age and vocabulary size were explored for each task separately as well as for the relationship between the tasks. In order to explore parental input and how children learn words, these issues were explored in the context of a two-task study in which 1) parents and children were asked to play with sets of objects in a naturalistic play task and 2) children were asked to learn new words for familiar and unfamiliar objects either directly or indirectly in a word learning task.

The first major goal of this study was to characterize the input that parents provide to their children in terms of how they use more than one name for the same object. Results were largely consistent with previously literature showing that parents provide their children with pragmatic information when they name objects with multiple different labels. Furthermore, the current study extends this finding to show that parents differed in how they contrasted multiple names for objects along five unrelated dimensions. Importantly, these five dimensions validate several word learning principles that have been studied extensively in the word learning literature. These results are a first step toward describing how the input that parents provide to their children might support word learning.

The second goal of this study was to characterize how children learn multiple names for objects. Children were tested separately on two skills – both the ability to associate two words to the same object, and the ability to learn a new name indirectly (i.e. by inference). To the author's knowledge, this is the first time that these two skills have been tested in the same experimental design. Results showed that children were less accurate when required to perform both of these skills simultaneously than when required to perform either skill alone. In addition, results showed that making an inference was easier than associating two names to the same object. These results are discussed below in terms of the contributions that they make to the understanding of several important cognitive processes, such as memory and attention.

The third goal of this study was to investigate the relationships between the input provided by parents to their children, and the way that children learn new words. That is, we asked whether children process and use the information that is presented to them by their parents to help them learn multiple names for objects. Results suggest that children do make use of some aspects of their parent's input. In particular, children's ability to learn to associate two names to the same object while making an inference was related to parents comparisons of multiple names at the same basic-level (e.g. "banana" and "apple"), as opposed to two taxonomically-related levels (e.g. "banana" and "fruit"). These results are discussed below in terms of their contribution to a large literature that suggests that these basic-level comparisons are important for children's understanding of how words relate to one another. Each of these three questions is discussed in depth in the next three sections, followed by further discussions for future directions and conclusions.

Question 1: How do Parents Name and Compare Multiple Labels for Objects?

Parent's Use of Names for Objects

The finding that parents labeled a larger proportion of familiar than unfamiliar objects is consistent with previous research. For example, Masur (1997) also reported that parents were more likely to name familiar rather than unfamiliar objects. However, the results are at the same time inconsistent with a large literature suggesting that parents name more objects as their children get older and have larger vocabularies (e.g. Hart & Risley, 1995). There are several reasons why the current study may not have supported this finding. First, in the current study, we did not code several measures of language input that could indicate to what degree the parental input is simplified for the child. For instance, research shows that several aspects of the richness of the input are related to the development of the child, including the complexity of the syntactic frame that the words are presented in (e.g. Huttenlocher, et al., 2002), how responsive parents are to their child's utterances (e.g. Hart & Risley, 1995), and the use of corrections to compel children to interact with labels (e.g. Banigan & Mervis, 1988a). Though all of these things have been shown to be related to vocabulary size, in the current study we only recorded the nouns used to describe the object – obscuring other richer information in the input. Second, we had a limited amount of input for each child. Thus, our work is not necessarily inconsistent with past research showing that the amount of input is related to age and vocabulary level; we simply did not have a large enough or detailed enough input sample to find this relationship.

Parent's Comparisons of Multiple Names for Objects

The goal of the input task was to replicate and extend an important result reported in the literature. This task was designed to replicate the experiments reported by Callanan and Sabbagh (2004), which showed that although parents rarely gave objects multiple names, when they did, they almost always provided information to support their children's understanding of the names. In that study, parents almost always contrasted (or compared) names with each other when introducing more than one name for the same object. The current study replicated several important findings from Callanan and Sabbagh (2004), though across a wider range of ages. As in Callanan and Sabbagh (2004), parents in our study 1) only provided multiple names for objects sparingly (about 28 percent of the time), 2) when they did use more than one name for an object, they made very clear contrasts between them, and 3) multiple labeling was correlated with the vocabulary of the child.

Callanan and Sabbagh (2004) also suggested, based on their coding, that when parents gave multiple names to objects, they were likely to use one of three types of "bridging information" or contrasts to compare the multiple names. They hypothesized that this pragmatic information was important in helping children interpret the meanings of words. The authors identified three types of contrasts made by parents, including 1) contrasts with uncertainty about how the two names related (i.e. *equivocal*), 2) contrasts using one name as a subordinate level name (i.e. *kind*), and 3) contrasts in which parents suggested that one label was a correct name for the object and the other label was not (i.e. *which one?*). The current study provides additional evidence that parents give their children extra pragmatic support when providing them with multiple names for the same object. The components that were identified in the factor analysis of this study were consistent with Callanan and Sabbagh's analysis in that we found evidence that parents use these same three types of contrasts. However, we also found two additional styles of labeling in the parental input – the use of 4) no relation between names and the 5) whole-object/part-name comparisons. The current study additionally extends Callanan and Sabbagh's findings by exploring the relationships between these contrast types.

Because Callanan and Sabbagh only looked at the proportion of each type of contrast made, it may have been that in their study, parents were likely to use all three types of contrasts more, or only two of the types, but not all three. The current study extends the Callanan and Sabbagh (2004) findings by taking the analysis of the parental input data one step further to look at the relationships between the contrasts that parents made. Analyses from our study suggest that the five “styles” of contrasting multiple labels are independent of one another.   That is, saying that a parent is likely to relate names for objects at the same basic-level, does not tell you whether or not that same parent is also likely to make part-whole object contrasts. This is because, in the exploratory factor analysis, the components are necessarily unrelated to each other (Kim & Mueller, 1978). In other words, parents’ styles of contrasting multiple names for objects varied independently on these five dimensions.

The results of both the current study and those by Callanan and Sabbagh (2004) suggest that pragmatic information present in the language input supports children’s learning of word meanings.   There is a large literature of research suggesting that children use their knowledge about other speaker’s naming intentions to determine the meaning of a word (for a review see Diesendruck & Markson, 2001; Diesendruck, et al., 2004). Furthermore, Masur (1997) argued that parents provide cues to their intention in naming words by demonstrating the actions of an object when using a familiar word, and by naming the whole object before naming a part of the object. Masur (1997) further argued that this pragmatic support provides the means by which word learning principles develop. The current results provide additional support for this idea. In particular, we have results that bear on the development of at least three proposed word learning principles – the mutual exclusivity principle, the basic-level bias, and the whole-object assumption. In all three cases, parents differed along a continuum, from providing pragmatic evidence in favor of the word learning principle, to providing pragmatic evidence against the principle.

The first word learning principle that may be supported by parental input is mutual exclusivity. The mutual exclusivity principle is thought to help children map words to their correct referent by biasing them to attach words to unfamiliar, rather than familiar objects (Au &

Glusman, 1990; Markman & Wachtel, 1988). Two aspects of parent's contrasts were relevant to the mutual exclusivity principle. First, parents varied in their tendency to give objects two correct labels or only one correct label (i.e. the contrast component). Providing children with two correct labels for the same object could provide pragmatic information counter to the mutual exclusivity principle, since this principle would predict that familiar objects should not be given another label. Second, parents differed in their tendency to either make immediate contrasts between multiple labels or not. Again, contrasting labels should help children understand how labels are related, and help them reject multiple labels for the same object. However, neither of these components of parental input was related to children's learning of names for already familiar objects, though the correlation analyses may not have been reliable, as discussed below.

The basic-level bias is the second word learning principle that may be influenced by pragmatic support in the input. This principle refers to children's bias to expect labels to name objects at the basic-level (e.g. "dog) rather than at a subordinate (e.g. "poodle") or superordinate (e.g. "animal") level (Golinkoff, et al., 1995; Ishida, et al., 2003; Taylor & Gelman, 1989). Additionally, possibly because of the mutual exclusivity principle, children are more likely to interpret a second name for an object at the sub- or superordinate level rather than at the basic-level (Haryu & Imai, 1999). In the current study, parents varied in the extent that they contrasted multiple labels for an object at the basic-level or between levels (i.e. specificity component). This pattern of findings is consistent with previous input studies. Callanan (1985) showed that when parents were asked to teach their children words at different levels of the hierarchy, parents almost always "anchored" the superordinate terms by first providing their children with a basic-level term. In addition, Mervis and Johnson (1994) showed that describing the attributes that make an object part of a subordinate category, lead to better learning of subordinate names for objects. This component of the parental input was also related to children's ease in learning multiple names for objects, again with the same caveat that the correlations may or not be reliable, as discussed later.

The third word learning principle supported in the input is the whole-object assumption. It has been suggested that children expect labels to name whole objects before parts of objects (Banigan & Mervis, 1988b; Saylor, Sabbagh, & Baldwin, 2002). In the case of whole-object/part-name comparisons, parents may be attempting to bootstrap their children's word learning by making reference to familiar whole object names before teaching them unfamiliar part names. Indeed, past research suggests that parents, almost unfailingly, provide clear contrasts between the name for a whole object, and a part of the object when presenting part names (Masur, 1997; Ninio, 1980). That is, before providing the name for a part, parents first provide children with the name for the whole object. It is also important to note that part names were treated differently than the other types of contrasts. Not only were they the most common type of contrast used overall, but this was also the only contrast component that changed with age. Parents used more part names as children got older and had larger vocabularies. For the older age groups, whole-object/part-name contrasts were the most common type of contrast that parents made. It is unclear why this component changed with age while the others did not, except that perhaps once children had larger vocabularies, it made sense for parents to begin labeling parts of objects since children likely already knew the names for the whole object.

This study, along with past research, suggests that parents may provide children with clear indications as to how names contrast when teaching children multiple names for the same object, validating several word learning principles, including rejecting new names for familiar objects, naming objects at levels other than the basic-level, and providing two names for the same object rather than a part of an object. Overall, these results in conjunction with past research suggest that the way that parents label objects with multiple names differs along five dimensions, each of which might support word learning in different ways (Callanan & Sabbagh, 2004).

Changes in Multiple Names for Objects with Child's Age and Vocabulary Size

The relationship of parental input with child's vocabulary size is consistent with previous research showing that the vocabulary of the child is related to parents use of multiple labels for an object, though not necessarily to the separate types of contrasts made (Callanan & Sabbagh, 2004; Masur, 1997). In particular, previous research shows that the more often that parents gave multiple names to objects, the greater their child's vocabulary. No studies have shown a similar relationship to the child's age, suggesting that vocabulary is a better predictor of the degree to which parents provide children with instances of multiple names for objects. Neither age nor vocabulary has been shown to be related to the different ways in which parents contrast multiple labels with each other, which is consistent with the results of the current study.

Question 2: How do Children Learn Words under Different Conditions?

Children's Learning of Multiple Names for Objects

The children's response pattern in the word learning task is both consistent and inconsistent with the mutual exclusivity principle (Au & Glusman, 1990; Markman & Wachtel, 1988). Inconsistent with this principle, children were equally likely to learn a new word for an unfamiliar object than a familiar object in the direct learning conditions. Consistent with the principle, children did show a difference in the indirect learning conditions. Because our results are both consistent and inconsistent with this principle, it is worth discussing other interpretations for children's behavior. Indeed, Deák (2000) suggested that word learning biases are best described in terms of “a wide range of cognitive and contextual influences”, citing several examples showing that the mutual exclusivity principle is very sensitive to the design of the task (p. 35):

> This tendency increases with cognitive load (Liittschwager & Markman, 1994) and typicality of the nameable object (Merriman & Schuster, 1991). It decreases with familiarity of the unnamed referent (Merriman & Bowman, 1989) and with phonetic similarity between the novel word and the nameable item’s name (Merriman & Schuster, 1991).

Other researchers have come to similar conclusions (Nelson, 1988; Uchida & Imai, 1999). In the current study, we included four conditions that allow us to disentangle two different processes that may influence how likely children are to learn multiple labels for an object, at least in a laboratory setting.

The word learning task that was used required that children engage three different skills to be successful in the task including: 1) associating a new name to an unfamiliar object (also called fast mapping), 2) remembering the recently associated name in order to make an inference about a new label, and 3) associating multiple (in this case, two) names to the same object. By testing children on their abilities to learn first and second labels directly and indirectly, we can separate out the effects of the latter two processes. Furthermore, though all four conditions required that children make an association between a new name and an unfamiliar object (fast mapping), the conditions differed to the extent that they required children to both make an inference, and to associate two labels to the same object (see Table 34). Learning first labels directly did not require either skill. Learning second labels directly required associating multiple

Table 34. Shows the processes that were required for each of the four word learning conditions. "Yes" indicates that the process was required, "No" indicates that it was not required.

	First Direct	**Second Direct**	**First Indirect**	**Second Indirect**
Associate a label	Yes	Yes	Yes	Yes
Inference	No	No	Yes	Yes
Associate two labels with one object	No	Yes	No	Yes

labels, and learning first labels indirectly required making an inference. Learning second labels indirectly required both skills.

By interpreting the word learning results in this way, as dependent on contextual and cognitive influences, we are able to draw three conclusions. First, requiring children to both make an inference, and associate multiple labels to an object, made the task more difficult than not requiring either skill or only one of these skills. Moreover, children were less likely to learn second labels by indirect means than in any other condition. Second, requiring children to associate multiple labels to one object was more difficult than requiring them to make an inference alone. This is supported by the finding that children learned labels better when learning first labels indirectly than when learning second labels directly. Third, requiring children to associate multiple labels made no difference (there was no difference between the two direct learning conditions), but requiring them to make an inference actually made the task easier (children learned first labels indirectly better than directly). This last conclusion may be due to an additional skill confounded in these two conditions – flexible attention. This confound is discussed in detail below.

The first conclusion that can be made is that children had a very difficult time learning new words when they had to make an inference and also associate multiple labels to the same object. Children did significantly worse when learning second labels indirectly than learning labels in any of the other three conditions. This suggests that having to do both of these processes simultaneously was harder than either process alone. The result that children are less likely to associate two labels with the same object when they also have to make an inference is consistent with the broader literature. Carey and Bartlett (1978) showed that only half of their participants performed well when required to make an inference and to associate two words– chromium and olive – to the same object. The children in the current study showed a very similar pattern to Carey and Barlett's sample with approximately one-third of each age (and vocabulary) group failing, one-third succeeding, and one-third at chance in this condition.

Moreover, past research shows that children are more likely to succeed in word learning when they only have to engage one of these processes, but not both. First, children can accept two names for the same object when they don't have to make an inference. Liittschwager and Markman (1994) showed that children were just as likely to learn two names for an object as to learn a first name when they were taught the labels directly. However, when the experimenter required that children learn two new names for two familiar objects, requiring them to additionally infer to which object each new name referred, children were less likely to be able to map both names to the same object. On the other hand, children can also easily make an inference when they don't have to accept two names for the same object. Jaswal and Markman (2001) asked children to perform actions on several objects by asking them, for example, to "put the dax down the stairs". In one condition, children had to infer the referent of the word "dax", in the other, they were told which object was a "dax" directly. Children did equally well in either case, suggesting that making an inference did not significantly increase the demands of the task of associating a name to an object. Overall, these studies in conjunction with the current research suggest that making an inference and associating multiple labels to an object are not as difficult as requiring both processes simultaneously.

The second conclusion that can be drawn from the results of the word learning task is that requiring children to associate multiple labels to one object was more difficult than requiring them to make an inference. This is a new result that has not yet been reported in the literature, to the best of the author's knowledge. However, previous research does suggest that children have a much more difficult time associating two names to an object than making an inference. When presented with two labels for the same object, children are more likely to interpret the second label as a name for a part of the object, or as the name for the substance that the object is made out of, for example, rather than accept both names as labels for the whole object (Au & Glusman, 1990; Markman & Wachtel, 1988). These results suggest that associating two names to the same object is unlikely for children (and adults). On the other hand, children can easily infer the referent of a new name. Children can 1) determine the referents of several new words for unfamiliar objects across several exposures to each word, even though the referent of each word is ambiguous at each individual presentation of the word (Smith and Yu, 2008), 2) extend proper and common names similarly regardless of how they are initially taught the word – by ostensive labeling or by inference (Jaswal and Markman, 2001), and 3) infer that a name maps to a referent that was present when the name was used, rather than to an object that they played with subsequent to the labeling event (Baldwin, 1993).

It is unclear why, for children, making an inference was easier than associating multiple names to an object, especially since inference-making is likely made up of several other processes. For example, in the current study, we could not separate out the contributions of memory capacity and the ability to make an inference. The indirect learning conditions required children to remember a label, and to use that label to make an inference about another label. Though these processes could not be separated out in the current study, previous research suggests that these two skills are related. For example, Mather and Plunkett (2009) showed that young children only indicated their ability to correctly infer the referent of a new name in a preferential-looking paradigm after repeated exposure to the new name, suggesting that their memory for the referent needed to be boosted before they were able to make an inference. It will be important in future research to examine the separate contributions of memory and inference-making skills in relation to learning multiple names for one object in order to determine exactly which processes are engaged in learning a new word and when.

The final conclusion that can be drawn is that participants had an easier time learning first labels by indirect means than by direct means, so that requiring children to make an inference actually made the task easier. This conclusion must be considered tentative as these differences may be due to yet another cognitive process that was not tested in this study – the ability to flexibly shift attention. In fact, Hollich, Hirsh-Pasek, and Golinkoff (2000) showed in several experiments that children can, and do, flexibly shift their attention to cues useful for disambiguating the referent of an object when learning new words, and that attention is focused differently depending on the word learning context. Two manipulations in the current study indicate that the ability to flexibly attend might be responsible for the result that indirect learning made learning first labels easier to learn.

The first manipulation that may have made it to learn first labels in directly is that children had to map an unfamiliar word to an unfamiliar object only after having been told the name of the distractor object in training.   That is, when identifying the referent of a first label after direct learning, the distractor object had not previously been labeled. When learning indirectly, the distractor object had already been labeled by the experimenter in training, making it clear to the child that it was not the correct object. This may have shifted attention away from the distractor when learning indirectly, allowing them to correctly choose the target object.

A second reason to believe that the ability to attend flexibly was responsible for this result is that in this condition, and this condition alone, children treated familiar and unfamiliar distractor objects differently in testing. When learning first labels indirectly, children found it much easier to learn a new label for an unfamiliar target object if the distractor was an *unfamiliar* labeled object from training rather than if it was a *familiar* labeled object from training. Although it is not intuitive at first glance, the answer lies in the training part of the task. It may be difficult for children to associate a label to the familiar distractor labeled in training because they already have a word for it. Then, when hearing a second new word at test, their attention is not automatically drawn away from this familiar distractor; they don't already have a recently mapped word for this object. Rather, for them, either the distractor or target object is highlighted as the referent of the new word. When the distractor object is unfamiliar, the label from training is likely quickly associated with it, making the new word presented in testing shift attention to the unlabeled target object.

Separate studies will need to be conducted to partial out the effects of being able to flexibly attend to the objects and names in test. In the current study, each new label was taught in a separate context – with different distractor objects – and the two referent objects were never present at the same time. This made it impossible for us to partial out how dividing children's attention among names for objects affected the task. It is possible that if, instead, children had been required to flexibly shift their attention to several referents simultaneously to learn several new labels, we may have seen a different pattern. Specifically, this manipulation may have caused children to have a harder time learning second labels than first labels in both the direct and indirect conditions. This manipulation will be important in future research in order to investigate the contribution of flexible attention to word learning.

Word Learning Across Age and Vocabulary

Overall, children learned labels better as they got older. Additionally, children's performance on the two direct learning conditions was related to their vocabulary size whereas in the indirect learning conditions, none of the demographic variables were related to performance. These results are surprising given that the ability to infer the referent of new words has been shown to increase with age (e.g. Bloom, 2000; Halberda, 2003). However, this lack of correlation may simply be an artifact of having small samples at each age group, and a word learning task that only has five possible outcomes or response levels – this small variability may have made it very difficult to find a significant correlation.

Interestingly, the same overall response pattern was found across the five age groups such that first and second labels were learned equally well when learning directly, but second labels were harder when learning indirectly. However, subtle changes were found in the degree to which this pattern was significant across ages. In particular, children were able to learn first labels indirectly and second labels directly at a younger age when compared to chance. By 28 months, children were also able to learn first labels directly. At no point were children able to learn second labels indirectly better than would be expected by chance. This response pattern when learning second labels indirectly, as compared to the other conditions, is consistent with the literature on the mutual exclusivity principle in which children are less likely to accept multiple labels for an object as they get older (Halberda, 2003; Hollich, et al., 2000).

Question 3: Is the Type of Parental Input Related to Children's Word Learning Ability?

Relationships between Word Learning and the Amount of Input

Children's learning of first and second labels, either directly or indirectly, was not related to any measure of the amount of labels used by parents. This lack of a significant result cannot be taken as definitive evidence given the limitations of the study. There were both a very small amount of input data available for each child – only 16 minutes – and the input was recorded in a laboratory setting rather than a setting with which the parent and child were familiar. However, it is also important to note that this result is not entirely inconsistent with the literature. Previous research shows that parental input is related to child vocabulary. However, the measure being used in the current study is one of word learning not of total vocabulary size. In addition the measure of language being different, the measure of input in this study is also different – we are looking specifically at the ways in which parents contrast multiple labels for objects. Other studies have also failed to find a relationship between how parents contrast labels and children's vocabulary (Banigan & Mervis, 1988a; Callanan & Sabbagh, 2004). For example, Callanan and Sabbagh (2004) found no relationship between the individual types of contrasts that parents used and the vocabulary of children. Although previous research supports a lack of relationship between parents' label contrasts and word learning, this result must be filed as inconclusive until replication shows it to be a reliable lack of effect.

Relationships between Word Learning and Multiple Label Contrasts

The correlations found between the types of label contrasts that parents made and word learning may also not be reliable. This is further supported by the fact that the significant relationships between first label learning and part names and first label learning and ambiguous contrasts were seen for the whole sample, but were not close to significance for each age group separately. In fact, they often tended to be in different directions for the different groups.

Likewise, the relationship between learning second labels indirectly and taxonomic contrasts was only a trend for the sample as a whole, though there was a similar non-significant trend for each age group separately. Furthermore, these correlations may be obscured by the fact that there were only five possible response levels in the word learning task – children's performance was not a fully continuous variable. The lack of variability in the word learning task may have made it very difficult to find significant relationships between children's word learning and the input. These effects clearly need to be replicated in a separate sample to test for their reliability, preferably in a longitudinal sample of children as this would significantly reduce the variability between the age groups, allowing the relationships to be more transparent.

To the extent that these correlations are reliable and replicable, they are consistent with a broad literature suggesting that children do use pragmatic information from their environment to learn new words (see Clark, 1997). For example, Clark and Grossman (1998) showed that participants made more consistent extensions of words when given descriptions of exactly how words related to each other taxonomically. There is a large area of research supporting the idea that children both understand and use their knowledge of other's intentions to help guide their understanding of word meaning (Baldwin & Moses, 2001; Diesendruck & Markson, 2001). We add to this result by suggesting that children may be making use of another type of pragmatic information that would help them disambiguate the referents of new names for objects – namely, parents' contrasts of multiple labels.

In particular, the current study provides additional indirect evidence that children use direct information about labels to help guide their learning. That is, children may use information about how the two labels are contrasted at the time of labeling. It is not only the understanding of intentional acts in general that influences children's learning of new labels, but also how labels are explicitly contrasted in the input. This conjecture is consistent with Banigan and Mervis's (1988) study showing that providing children with both a demonstration of an object and a description of the category, helped them learn the name of an object better than just providing them with a label for the object. It is also consistent with Booth's (2009) study in which telling children the causal properties of objects helped children remember words a week later. Finally, Heibeck and Markman (1987) also showed that children quickly made responses consistent with the mutual exclusivity principle once new words were taught by contrasting them with known words. Overall, these studies, in conjunction with the results of the current study, suggest that how labels are situated in the context relative to one another can be an important source of information for children as they learn new words.

However, it may be that certain types of label contrasts are more informative than others. Though the input reported here supported several different kinds of contrasts between multiple labels (part names, correction, specificity, etc…), only the specificity or contrast at the taxonomic level showed any relation to how children learned multiple names for objects. Again, assuming that this result is replicable, it complements Gelman, Wilcox, and Clark's (1989) finding that, after teaching children hierarchical relationships with one basic-level term and one subordinate level term, children were still likely to assume that the two words were for the same object at the basic-level. In our study, parents that made more taxonomic contrasts (one basic-level term and one subordinate level term) had children that accepted two names for the same object more often. We extend this finding to show the opposite is also true – parents that made contrasts where both terms were at the basic level had children that interpreted the second new name as a name for a different object.

However, it should also be noted that it is unclear whether the taxonomic contrasts that parents made were related to learning second labels indirectly simply because the word learning task allowed children to make a subordinate name interpretation for the second novel word, or whether the taxonomic contrast is simply related to learning multiple labels in general. Possibly, had the task allowed children to make alternative interpretations such as attaching the second novel word to a part of the object, that other components would have been related to the word learning task. For instance, if, rather than providing children with a distractor object at test, we had attached salient parts to the familiar objects and asked the child whether the second novel label was a name for this part or the whole object (as in Hansen & Markman, 2009), children's performance in this task may have been related to parents' use of whole-part contrasts instead of taxonomic contrasts. If this were to hold true, we would then be able to say that the type of input is specifically related to the task, rather than just that the type of input has a general effect on learning multiple labels.

This hypothesized finding however seems unlikely given a broad literature suggesting that taxonomic contrasts might have a more general effect. In fact, parents use part names and property names in order to compare objects at the basic and subordinate levels, possibly suggesting that basic-level and subordinate names permeate word learning to a greater extent than the other types of contrasts (Callanan, 1990). Research shows that, relative to one another, children are more likely to make a subordinate level interpretation for a new word for a familiar object than say a part name or proper name (Taylor and Gelman, 1989). Thus, it might be that part names are easier to learn than taxonomic relationships, which need more support than the other types of contrasts from the input. This idea needs to be tested in future research as the current results cannot disentangle the two possibilities.

The way that parents contrasted multiple labels was not only related to the way that children learned second labels, but also first labels. It is not immediately intuitive that first labels would depend on how parents contrast *multiple* labels. One idea, however, is that the two contrasts that were related to first label learning – part names for direct learning and ambiguous relations for indirect learning – were really about giving first labels to objects. In particular, in the whole-part contrasts, the label given to the part is really a first label for that part. In addition, the ambiguous contrasts ("don't know" and "or") may have hinted to the child that one label was correct and one was incorrect. Thus, both of these contrasts may be interpreted as contrasts that supply a first name, but not a second one. In this sense, then, these results are unsurprising and consistent with a broad area of research showing that how names are taught for objects are related to both how children learn, and their overall vocabulary size (Banigan & Mervis, 1988a; Booth, 2009; Hart & Risley, 1995).

Changes in the Relationships across Age Groups

Very few conclusions can, or should be made regarding the change in these relationships across age and increasing vocabulary size. As stated earlier, the sample sizes within each age group were quite small – only 24 children in each group. In addition, the small variability of scores allowed in the word learning task, means that this variable was not a truly continuous variable, so any correlations (or lack thereof) between this measure and the input should be taken with a grain of salt. This study clearly needs to be replicated before any conclusions are drawn.

However, it is important to note that age and vocabulary size could not account for the relationships found between the input measures and the word learning task. Adding both age and vocabulary size as covariates did not change the interpretation of any of the effects. This lack of mediation by the age and vocabulary variables stands in contrast to the results of each individual task. Age and vocabulary mediated all of the effects of the input task results, such that adding age and vocabulary as covariates showed that objects were not labeled differently depending on object familiarity or age of the child. The different types of contrasts were also not used differently depending on age and vocabulary of the child. Moreover, in the word learning task, the overall differences in children's abilities to learn labels for familiar versus unfamiliar objects and in the direct versus indirect conditions were eliminated when age and vocabulary were entered into the model. It seems that age and vocabulary are very important predictors for how parents label objects and how children learn words, but the relationship between those two cannot be explained away by changes in age and vocabulary size. Again, however, this lack of result must be replicated before it is considered reliable.

Future Directions

As mentioned several times, one of the most obvious future directions for the current work would be to replicate the study. This is particularly important given the severe limitations of such an exploratory study. Any replication of this study should be conducted as a follow-up longitudinal study as it would provide greater power to find relationships across age and increasing vocabulary size. As it is, using a cross-sectional sample of children instead of following children across development makes it difficult to know whether age or vocabulary was a better predictor of each task separately.   This is because age was measured as a between-subjects variable. Some of the differences seen in parent's use of labels and label contrasts, and children's ability to learn words across age may simply be due to the sample chosen. It is difficult with a cross-sectional sample to assume that differences in age groups truly mean that the variables change with age. Moreover, it is possible that changes in the relationship between input and word learning seen across age were due more to parent's varying styles of input at each age level, rather than true differences in the ways that parents adjust for the developmental stages of their children. Finally, by only sampling specific ages, we reduced the possible data points available, though the size of children's vocabulary was allowed to vary to a greater extent. Together, these limitations make it imperative that a similar longitudinal study be conducted.

Another important direction for this research is to begin testing other types of word learning processes that may be related to the way that parents use language. For example, it is important to test other word learning principles proposed in the literature, such as the taxonomic assumption in which children expect second labels to be at a more or less specific level of the taxonomic hierarchy (Ishida, et al., 2003; Markman, 1991), the whole-object bias in which children expect new labels to be for a whole object and not a part of the object (Hansen & Markman, 2009; Markman, 1991; Saylor, et al., 2002), and the shape bias in which children expect words to extend to other new objects based on the shape of the object and not the texture or color of the object (Landau, Smith, & Jones, 1988; Landau, et al., 1998). These other word learning principles, in addition to the mutual exclusivity principle, may be especially important to study. The five major styles of contrasting labels suggest that parents' input includes information to support these principles. It may be that some aspects of the input are related to one principle positively, but to another one negatively. For instance, the mutual exclusivity principle may be positively related to parents labeling of two objects at the same basic-level as was suggested by the current data, but this same input may be negatively related to learning words for parts of objects.

Another direction for this line of research is with bilingual children. Testing bilingual children has recently become especially popular as it provides a "natural experiment" in which the context of word learning has already been manipulated prior to the experiment. Of course, this limits the internal validity of the study, but does provide a nice way of investigating the relationship between previous experience and the word learning process. Indeed, research shows that bilingual children often accept more instances of multiple labeling (Byers-Heinlein & Werker, 2009; Davidson & Tell, 2005; Diesendruck, et al., 2004; Margarita, 2009; Yow & Markman, 2007), and tend to focus more on the sociopragmatic context than do their monolingual counterparts (Au & Glusman, 1990; Brojde & Colunga, 2009; Diesendruck, 2005). Future research in this domain will help to clarify the relationships between the overall word learning context and the process by which words are learned. In particular, it will help clarify exactly what it is about the bilingual context that influences how children learn words – is it the difference in phonology, the extra sociopragmatic cues that parents provide to their children, or the frequency with which objects get multiple labels?

Conclusion

This study was designed to be an exploratory study that investigated both the contextual (input) and cognitive (word learning task) constraints that determine how children learn words. Though this study was exploratory, we can make a few tentative conclusions. First, there is information in the input that supports several word learning principles. Second, parents' contrasts at the basic-level seem to be related to children's ability to learn multiple labels for objects. Finally, contextual and cognitive processes provide better descriptions of the word learning behavior of children than internal constraints, like the mutual exclusivity bias. Investigating both the amount and type of parental input is important, as is the need to look at both the output produced by children and the process by which they learn language in the first place. Understanding the relationship between how parents label objects and the child's own word learning processes can provide a lot more information and a clearer picture, than merely investigating the relationship between the amount of input and output. In particular, this approach suggests distinctions not born out in the input or behavioral data of children alone. Overall, this approach to word learning research seems to be a very promising direction to take in order to understand the mechanisms driving word learning.

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APPENDIX A

Object	Set #1: Fruits and Vegetables	Set #2: Vehicles	Set #3: Sea Animals	Set #4: Kitchen Utensils
1	Apple	Tractor	Beluga Whale	Spatula
2	Banana	Dump truck	Penguin	Clip
3	Carrot	Tow truck	Octopus	Salt Shaker
4	Orange	Snow plow	Swordfish	Rolling pin
5	Tomato	Garbage truck	Killer whale	Basting brush
6	Watermelon	Police car	Shark	Measuring cup
7	Eggplant	Digger	Crab	Tongs
8	Onion	Steamroller	Jellyfish	Strainer
9	Radish	Crane	Manatee	Baster
10	Asparagus	Caterpillar	Puffer fish	Garlic press
11	Pepper	Pick-up truck	Stingray	Egg slicer
12	beans	Cement truck	Walrus	Whisk
Thematic	Cutting Board	Man/Driver	Boat	Bread
Taxonomic	Egg	Plane	Swan	Hammer

APPENDIX B

PART I:

Children understand many more words than they say. We are particularly interested in the words that your child UNDERSTANDS. Please go through the list and mark the words that you child has heard or understands. If you are unsure, make the best guess you can about your child's current knowledge. Remember that this is a list of words that are used by many different children. Don't worry if you child knows only a few of these right now.

Food

apple ☐
asparagus ☐
banana ☐
beans
carrot ☐
cutting board ☐

egg ☐
egglplant ☐
garlic ☐
orange ☐
peach ☐
peas ☐

pepper ☐
radish ☐
tomato ☐
turnip ☐
watermelon ☐

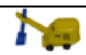
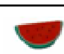
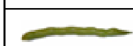
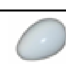
Vehicles

tractor ☐
car ☐
catepiller ☐
cement truck ☐
crane ☐

digger ☐
driver ☐
garbage truck ☐
pickup truck ☐
plane ☐

dump truck ☐
plow ☐
steam roller ☐
toy truck ☐

PART II:

Picture	What would YOU call this?	What would YOUR CHILD call this?	Picture	What would YOU call this?	What would YOUR CHILD call this?
					
					
					
					
					
					
					
					
					
					
					
					
					
					

PART I:

Children understand many more words than they say. We are particularly interested in the words that your child UNDERSTANDS. Please go through the list and mark the words that you child has heard or understands. If you are unsure, make the best guess you can about your child's current knowledge. Remember that this is a list of words that are used by many different children. Don't worry if you child knows only a few of these right now.

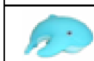
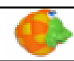
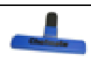
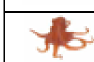
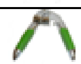
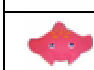
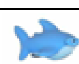
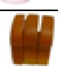
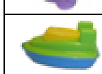
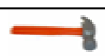
Animals

- beluga whale ☐
- boat ☐
- crab ☐
- fish ☐
- jellyfish ☐
- manatee ☐
- octopus ☐
- orca whale ☐
- penguin ☐
- puffer fish ☐
- seal ☐
- shark ☐
- stingray ☐
- swan ☐
- walrus ☐

Vehicles

- baster ☐
- bread ☐
- brush ☐
- clip ☐
- egg slicer ☐
- hammer ☐
- garlic press ☐
- measuring cup ☐
- rolling pin ☐
- salt shaker ☐
- spatula (pancake) ☐
- strainer ☐
- tongs ☐
- whisk ☐

PART II:

Picture	What would YOU call this?	What would YOUR CHILD call this?	Picture	What would YOU call this?	What would YOUR CHILD call this?
					
					
					
					
					
					
					
					
					
					
					
					
					
					

APPENDIX C

Measure	Description
Labeled Objects	
All Objects	
Total	Average number of objects labeled
Proportion familiar objects	Average proportion of familiar objects labeled
Proportion unfamiliar objects	Average proportion of unfamiliar objects labeled
Objects given 2+ labels	
Total	Average number of objects (out of 56) given two or more different labels
Proportion familiar objects	Average proportion of familiar objects given two or more different names
Proportion unfamiliar objects	Average proportion of unfamiliar objects given two or more different names
Labeled objects given 2+ labels	
Proportion	Average proportion of *labeled* objects given two or more different names
Proportion familiar objects	Average proportion of *labeled* familiar objects given two or more different names
Proportion unfamiliar objects	Average proportion of *labeled* unfamiliar objects given two or more different names
Labeling Instances	
All Objects	
Total	Average number of labeling instances for labeled objects
Total familiar objects	Average number of labeling instances for labeled familiar objects
Total unfamiliar objects	Average number labeling instances for labeled unfamiliar objects
Objects given 2+ labels	
Total	Average number of labeling instances for objects that were labeled with two or more different names
Total familiar objects	Average number of labeling instances for familiar objects that were labeled with two or more different names
Total unfamiliar objects	Average number of labeling instances for unfamiliar objects that were labeled with two or more different names

APPENDIX D

Five language variables were collected. These variables included 1) child's vocabulary size, 2) child's vocabulary percentile rank, 3) number of known play objects in the parental input task that children knew, 4) parent's vocabulary level, and 5) amount of child's exposure to print. See Table 35 for means and standard deviations.

Table 35. Means and standard deviations of demographics by age group.

		Age Group				
		12	16	20	24	28
Vocabulary Size	Mean	9.29	41.54	131.75	339.33	483.13
	Std. Dev.	21.61	34.37	95.57	163.57	126.30
Vocabulary Percentile	Mean	47.46	43.54	41.25	54.17	52.71
	Std. Dev.	20.69	27.17	26.43	27.69	22.21
Known Objects	Mean	11.88	17.04	24.46	29.25	35.63
	Std. Dev.	11.33	7.37	11.59	7.71	6.98
Parent Vocabulary	Mean	15.83	18.52	20.20	20.20	20.08
	Std. Dev.	5.93	8.12	6.81	7.96	6.93
Print Exposure	Mean	21.04	22.63	24.58	25.50	25.71
	Std. Dev.	7.33	5.04	8.08	5.99	6.48

One-way ANOVA tests with age-group as a between-subjects factor showed that vocabulary size increased with age, $F(4,115)=92.94$, $\eta^2=.76$, $p<001$, though vocabulary percentile did not, $F(4,115)=1.21$, $\eta^2=.04$, n.s. Additionally, the number of play objects from the parent input task increased with age, $F(4,115)=25.24$, $\eta^2=.47$, $p<001$. Neither parent vocabulary level or print exposure differ by age group of the child, $F(4,115)=1.66$, $\eta^2=.05$, n.s. and $F(4,115)=2,17$, $\eta^2=.07$, n.s., respectively. An additional one-way ANOVA showed that the average number of days between experiment sessions did not differ by age group, $F(4,115)=.81$, $\eta^2=.03$, n.s.

A series of correlations were also conducted to investigate any relationships between these language variables (see Table 36). Results showed that these five variables were highly interrelated. Several important patterns emerged. First, although parents' vocabulary level did not differ by child's age group, it was significantly related to age (measured in months). It is unclear why parent vocabulary level would be related to child's age. A cook's D analysis showed no significant outliers, all *D*'s<.4, suggesting that this correlation was not due to only a few participants. However, including parent vocabulary level as a covariate did not change the interpretation of the word learning results.

Second, parent vocabulary level was significantly related to the child's vocabulary size. Because of the significant relationship between parent vocabulary size and child's age, it was possible that age would mitigate this relationship. The correlation analysis for parent vocabulary level and child's vocabulary size was repeated with age in months as a covariate. This relationship disappeared when controlling for age, $r(117)=.04$, $p=.66$. Although parent vocabulary level and child vocabulary size was not significantly related when controlling for age, there continued to be a significant relationship between parent vocabulary size and the number of objects that children knew in the parent input task, even when controlling for age, $r(177)=.19$, $p<.05$.

Finally, print exposure was significantly related to vocabulary size and percentile, vocabulary size, and number of parent input task objects known. When controlling for age the

Table 36. Language variable correlations.

	Age (months)	Vocab Size	Vocab Percentile	Known Objects	Parent Vocab
Vocab Size	0.84**				
Vocab Percentile	.135	0.53**			
Known Objects	0.69**	0.74**	0.49**		
Parent Vocab	0.20*	0.19*	.160	0.27**	
Print Exposure	0.25**	0.30**	0.27**	0.36**	0.22*

**p<.001
*p<05

relationships between print exposure and child's vocabulary size, *r*(117)=.17, *p*=.07, and print exposure and parent vocabulary size, *r*(177)=.18, *p*=.06, became marginally significant. Interpretations of the other relationships did not change.