THE REGRESSION HYPOTHESIS[1]

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Periodically, the Regression Hypothesis has surfaced in an attempt to formulate a comprehensive theory of language development by linking language acquisition to language dissolution. This hypothesis claims that the breakdown of language is the inverse of its acquisition (Jackson 1958; Jakobson 1941/1968). Typically, the Regression Hypothesis is put forth to account for aphasia disorders (Dennis & Wiegel-Crump 1979; Grodzinsky 1990; Lesser 1978) although it has also been applied to the effects of normal aging and dementia (Emery 1985) on language. Both strong and weak forms of the Regression Hypothesis have been suggested; in the strong form, language dissolution should be a mirror-image of language acquisition whereas in the weak form, language dissolution should merely parallel language acquisition but reflect different processing mechanisms and/or linguistic principles.

The Regression Hypothesis has been applied to phonology (Jakobson 1941/1968), vocabulary (Rochford & Williams 1962), morphology (de Villiers 1974; Berko Gleason 1978), and grammar (Crystal, Fletcher, & Garman 1976; Lesser 1974; Wepman & Jones 1964; Whitaker & Selnes 1978). Each of these studies used a similar approach: a rank ordering of the order of acquisition of phonological contrasts, vocabulary items, morphemes, or grammatical forms is established and then compared to a rank ordering obtained from aphasics. While certain common patterns have emerged, significant differences have emerged as well. For example, although Rochford & Williams (1962) report a close parallel between the age at which children first acquire words and the number of correct responses given by aphasics on vocabulary tests, children and aphasics respond on the basis of different retrieval cues and produce different error patterns. The rank order of omission of grammatical morphemes by agrammatics does not parallel the order in which morphemes are acquired by children (de Villiers 1974) although a common ordering of the difficulty of syntactic structures appears in child language and aphasic language (Crystal, Fletcher, & Garman 1976).

A strong form of the Regression Hypothesis has been advanced (Emery 1985) as an account of the effects of normal aging and dementia on language. Emery's application of the Regression Hypothesis to normal aging is explicit:

> ...our data show that there is an inverse relationship between sequence of language development and sequence of language deterioration, i.e., the syntactic forms mastered latest in development, and concomitantly the most complex, are the forms showing quickest and/or greatest processing deficits. Put another way, increasing linguistic complexity has a direct linear relationship with sequence in linguistic development; the data show an inverse relationship between the ontogenesis of complex linguistic forms and linguistic deterioration, i. e. the more complex, the later to develop, the earlier to deteriorate. (Emery 1985:34)

Hence, Emery claims that language dissolution re-traces the steps of language acquisition. Emery goes on to extend the Regression Hypothesis to dementia. She argues that dementing adults "show evidence of regression toward the use of the most simple forms ... of syntactic patterning" (Emery 1985:42). Hence, for Emery, the process of language development across the life-span could be characterized as an inverted u-shaped curve: the language of very young children resembles that of severely demented adults, at least with regards to grammar.

Emery's (1985) support for these claims is derived from studies of the adults comprehension of different grammatical forms. The normal elderly adults had difficulty comprehending prepositions, as in *Do you put your stockings on after your shoes?*, passives, such as *The boy is called by the girl; who is called and who did the calling?*, and other complex constructions, including *What is the relationship of your brother's father to you?*. Dementing adults rarely answered such questions correctly and they failed on word retrieval or naming tasks, as well. In addition, she asked elderly adults and dementing adults to respond to questions such as *He found out that Mickey won the race. Who found out?* or to act out sentences such as *Mickey tells Donald to hop up and down. Make him hop.* Based, in part, on the work of C. Chomsky (1979), the questions and sentences were ordered on the basis of grammatical complexity and order of acquisition. Since

Emery found that the elderly adults and the dementing adults performed most poorly on the most complex sentences, she concluded that language dissolution mirrors language acquisition. However, in order to maintain this model of language dissolution, Emery must also adopt a particular view of the relationship of language and cognition expressed by The Strong Cognition Hypothesis.

The Strong Cognition Hypothesis is an extension of Piaget's views on the relationship between language and cognition. According to the Piagetian perspective, language is simply one of several representational abilities, including symbolic play, and deferred imitation. These representational abilities emerge and develop in parallel (Sinclair 1971; Greenfield, Nelson, & Saltzman 1972). For example, the developmental of object permanence at the end of the sensorimotor stage of development has been linked to the emergence of children's first words (Sugarman 1978). Sinclair-de-Zwart (1973) showed that the shift from preoperational thinking to operational thinking is linked to a shift in how children use adjectives to describe arrays of objects. According to the Strong Cognition Hypothesis, these examples show that the development of linguistic structures is contingent on the prior development of the appropriate cognitive structures.

When extended to the study of adult language and cognition, this account usually holds that adult development is characterized by the emergence of a period of post-formal thinking (Kramer 1983; Perry 1968; Riegel 1973 1977; Rybash, Hoyer, & Roodin 1986). The characteristics of postformal thinking contrast with those of formal thinking. Whereas formal thinking is absolute, analytic, fixed, rule-governed, and logical, cognition during the period of postformal thinking is relativist, nonabsolute, synthetic, contextual, open to uncertainty, and tolerant of contradiction. Such a restructuring of thinking ought, according to the Strong Cognition Hypothesis, to be paralleled by linguistic changes (Labouvie-Vief 1989; Adams, Labouvie-Vief, Hobart, & Dorosz 1990; Jepson and Labouvie-Vief 1990).

Emery (1985) suggested a very different variant of the Strong Cognition Hypothesis to account for the language changes she has observed among healthy elderly adults and dementing adults. In addition to sentence comprehension tests (described above), the adults were given a wide range of tests including Piagetian tests

of conservation. Emery linked the adults' syntactic processing problems to their performance on the Piagetian tasks; the elderly adults performed poorly on the conservation tasks and the dementing adults had near zero performance on these tasks, indicating "*regression to the pre-operational, and sometimes, even to the sensori-motor level of cognitive operations*" (Emery 1985:43). Emery concludes that aging leads to the "de-socialization" of thought which in turns leads to the inability to processs linguistically abstract, logical, and complex relationships. The near absence of language in the demented adults and their near zero performance on the syntactic tests confirmed for Emery that "*The progressive loss of capacity to use language as a rule governed system is synonymous with progressive de-socialization*" (Emery 1985:43). Emery thus espouses both a strong form of the Regression Hypothesis and the Strong Cognition Hypothesis with respect to the relationship between language and thought.

Emery's empirical support for both hypotheses is, however, weak. First, Emery's battery of syntactic tests included many items whose comprehension involves, not syntactic judgments, but semantic and pragmatic knowledge. An adult who is unable to retrieve the appropriate schema for dressing might incorrectly answer yes to *Do you put your stockings on after your shoes?* while someone who is unable to retrieve the word *uncle*, or someone whose father did not have a brother, might not be able to respond to *What is the relationship of your father's brother to you?*. Second, the task of acting out sentences such as *Make Mickey promise Donald to hop up and down* with hand puppets may have been too childish to elicit appropriate responses from the adults.

More critically, Emery's (1985) conclusions are not supported by other lines of research. For example, the analysis of speech samples producing by dementing adults has revealed that they are capable of correctly producing many different types of grammatical morphemes and syntactic constructions (Blanken, Dittman, Haas, & Wallesch 1987; Kempler, Curtiss, & Jackson 1987). Whereas the speech of young children might be considered to be "telegraphic" in that grammatical morphemes are lacking and word combinations based on agent-action-object concatenations predominate (Brown 1973), the speech of dementing adults nonetheless includes obligatory grammatical morphemes and a wide range of grammatical forms. Kempler et al (1987) have

shown that the language of dementing adults does not, in fact, regress "towards the use of the most simple forms" of grammar.

In contrast to the Regression Hypothesis and the Strong Cognition Hypothesis, the Capacity Limitations Hypothesis holds that adults' language processing is constrained by capacity limitations (Hasher & Zachs 1988; Light & Burke 1988). This hypothesis is derived from the working memory framework of cognitive psychology.

Within cognitive psychology, working memory is viewed as a limited-capacity storage and processing mechanism. Baddeley (1986) has proposed a triparate model of working memory in which a central executive component is responsible for most processing operations and two subordinate storage systems, an articulatory loop and a visual-spatial sketchpad, provide temporary storage of verbal and visual-spatial information, respectively. Under this framework, processing deficits can arise because the central executor is over-loaded with processing operations or because the capacity of either temporary store is exceeded. Daneman & Tardiff (1987) have suggested that the articulatory loop and visual-spatial sketchpad are not simply storage systems but also specialized, limited-capacity processors; under this re-formulation, domain-specific limitations on language processing, such as the individual differences in reading comprehension noted by Daneman & Carpenter (1980) Turner and Engle (1989), and Waters, Caplan, and Hilderbrandt (1987), would be expected.

A limited capacity component is typically incorporated in models of syntactic parsing operations. It may be embodied as limitations on particular parsing operations or in assumptions about the architecture of the parser: (i) Chomsky (1963, 1965) and Miller & Isard (1964) suggested a prohibition on the multiple recursive application of the same parsing operation to account for the difficulty of sentences with two or three levels of center-embedding but the acceptability of sentences with a single level of center-embedding. (ii) The parser may be limited by restricting the retrieval of partially analyzed constituents from a push-down stack by a "first-in, last out" principle (Woods 1973; Fodor 1978; Marcus 1980). This limitation accounts for the preference for nested rather than crossed dependencies among constituents. (iii) The parser may be "short-sighted" or limited to a specific

number of lexical items (Frazier & Fodor 1978) to account for parsing biases such as right-attachment. (iii) The parser's access may be limited to a "look-ahead" buffer of a specified number of lexical items (Berwick & Weinberg 1984; Marcus 1980) to permit the deterministic parsing of local structural ambiguities.

Working memory limitations have been implicated in studies of adults' speech processing by Wingfield and Stine and their collaborators. In their task, adults listen to oral prose which may vary in linguistic complexity or rate of presentation. In some studies, the adults are tested on their immediate recall of sentences; in others, the adults are able to stop the tape recording at various points in order to recall the preceding material. Wingfield and Stine (1986) demonstrated that, at normal or slightly faster than normal presentation rates, elderly adults are able to segment speech appropriately at linguistic constituent boundaries and to recall these segments accurately. As presentation rates increased, the elderly adults were still able to segment appropriately the speech but their recall declined. Older adults are not differentially affected by propositionally dense speech (Stine, Wingfield, & Poon 1986) but they are more dependent on linguistic prosody (Wingfield, Poon, Lombardi, & Lowe 1985) and redundancy (Stine & Wingfield 1987) than young adults. Indeed, when prosody is disrupted, elderly adults have difficulty recalling speech (Wingfield, Lahar, & Stine 1989). Thus, it appears that fast presentation rates and disruptions of prosody and redundancy impose performance limitations on elderly adults' ability to process speech by overloading the central executor.

Other research has also implicated working memory limitations as a primary determinate of language change across the life-span. Kynette, Kemper, Norman, & Cheung (in press) have confirmed a link between adults' word span and word repetition rates (Hulme, Thomson, Muir, & Lawrence 1984; Schweickert & Boruff 1986). Elderly adults are able to recall as much as they can say in approximately 1.2 seconds; thus word span, as well as word repetition rates, for short one-syllable words exceed those for longer two- or three-syllable words. This relationship between word span and word repetition is stable across the life-span and appears to be an accurate index of the capacity/duration of working memory.

This finding suggests that at least part of the observed age-related decrements in language processing and working memory may be due to age-related slowing of phonological or articulatory processes. A similar account of some forms of childhood reading impairments has been recently put forth by Crain and Shankweiler (1988, 1990) and Shankweiler and Crain (1986). Crain and Shankweiler (1988; 1990) note that poor readers lag behind good readers in their comprehension of complex syntactic structures such as relative clauses and poor readers also evidence a variety of working memory limitations, especially those involving phonological analysis. Language processing deficits, including reading disorders in childhood and syntactic processing limitations in late adulthood, may arise whenever sentences impose severe processing demands on working memory.

The picture of language change in adulthood that emerges from studies of adults' speech and writing is very different from Emery's (1985). While there is evidence for a loss of syntactic complexity, there is no evidence that adults' language regresses to "baby talk." Rather the loss of syntactic complexity appears to be related to working memory capacity limitations.

Kynette and Kemper (1986) compared adults 50 to 90 years of age on six different aspects of speech: simple and complex syntactic structures, verb tense constructions, grammatical forms, lexical diversity, and disfluencies including sentence fragments and lexical fillers. Across the age range, there was a reduction in the variability and accuracy of the adults' syntactic structures, verb tenses, and grammatical forms but no age-related changes to lexical diversity and speech disfluencies. Kynette and Kemper suggested that these age-group differences reflected a loss of syntactic complexity; the older adults produced few sentences with multiple clauses and made more errors when they attempted to do so.

Kemper (1987a) analyzed the incidence of different types of embedded clauses in both a longitudinal sample and a cohort-sequential sample of adults' writings taken from diary entries. The longitudinal record spanned seven decades; the cohort-sequential sample contrasted adults born in the 1820s with those born in the 1860s for diary entries made when the adults were in their 40s versus in their 80s. The primary finding was the overall complexity of the adults' writing declined across the life-span; 70 and

80-year olds produce few sentences with embedded clauses, especially left-branching embeddings.

A similar finding emerged from the analysis of Kemper, Kynette, Rash, Sprott, and O'Brien (1989) of adults' speech. This analysis examined age-related changes to the length, clause embedding, and fluency of adults' speech. The initial analysis revealed that there is a gradual loss of complexity with advancing age; older adults in their 70s and 80s were less likely to produce sentences with embedded clauses, especially left-branching clauses, than young, college-aged adults.

However, the ability to produce a complex, multi-clause sentence, especially a left-branching one, is not constrained by age alone but by working memory. Kemper et al (1989) also measured of the adults' educational level, vocabulary, and their performance on digit span tests. Better educated adults scored higher on the vocabulary test and produced longer sentences. Adults with greater digit spans produced more complex sentences containing more clauses, especially left-branching ones. This relationship between digit span and syntactic complexity holds even when age is statistically controlled. Since digit span tends to decrease with advancing age, it appears that the production of complex sentences is linked to the capacity of working memory and that the capacity of working memory decreases with advancing age.

This view of the relationship between age, working memory, and the complexity of adults' speech receives further support from a three-year extension of this project by Kemper, Kynette, and Norman (in press). Digit span scores obtained in Years 1, 2, and 3 are inter-correlated, suggesting that they measure of common component of working memory. Two measures of linguistic complexity were analyzed: the average number of clauses per utterance and the incidence of left-branching clauses. Both language sample measures were inter-correlated across this span indicating that the complexity of adults' speech is a stable characteristic. Further, digit span was significantly correlated with the complexity scores, even when the effect of age was statistically controlled. Whereas the digit spans and complexity scores of most of the participants had not changed by Year 3, a few participants experienced a significant loss of digit span after three years. Most of these participants (91%) also evidenced a significant loss of linguistic

complexity. While these results must be viewed cautiously, they do suggest that there is link between the loss of working memory capacity, as measured by digit span, and the decline in the production of complex, multi-clause sentences.

The strongest support for the Capacity Limitations Hypothesis comes from studies of adults' narratives. Kemper, Rash, Kynette, & Norman (1990) have analyzed oral narratives told by elderly adults and Kemper (1990) analyzed a seven decade longitudinal record diary entries. Both studies found that elderly adults employed elaborate narrative structures that included hierarchically elaborated episodes with beginnings describing initiating events and motivating states, developments detailing the protagonists' goals and actions, and endings summarizing the outcomes of the protagonists' efforts. The elderly adults provided background information regarding the setting and story protagonists through the use of sequential and embedded episodes. The elderly adults also attached evaluative codas to their narratives which assessed the contemporary significance of these episodes. The elderly adults may have used more complex narrative structures, perhaps, because they had learned how to capture and maintain the attention of their audience by establishing the setting, describing the goals and motives of the characters, and structuring their stories as hierarchies of events and episodes.

These studies also consistently obtained positive correlations between the age of the story-teller and ratings of the quality of the narratives. Naive raters as well as English teachers apparently agree on what makes a "good" story: good stories involve complex plots with multiple episodes and evaluative codas. Whether older adults have learned through experience to tell such stories or whether they simply have more interesting experiences and points of view to relate, their stories conform more closely to this ideal than those of young adults.

However, the ability to tell a good story by constructing an elaborate, multi-episode plot is not an isolated ability. Rather, it too, like the ability to produce a complex, multi-clause sentence, is constrained by working memory. When measures of the narratives' structural complexity as well as their syntactic complexity are jointly examined, a clear picture of the effects of working memory capacity limitations emerges. As narratives become structurally

more complex, they became syntactically less complex. Although there is no effect of narrative complexity on syntactic complexity for the stories told by the young adults, the older adults used complex sentences to tell simple stories and told complex stories using simple sentences. This suggests that the demands of creating complex narratives "traded-off" with those of creating complex syntactic structures.

This view is supported by the pattern of correlations with the storytellers' age, education, vocabulary, digit spans. Again, better educated adults tend to produce long sentences. However, adults with larger digit spans, especially backward digit spans produce narratives with more complex structures and more complex sentences. Working memory capacity is required to produce both complex narrative structures and complex syntactic structures. Note that, working memory capacity alone is not sufficient to guarantee complex narrative structure since the college students produced narratives which were syntactically complex but which lacked complex narrative structure. Rather it appears that the elderly adults had indeed learned to tell "good" stories by capturing the attention of their listeners through the use of settings, evaluative codas, event hierarchies, and multiple episodes. But the production of complex narratives carries with it a price in that syntactic complexity must be sacrificed to working memory limitations.

The goal of formulating a comprehensive account of language development across the life-span is a laudable one but it is not an easy one. No simple, account of language development, such as the Regression Hypothesis, is going to characterize both the acquisition of language in childhood and its nature in adulthood. While there is evidence that working memory capacity limitations affect the complexity of adults' speech, references to working memory in the language acquisition literature have been limited to occasional, and typically brief, suggestions that working memory limitations may play some role in constraining the length of children's utterances (Bates, Bretherton, & Snyder 1989; Bloom 1970; Bever 1970; Valian 1986). Thus, reasoning backwards, from the effects working memory capacity limitations in adulthood to their role in language acquisition, presents a formidable challenge.

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