

LEXICAL REPRESENTATION AND ACCESS IN CHILDREN AND ADULTS

By

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## ABSTRACT OF THE THESIS

Lexical Representation And Access In Children And Adults

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The goal of the research presented in this paper is to shed light on the nature of lexical representation and access: how the lexicon develops between early childhood and adulthood; what linguistic factors are associated with lexical access, and most importantly, how the lexicon is organized. On this last point, the questions of interest are whether the lexicon is semantically organized, and if so, what semantic features drive lexical access.

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## I. INTRODUCTION

The goal of the research presented in this paper is to shed light on the nature of lexical representation and access: how the lexicon develops between early childhood and adulthood; what linguistic factors are associated with lexical access; and most importantly, how the lexicon is organized. On this last point, the questions of interest are whether the lexicon is semantically organized, and if so, what semantic features drive lexical access. Certainly, these are not new questions, but rather, our methods of addressing these questions take a new turn.

The lexicon is a mental dictionary. When people learn new words, they store these words in their lexicon for later retrieval. A major question in psycholinguistics research is how the lexicon is organized. A card catalogue can be organized by genre, author's last name, title, and so on. Previous research, described below, has suggested that the lexicon might be organized phonologically (e.g. *cat* and *hat* might be stored under the AT file. *Cat* and *camp* under the /k/ file). Alternatively, or additionally, the lexicon might be organized semantically, with words that share similar meanings filed together (Rabinowitz and Mandler, 1983). Here *dog* and *wolf* might be filed under CANINE. A third possibility is that associated words--those often appearing together, such as *butter* and *knife*--are stored together. Finally, frequent words are more quickly accessed than infrequent words (Rubenstein, Garfield, and Millikan, 1970, Segui, 1982), suggesting that frequent words might be stored together for easy retrieval.

Understanding the organization of the lexicon is a timeless psychological and philosophical question. How is it that every English speaker over the age of two *knows* what a *dog* is, but even the most astute linguist cannot give you a definition of

*dog*, short of telling you about DNA. Words must have some discrete, representable meaning; after all, we store the meanings of words in our minds. But, with perhaps the exception of a few mathematical terms, words don't seem to have definitions--sets of necessary and sufficient conditions. As Wittgenstein (1965) famously proved, there is no definition of *game* that is sufficient to include all games while being necessarily narrow. Similarly, a continuing debate in the study of concepts is whether, as argued by Fodor (2004) the smallest unit of meaning corresponds to whole items (e.g. DOG cannot be decomposed) or whether these items are composed of features (e.g. DOG is composed of, perhaps, BARKS, MAMMAL, PET and so on). It appears that DOG can be broken down into these features, but this is a problem since there doesn't appear to be a necessary and sufficient set of features composing DOG. Intuitively, it might seem that the meaning of a word is simply the thing to which it refers. But this can't be right either. *Saying a pupil is a student* would be a tautology, like  $1=1$ , if words didn't have some meaning independent of their references.

It is a great paradox; words must have meaning, and people know how to use words to approximate the things they mean to say, but it is still not clear what it means for a word to mean something. And not being able to find a word, whether just for a moment in hurried speech or forever after a stroke, can feel like all meaning is lost. For these reasons, understanding words in the mind is a timeless question, with so much progress made and yet so much more learn.

The lexicon, like all psychological representations, cannot be studied directly. Rather, psycholinguists generally investigate the lexicon by studying lexical access--the process of retrieving words from the mental dictionary--or by taking note of

common speech errors--times when lexical access goes awry--or neurological or speech disorders. These are indirect methods of getting at this most essential of psychological and philosophical questions.

### **Previous Investigations into the Lexicon:**

In her seminal 1975 paper, Eleanor Rosch, premiere cognitive scientist and creator of Prototype Theory, found that people are willing to rank category members in terms of typicality. For example, people generally say that ROBIN is a more typical bird than PENGUIN is, and that CHAIR is a more typical example of FURNITURE than TELEVISION is. Her research shows that word meanings are not black or white. The meanings of *bird* and *furniture* must be somewhat fuzzy. Furthermore, she found that when asking people whether category members are members of a category (i.e. *is a robin a bird?*) people are faster to answer for more typical items. This tells us something about lexical access and possibly about the lexicon itself: More typical items are in some way easier to reach.

### **I. Priming Studies**

Priming studies also shed light on the organization of the lexicon. One word primes another if hearing the first word leads to faster recognition of the second word. Researchers have found that associated words--those that frequently appear together, such as *bread* and *butter*--prime one another. For example, Meyer & Schvanevelt (1971) showed a pair of words or non-words to subjects and asked them whether they saw words or non-words. Subjects were faster at recognizing a word like *butter* when



the previously seen word was associated (e.g. *bread-butter*) than when the previously seen word was unrelated (e.g. *bank-butter*).

In another type of priming study, a free association task, subjects are given a word and asked to respond with the first word that comes to mind. Adults tend to respond paradigmatically, with associated words of the same grammatical class--following nouns with nouns and verbs with verbs (Brown, 1960, Entwisle, 1966). In contrast, children under seven tend to give a syntagmatic response, with a word that is semantically related but in a different grammatical class (Emerson and Gekoski, 1976). For example, while adults might follow *hammer* with *nail*, children would be more likely to follow it with *hit*. This suggests a shift in the organization of the lexicon during childhood, from grouping things together in terms of how they act on each other to grouping things together in terms of taxonomy.

Interestingly, although *cat* is often followed with *dog* by adults and with *meow* by children, people rarely respond with *camp*. In other words, items in word association tasks do not prime people phonologically. This is quite surprising because there is evidence that people are faster at processing a word if they have already heard a word containing the same initial phoneme (Slowiaczek & Hamburger, 1992). It seems that people can be primed phonologically but that they do not self-prime phonologically. People also generally do not respond with perceptually similar items; people do not respond to *needle* with *nail* although they are both long, pointed objects (Aitchison, 1987).

In another priming study (Freedman and Loftus, 1971), researchers asked subjects either to name a fruit that was red or a red fruit. In other words, they either

primed a category with an adjective or an adjective with a category. They found that people are faster when the category name was said first. Similarly, they found that people were faster when they asked people to name a fruit beginning with the letter “p” than a letter “p” fruit. These results suggest that it is by category, not description nor first letter, that people access words. Additionally, Federmeier & Kutus (1999) found that not only do plants prime other plants, for example, but also, plants that are members of the same subcategory (e.g. PALM and PINE are both TREES) prime each other better than plants that are not members of the same subcategory (e.g. PALM and TULIP), supporting the existence of a multi-tiered semantic hierarchy.

Priming studies have also shown that concrete words (e.g. *apple, umbrella*) and abstract words (e.g. *freedom, knowledge*) might be stored separately (Paivio, 1969). In one experiment, concrete words only primed other concrete words and abstract words only primed other abstract words. Furthermore, concrete words, which are more “imaginable”, were more easily recalled than abstract words, suggesting that the ability to attach an image to a word in the lexicon aids in lexical access (Paivio, 1969).

## **II. Speech Errors**

There is a large body of work investigating speech errors (Fromkin, 1973) and the “tip of the tongue” phenomenon (Brown and McNeill, 1966). Analyses of speech errors have revealed that people tend to mix up phonologically similar items (saying *bomb square* instead of *bomb scare*) and occasionally semantically related items

(*oven* and *fridge*, *apple* and *orange*), suggesting that the lexicon may be organized either phonologically or semantically, or both.

Similarly, researchers have studied the phenomenon of people having a word on the tip of their tongues. People generally know the grammatical class of the word they're searching for and often know the beginning and end sounds, but not the middle sound, of the word, suggesting that words might be grouped by first or last sound. According to one study, errors people make when experiencing "tip of the tongue" are phonologically similar to the target word 70% of the time and semantically similar 30% of the time (Brown and McNeill, 1966).

Although slips of the tongue and tip of the tongue studies have provided important insights into lexical access, one limitation of these studies is that instances of lexical access failure are used to make inferences about successful lexical access and the lexicon itself. Furthermore, corpora of speech errors tend to represent a biased sample since the majority of speech errors go unnoticed, with only the more humorous incidents being recalled, usually those of a phonological rather than semantic nature.

### **Models of Semantic Representation**

There are several models describing how concepts are organized. According to one model of semantic representation, taxonomic concepts (e.g. ANIMALS and FURNITURE) are organized in a hierarchical network. For example, ANIMAL might be a node above DOG which might be a node above LABRADOR. Collins and Quillian (1969) used a feature verification task to test this model. They asked people

questions like *is a dog an animal?*, *is a Labrador an animal?*, and *is a Labrador a dog?*. They found that people were faster at answering the first question than the second, and posited that, since in their model DOG is closer to ANIMAL than LABRADOR is to ANIMAL, subjects took less time to verify the answer. Furthermore they found that subjects were faster at answering the third question than the first question, which they explained by suggesting that the larger a category (e.g. ANIMAL contains more items than DOG), the more time it takes to sort through that category to find an item (e.g. to find DOG or LABRADOR, respectively).

However, Smith, Shoben, and Rips (1974) found that if they asked subjects the question in reverse—*True or false: A Labrador is an animal* or *True or false: A Labrador is an dog*—subjects were faster at answering the second than the first question, which is incompatible with the hierarchical network model. Smith, et al. revised the hierarchical network model and suggested that concepts are composed of defining (meaning necessary) and characteristic (meaning optional) features. A DOG is perhaps necessarily a MAMMAL but characteristically FOUR-LEGGED. They accounted for the semantic distance effects by suggesting that in a semantic verification task, people compare the number of overlapping features between two categories. They argue that the semantic verification times follow from the fact that DOG and LABRADOR share the most number of features; DOG and ANIMAL share the second most number of features; and LABRADOR and ANIMAL share the least number of features. There are several problems with this model as well. The distinction between defining and categorical features is not always apparent; it is unclear why category membership could not be stored directly as a feature of a

concept, making a semantic verification task extremely easy; and the model does not take into account the fact that many features are interrelated (e.g. things with wings typically have beaks, but things with fur typically have four legs).

A final version is the spreading activation network, (Collins & Loftus, 1975), in which both categories and features are nodes connected to each other by lines of various lengths, representing. This model accounts for semantic distance effects, because subjects take longer to verify nodes that are further apart. It also accounts for prototypicality effects; for example, ROBIN is closer than PENGUIN to BIRD. One problem with this model is that it is not falsifiable, since conceivably any two nodes could be said to be any distance apart.

### **In This Study**

Our main test of lexical access is a rapid naming of animals (RNA) task. In this task, people are given a set period to name as many animals as they can, and the number of animals named is taken as a measure of lexical access proficiency. This task has the advantage of being relatively natural, having little demand, being appropriate for both children and adults, and being able to be used non-clinically.

Verbal fluency tasks like RNA are often used clinically (Troyer, 2000) with the assumption that the better the person's ability to access lexical items, the more items the person would be able to name. There are two reasons for testing children's verbal fluency. First, typically-developing children's performance on verbal fluency tasks increases with age (e.g., Riva, Nichelli, & Devoti, 2000; Koren, Kofman, & Berger, 2005). Second, performance on verbal fluency tasks has been shown to be a

sensitive measure of the lexical access abilities of typically developing children (e.g., Riva, Nichelli, & Devoti, 2000; Koren, Kofman, & Berger, 2005), spoken language-impaired children (e.g., Weckerly, Wulfeck, & Reilly, 2001; Messer & Dockrell, 2006), children with neuropsychological deficits (Messer & Dockrell, 2006 and references therein) and dyslexic children (Levin, 1990; Cohen, Morgan, Vaughn, Riccio, & Hall, 1999), with typically-developing children performing better than children with spoken or written language impairments. Although rapid naming tasks are rarely used on healthy adults, assessing adult's verbal fluency is valuable both as a means of comparison to children and also as an insight into lexical access.

In Experiment One, we look at children's lexical access ability, measured by the number of animals named by pre-school-aged children. First we examine the effect of various demographic factors on this lexical access score: sex, birthweight, speech and language disorders, and age on lexical access ability. Next we look at longitudinal data that tracks the development of lexical access between the ages of three and five years. Finally, we look to see whether, in children, lexical access ability is its own linguistic module; whether it is simply part of a general language faculty; or whether children's lexical access ability is associated with their other linguistic abilities, evaluated by scores on tests of vocabulary, articulation, and syntax.

In Experiment Two, we look at lexical access ability in adults. We first look at demographic factors that might be associated with lexical access ability in adults—sex, GPA, SAT scores, and major. We then investigate whether lexical access is functional modular from subcomponents of language. Just as we did with children, we investigate the modularity of lexical access and receptive vocabulary and syntax.

However, for the adults (but not the children), we investigate whether lexical access ability is related to spelling rather than to articulation.

In the next set of experiments, we investigate, not the number of animals named but rather the order in which subjects name animals. If the lexicon is organized in a relatively flat structure, with the category ANIMALS on the top tier and all individual animals on the second tier, then we would expect the order in which people name animals to be completely random, except perhaps for effects of frequency and recency. If, however, the lexicon is organized in a more complex structure, with subcategories intervening between the ANIMAL superordinate category node and the nodes for individual animals, then we would expect the most efficient strategy for naming animals would be to name consecutively animals sharing the same subcategory node. If the lexicon is hierarchically organized, we would expect that subjects who consecutively name animals sharing the same subcategory (subsequently called “features”) would name more animals than subjects who do not produce semantic clusters of animals.

Experiment 3 is a categorization experiment in which we asked subjects to group animals and assign these groups features. Here, we look at what sorts of features subjects assign to animals when they specifically categorize animals. In Experiment 4A (adults) and 4B (children), we used the semantic features obtained in Experiment 3 to count how many times in a row subjects were using the same features. We evaluated the order in which subjects named animals to determine whether subjects were consecutively naming animals with the same features. We also look at each feature individually to determine which features are named

consecutively. Finally, we compare and contrast the results of adult and child subjects to determine whether the nature of lexical access changes throughout childhood.



## II. EXPERIMENT 1: LEXICAL ACCESS IN CHILDREN

### **METHODS**

#### **Subjects**

Experiment 1 included 275 children drawn from the Perinatal Environment and Genetic Interaction (PEGI) study (Stromswold, 2006). We included all 3-5 year old monolingual English-speaking twins who completed all tasks relevant to our analyses. Since the PEGI study is a longitudinal study, many children were tested at multiple ages. With the exception of our developmental analyses, we only included data collected from each child the last time that child participated.

The mean age of children was 4.6 years (SE=.04 years, range 3.1-5.9 years).<sup>1</sup> Approximately half of the children were females ( $N=139$ ) and half males ( $N=136$ ). Consistent with children being twins, their mean birthweight was 2356 grams, (SE=38 grams, range 616-3799 grams), with 2% being extremely low birthweight (Group A <1000 grams), 6% being very low birthweight (Group B =1000-1499 grams), 46% being low birthweight (Group C =1500-2499 grams), and 46% being normal birth weight (Group D >2499 grams). Also consistent with the children being twins, 20% ( $N=55$ ) of the children had received therapy for a speech or language disorder.

#### **Stimuli**

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<sup>1</sup> Age calculated from due date

Our tests, which were parent-administered, were designed to assess children's lexical access abilities as well as their skills in the areas of spoken and receptive language most frequently assessed in standardized language tests: vocabulary, articulation, and syntax.

### **Rapid Naming of Animals (RNA) Lexical Access Test**

Clinically, lexical access is often assessed by asking people to name words rapidly. In our test, children were told: *A dog is an animal. Can you name other animals?* Children then had 30 seconds to name as many animals as they could.

### **Other linguistic tasks:**

In addition to the rapid naming lexical access task, children completed 4 additional tests of linguistic ability, namely, tests of constrained Lexical Access, Receptive Vocabulary, Articulation, and Syntax.

### **Secondary Lexical Access Test: Naming Things**

In order to verify the accuracy of our main lexical access task, we tested children on a secondary lexical access task, Naming Things. This task differed from Naming Animals in that the children did not have the opportunity to name items freely. Rather, in this task, children had thirty seconds to give an example of each of the following: A part of a face, a vegetable, a number, a drink, something round, a piece of clothing, something red, a part of a car, a toy, something big. Although this task

does not give us as much information about how children access lexical items, it does demonstrate a consistency between children's lexical access abilities across tasks.

### **Receptive Vocabulary**

In the Receptive Vocabulary test, parents showed their children twelve pictures (see appendix) and asked their children to point to each of the following eight items: *nurse, dentist, mittens, helicopter, kayak, trumpet, saxophone, sandals*. Children also saw four distracter items: *gloves, astronaut, canoe, guitar*. We included pairs of items that fall under the same semantic category. For example, *saxophone* and *trumpet* are types of musical instruments; *kayak* and *canoe* are types of boats. We also chose words that are typically within the receptive vocabulary of the target age group and items that are easily depicted. In order to use the same words for all children but avoid ceiling or floor effects, we varied the frequency and difficulty of the words as determined by three sources: the frequency with which adults and children said the words in English in the CHILDES corpora, the number of web pages that contained the words as determined by Google searches, and the CDI age of acquisition percentiles. In our task children saw all twelve pictures on a single page and were asked to choose from all twelve pictures each time. This format contrasts with that of most receptive vocabulary tasks in which children see only two or three pictures at a time. We chose this format to allow a greater range of possible scores while simultaneously allowing for a shorter test.

### **Articulation**

The Articulation test was a word repetition task assessing the accuracy of children's articulation of onsets. We tested children on articulation because in order to name animals, children must literally be able to articulate them, and articulation problems might lead to a reduced number of animals. Children were asked to listen to and repeat mono-morphemic, monosyllabic words, and the child's response was considered correct if the child correctly articulated the onset of a word. For example, to be correct, the child must have pronounced the /r/ in *rat* or the /spl/ in *split*. We chose onsets because they are easier to detect than either nuclei or codas. We chose consonants instead of vowels because there is less variability in pronunciation of consonants among English-speaker dialects, and we chose onsets instead of codas because onsets have more variability than codas in terms of possible consonant clusters in English. The test was adjusted to be appropriately challenging for each age group, thereby avoiding ceiling or floor effects while minimizing the number of tested words. For each age group, we chose some words with onsets typically mastered by that age group and some with onsets typically not yet mastered (Sanders, 1972; Vihman, 1996). The three year olds repeated *fat, soap, yuck, van, rat, lip, ship, cheek, zip, jeep, that, thin*; the four year olds repeated *rat, lip, ship, cheek, zip, jeep, that, thin, split, trick, clock, frog*; the five year olds repeated: *split, trick, clock, frog, three, shrink, brake, flat, twin, street, scrub, squat*.

## **Syntax**

Sentence-picture matching comprehension tasks are widely used in research and clinical settings, yield relatively unambiguous responses that are easy to observe

and record, and are arguably the easiest syntactic test to administer to children (Gerken & Shady, 1996). In our syntax task, children viewed two pictures at a time while listening to a semantically-reversible sentence, and then pointed to the picture that best matched the sentence. A sentence is semantically-reversible if the propositional content is not straightforward from the individual vocabulary items. For example, in the sentences *the pig kissed the sheep* and *the pig was kissed by the sheep*, identifying the agent and patient requires an understanding of passive voice. We included passive sentences because passive sentences are harder to understand and produce than active sentences for typically-developing preschool children (O'Grady, 1997) and older SLI children (van der Lely & Dewart, 1986; van der Lely, 1996; Leonard, Wong, Deevy, Stokes, & Fletcher, 2006). Similarly, in the sentences *the cat scratched him* and *the cat scratched himself*, knowing whether the cat scratched the cat (himself) or someone else (him) requires knowledge of anaphora. We included active sentences with reflexive and non-reflexive pronouns because some studies have suggested preschool children who are linguistically normal (e. g., Chien & Wexler, 1990) and older children with specific language impairment (van der Lely & Stollwerck, 1997) sometimes interpret sentences with non-reflexive pronouns as if they had reflexive pronouns.

In order to ensure that our sentences were truly semantically reversible, we ensured that all sentences had verbs that are felicitous in active sentences and in verbal passive sentences with animate patients and overt animate agents; all sentences also contained noun phrases referring to animals, with animals paired such that either animal was equally plausible as the agent of the sentence (e.g., *pig* and *sheep*).

Furthermore, the pairs of pictures contained no cues as to which picture in a pair matched a sentence. Specifically, the animals in the pictures were all drawn in the same cartoon style, and pairs of pictures differed only in which animal was the agent and which was the patient. Finally, over the course of the test, each animal in each pair was the agent and the patient equally often, the animal that was the agent appeared on the left and the right of the patient equally often, and the correct picture was the left and right picture equally often.

For this task, we used vocabulary that the children almost certainly would know but syntactic structures that they might or might not be adept at understanding. To minimize the number of items on the test and prevent ceiling or floor effects, children were tested on different sentences depending on their age. Specifically, 3- and 4- year olds received 4 *by* passive sentences, 4 active sentences with 2 lexical NPs, 2 active sentences with reflexive pronouns, and 2 active sentences with non-reflexive pronouns. Five-year olds receive 6 passive sentences (3 *by* passives, 3 truncated passives), 1 active sentence with 2 lexical NPs, 2 active sentences with non-reflexive pronouns, 2 active sentences with reflexive pronouns, and 1 active sentence without an overt object NP.

## **RESULTS**

### **Analyses I: Factors affecting lexical access**

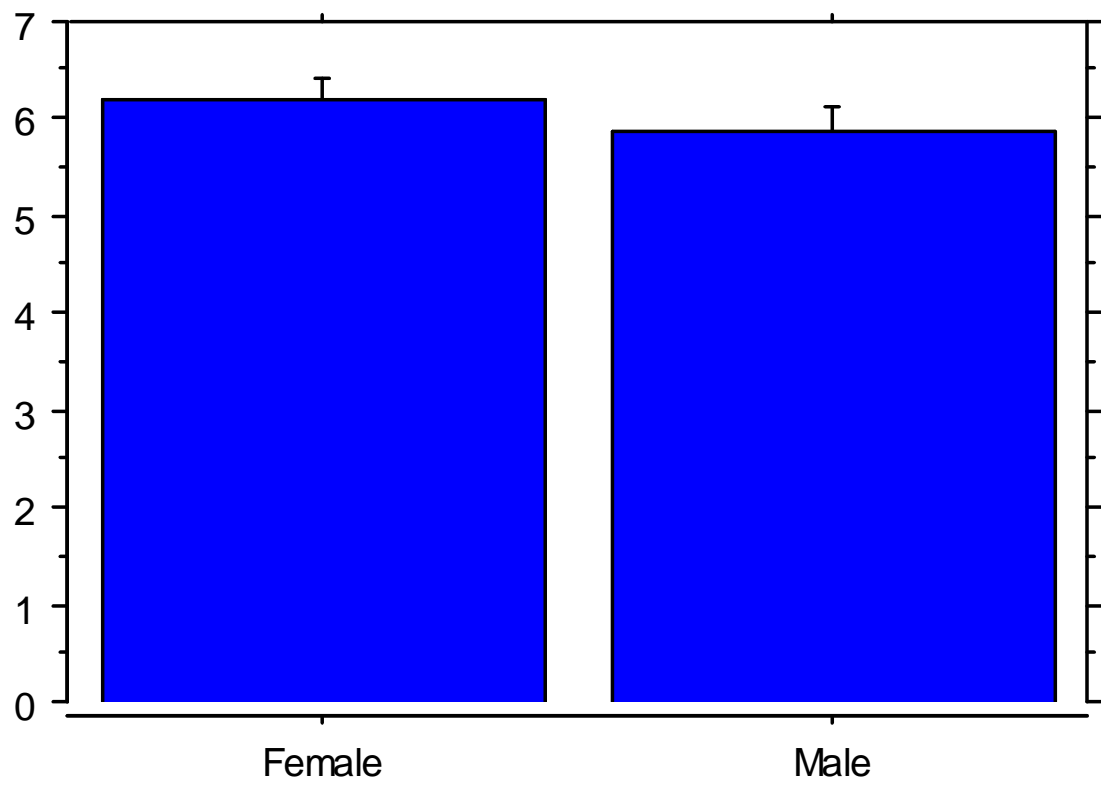
The first set of analyses we performed investigated the demographic factors affecting the number of animals named by children. Overall, children named a mean of 6.03 animals (range = 0-15, SE=.17).

### Sex

We included sex in our analyses because several studies have indicated that female pre-schoolers have a larger vocabulary than their male counterparts (Bornstein, Hahn & Haynes, 2004, Wolf & Gow, 1985-86).<sup>2</sup> Although females did name more animals than males (6.18 vs. 5.87) the difference was not statistically significant ( $F(1, 272) = .89, p=.35$ ). *See Figure 1.*

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<sup>2</sup> . Furthermore, we did not find a correlation between sex and receptive vocabulary. One possible explanation is that children's vocabulary sizes are often measured by parental checklists rather than by a clinical assessment of aptitude.



*Figure 1: Effect of sex on lexical access*

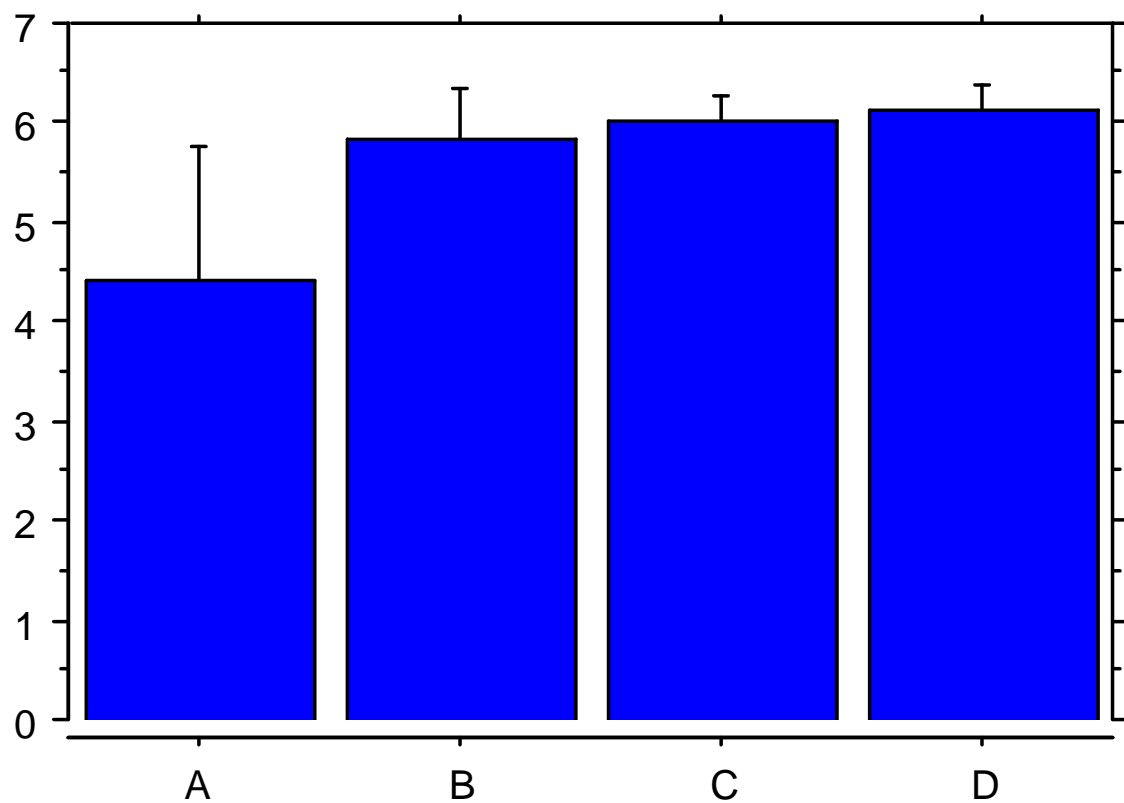
*Error bars = Standard errors*



## Birthweight

It is widely reputed that children who are born prematurely and thus have a lower birthweight often do worse on a wide range of speech and language tasks and are more likely to be diagnosed with speech and language disorders than their full-term peers. Even preterm children with normal cognitive function and no major neurodevelopmental disability are 2 to 3 times more likely to suffer from written and spoken language disorders than full-term children. (Barlow & Lewandowski, 2000). Luoma et al. (1998) argue that intellectually normal preterm children without major neurological disability have particular difficulty with rapid word retrieval.

When we looked at birthweight as a continuous variable ( $r=.10$ ,  $z=1.69$ ,  $p=.09$ ), birthweight was not significantly correlated with number of animals named. However, post hoc analyses revealed that, consistent with previous studies, extremely low birthweight children (Group A) named fewer animals than children in each other birthweight group (all  $p$ 's  $< .05$ ). See *Figure 2*.

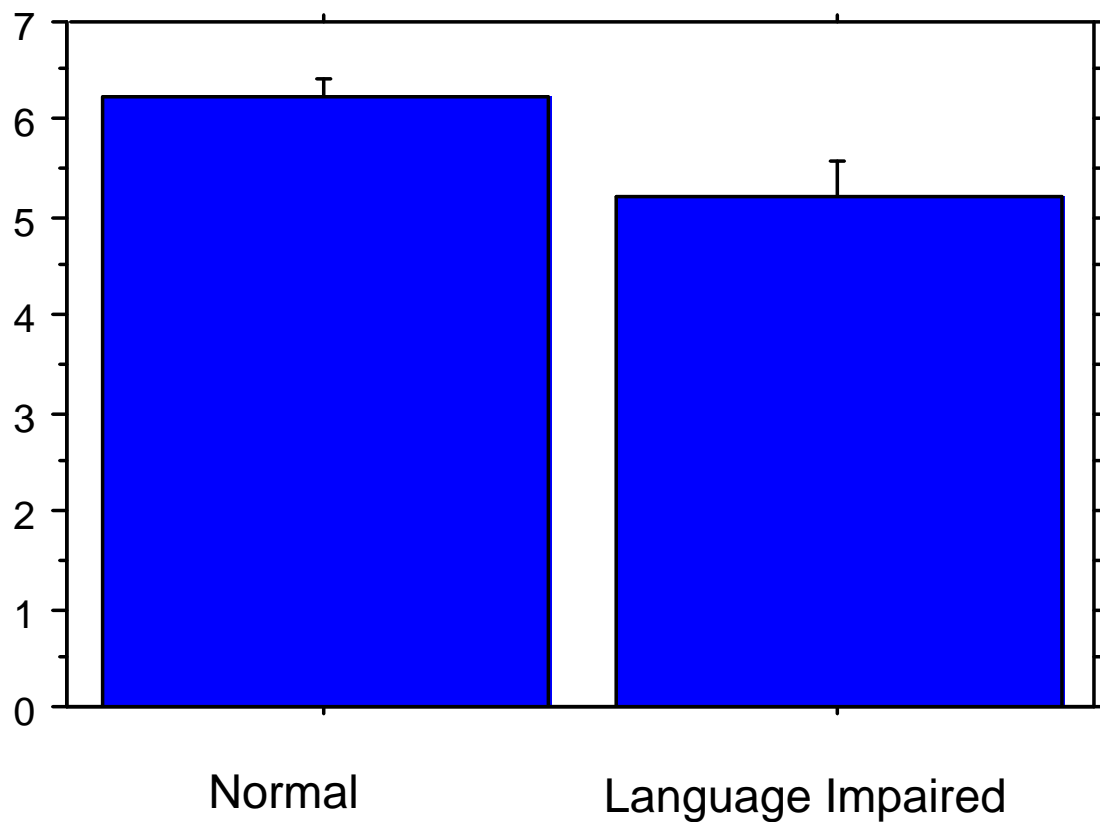


*Figure 2: Effect of Birthweight on Lexical Access*

## SLT

One of the most common reasons children are referred to SLT is reduced vocabulary size relative to age. Furthermore, some studies have shown that language-impaired children may have particular difficulty with rapid naming tasks (Weckerly, Wulfek & Reilley, 2001).

Children who had received speech or language therapy, a proxy for speech or language impairment, performed significantly worse than children who had not. As shown in *Figure 3*, children who received SLT named fewer animals than those who had not (5.20 vs. 6.23, respectively,  $F(1,272) = 6.3, p = .01$ ).



*Figure 3: Effect of Language Impairment on Lexical Access*

## Age

Three year olds named a mean of 3.51 animals, four year olds a mean of 6.05 animals, and five year olds, a mean of 7.61 animals. As shown in *Figure 4*, a simple regression analysis revealed that age was highly correlated with lexical access ( $r=.55$ ,  $z=10.06$ ,  $p=.01$ ) with older children naming more animals than younger children. As shown in *Figure 5*, categorical analyses revealed a main effect of age ( $F(2,271)=48.16$ ,  $p=.001$ ).

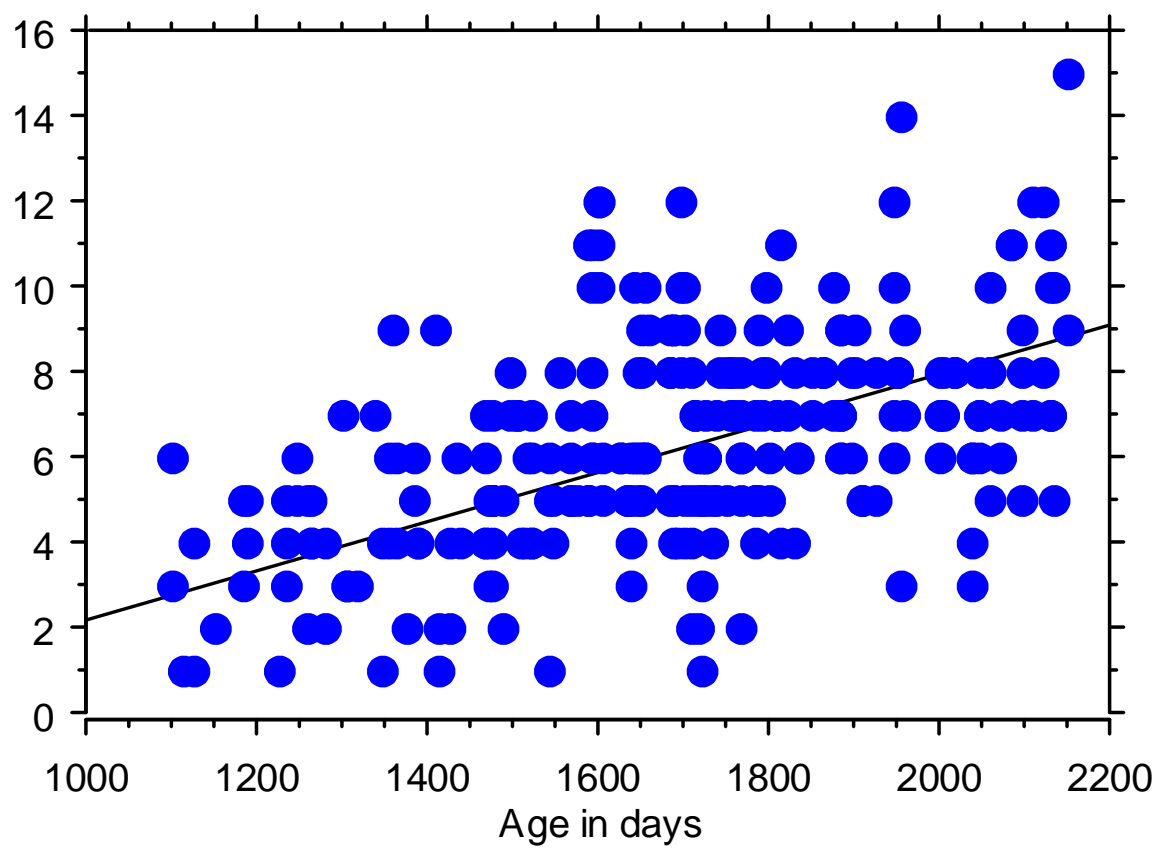
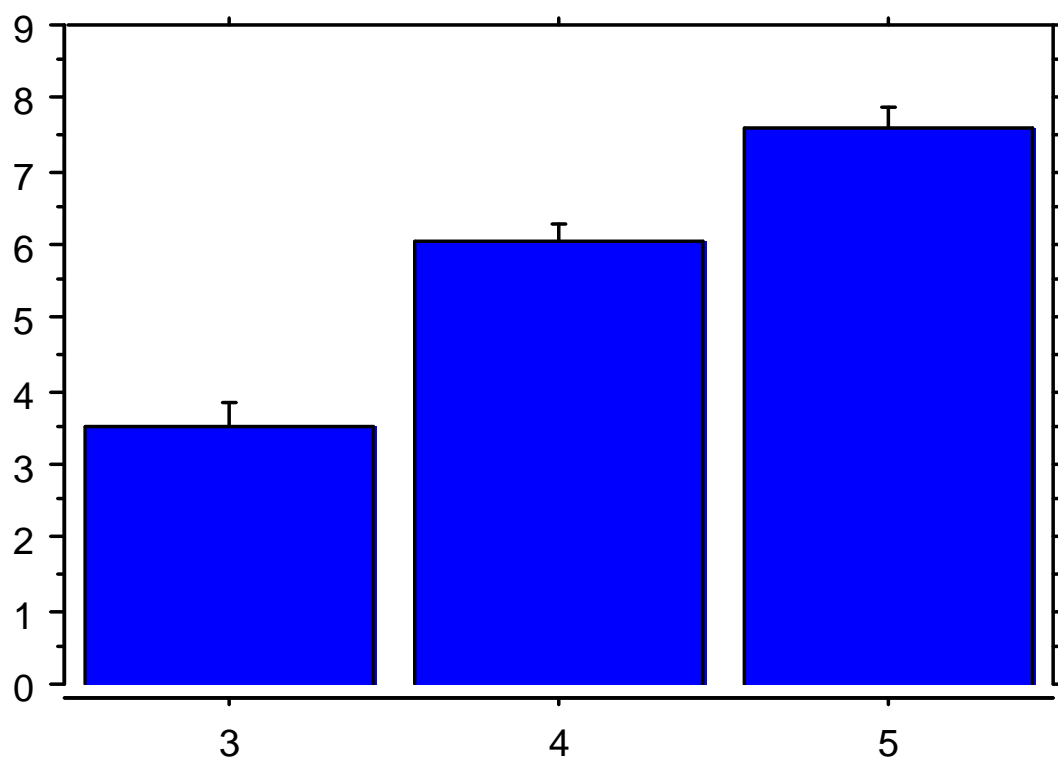


Figure 4: Effect of Age (in days) on Lexical Access



*Figure 5: Effect of Age (in years) on Lexical Access*

### Development of lexical access

For children who completed the task at multiple ages, performance at one age was a good predictor of performance a year later, with the correlation between scores at ages 3 and 4 ( $N=94$ ) being .38 and between ages 4 and 5 ( $N=30$ ) being .60 ( $p$ 's  $\leq .01$ ). *See Figure 6.*



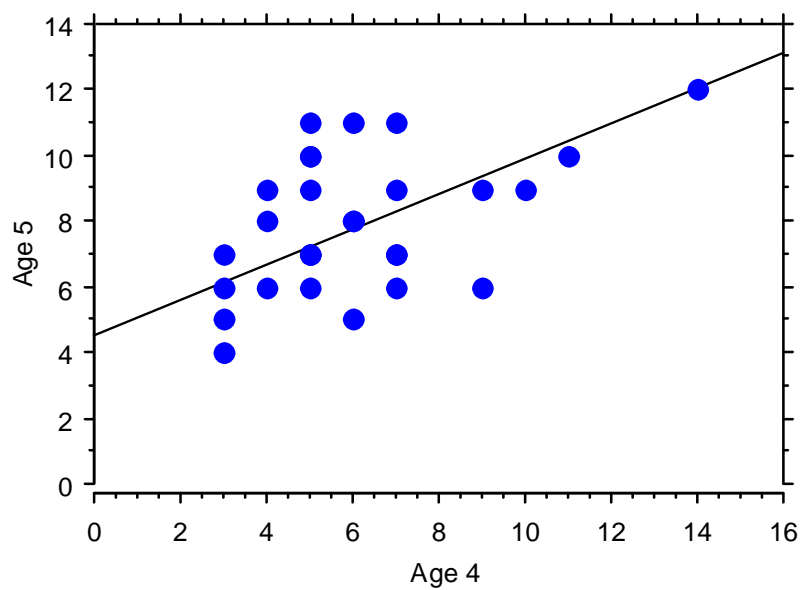
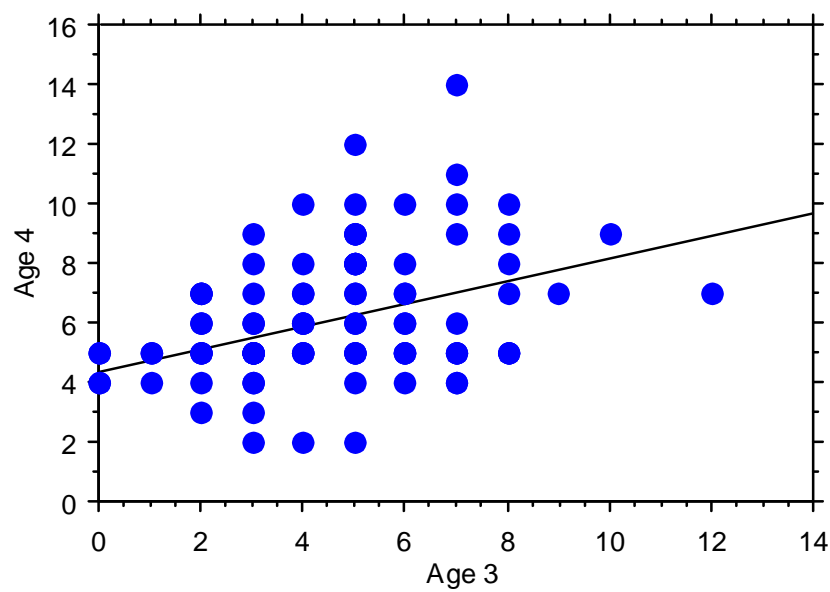


Figure 6: Correlations Number of Animals Named at Time 1 and 1 Year Later

## **Analyses II: Components of Lexical Access**

The next set of analyses investigated what, if any, linguistic skills are associated with lexical access ability. To address this question, we conducted a series of simple and multiple regressions. If there is a single language module, we would expect all linguistic skills to be significant independent predictors of lexical access. However, if lexical access is composed of only some linguistic abilities or if it is a distinct linguistic ability then we would expect at least some of the other linguistic tasks not to be significant independent predictors of lexical access ability. As outlined in the Stimuli section of Experiment 1, we assessed children's receptive vocabulary, articulation, and syntax abilities, and we also administered a secondary test of lexical access ability. *Table 1* shows the means and standard errors on each task at each age as well as the maximum possible score on each task. Note that there were no ceiling or floor effects on any task, suggesting that our tests were good measures of each skill being assessed.

<b>Age</b>		<b>Animals</b>	<b>Things</b>	<b>Vocabulary</b>	<b>Articulation</b>	<b>Syntax</b>
<b>3</b>	<b>Mean</b>	3.51	4.30	4.77	8.89	8.26
	<b>SE</b>	0.32	0.44	0.26	0.38	0.25
<b>4</b>	<b>Mean</b>	6.05	6.62	6.03	10.00	9.92
	<b>SE</b>	0.21	0.22	0.14	0.2	0.16
<b>5</b>	<b>Mean</b>	7.61	7.51	6.42	10.74	9.92
	<b>SE</b>	0.25	0.23	0.17	0.26	0.16
<b>Maximum Possible Score</b>		N/A	10	8	12	14

*Table 1: Children's Linguistic Tasks*

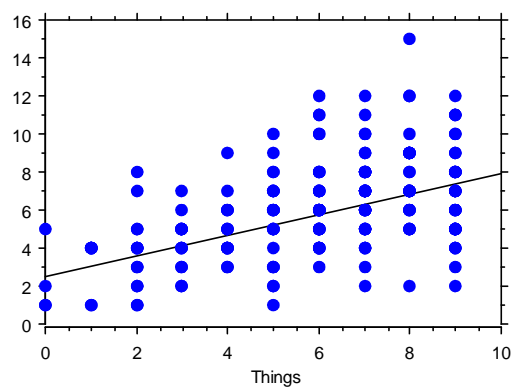
### Simple regressions

In order to investigate the linguistic skills composing lexical access ability, we performed simple regression analyses with scores on the lexical task at each age as dependent variables and scores on the other three linguistic tasks at each age as independent variables.

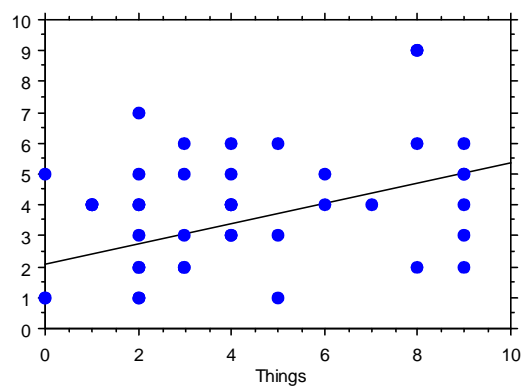
#### Secondary Lexical Access Task: Naming Things

Simple regression analyses revealed that Naming Things was highly correlated with Naming Animals across all ages ( $r=.55$ ) and was moderately correlated with lexical access at ages 3 ( $r=.46$ ), 4 ( $r=.48$ ), and 5 ( $r=.34$ ). *See Figure 7.*

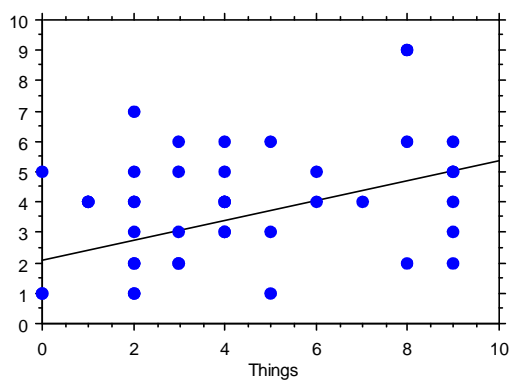
All ages



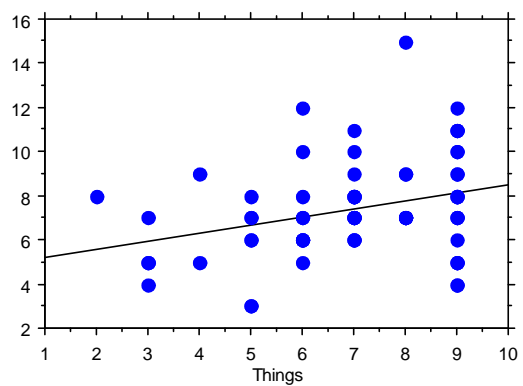
Age 3



Age 4



Age 5

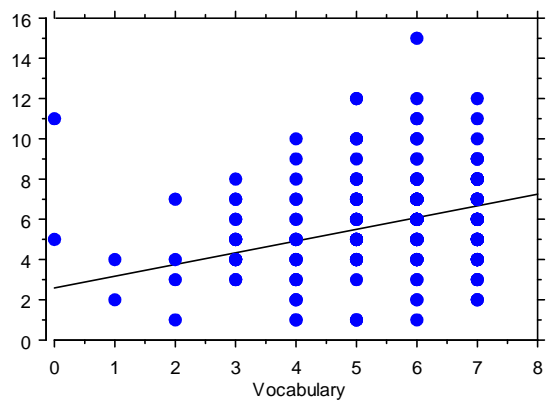


*Figure 7: Simple RNA and Naming Things*

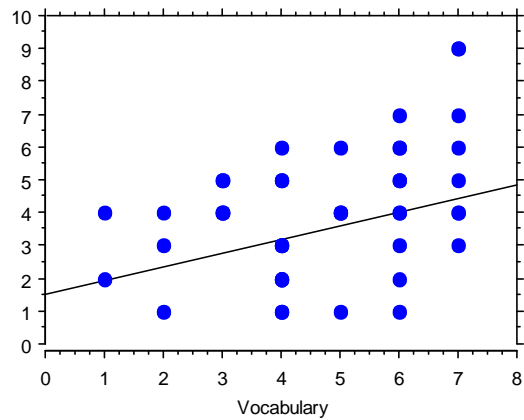
Receptive vocabulary

Simple regression analyses revealed that receptive vocabulary was moderately correlated with lexical access collapsed across all ages ( $r=.38$ ), as well as at ages 3 ( $r=.35$ ) and 4 ( $r=.31$ ), and modestly correlated at age 5 ( $r=.12$ ). *See figure 8.*

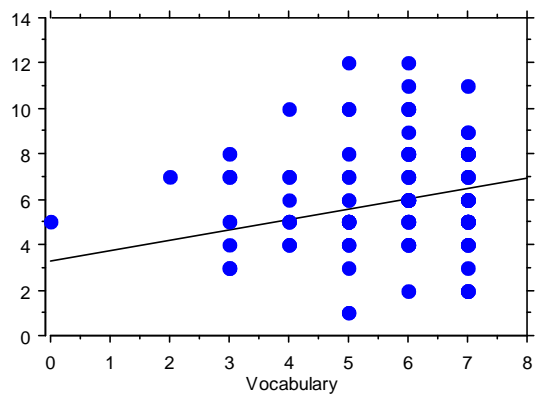
All ages



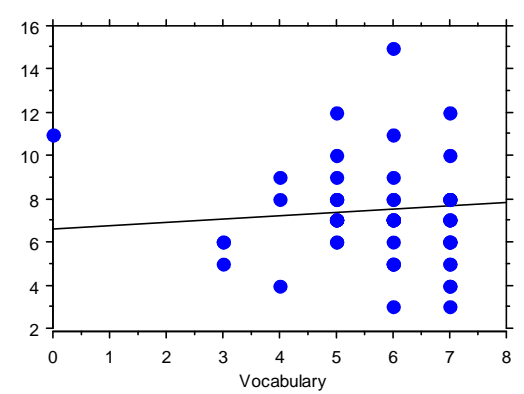
Age 3



Age 4



Age 5

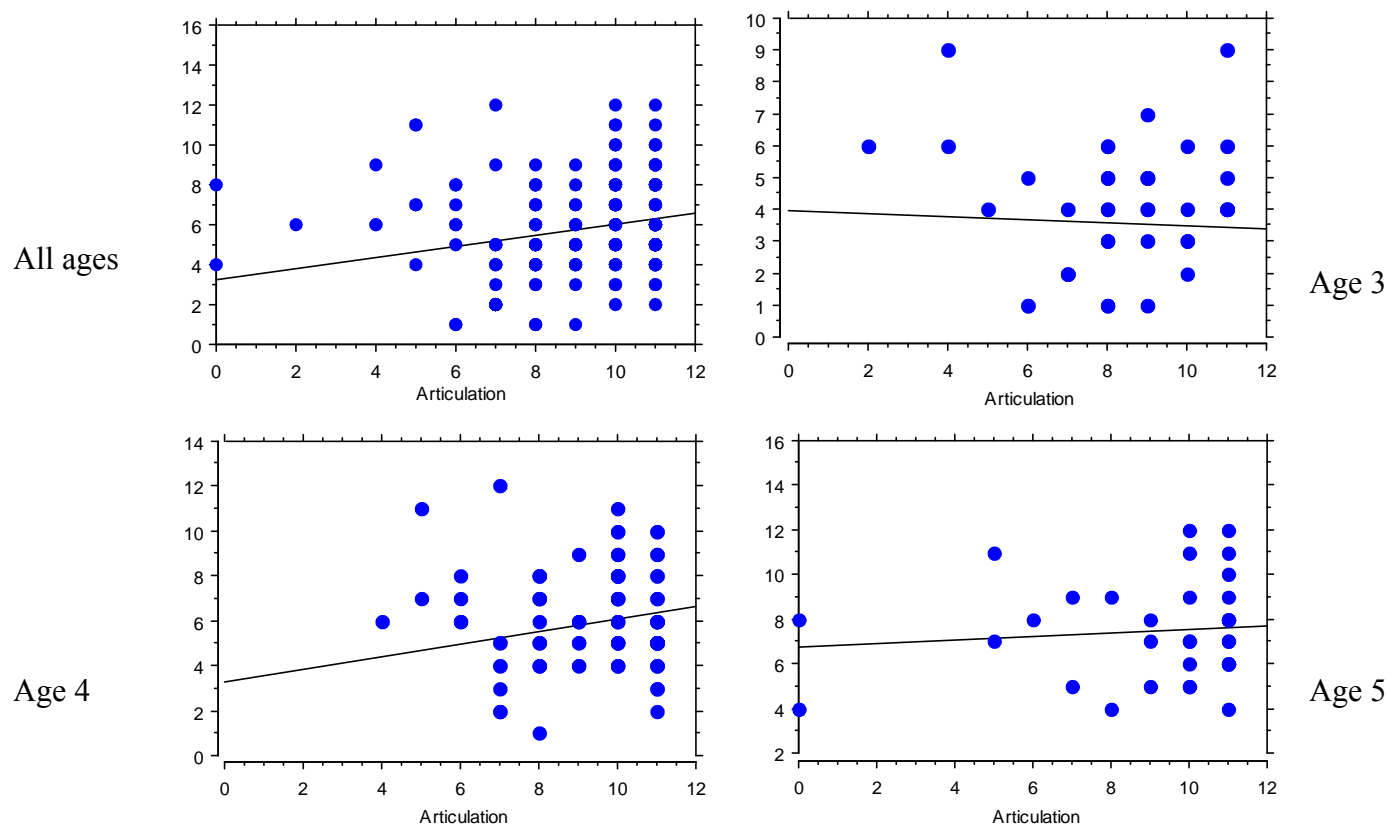


*Figure 8: Vocabulary & RNA*

### Articulation

Simple regression analyses revealed that articulation and lexical access were modestly correlated across all ages ( $r=.25$ ), were not correlated at age 3 ( $r=-.06$ ), modestly correlated at age 4 ( $r=.26$ ), and not correlated at age 5 ( $r=.08$ ). *See Figure 9.*





*Figure 9: Articulation and RNA*

## Syntax

Simple regression analyses revealed that syntax and lexical access were modestly correlated at age 3 ( $r=.26$ ), moderately correlated at age 4 ( $r=.41$ ), and not correlated at age 5 ( $r=.08$ ) *See Figure 10*.

A summary of the simple regression results can be found in *Table 2*.

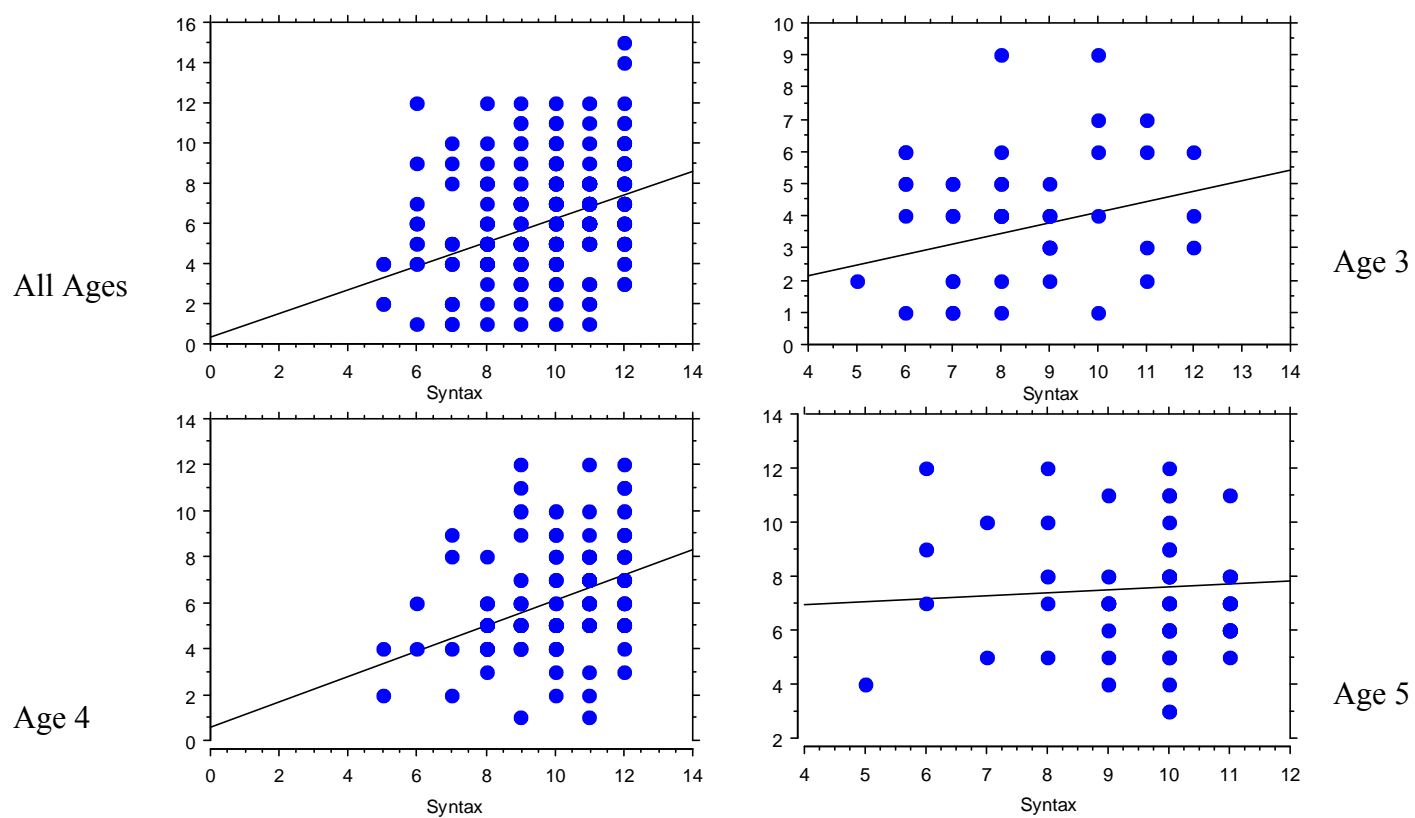


Figure 10: Syntax and RNA

	<b>Things</b>	<b>Vocabulary</b>	<b>Articulation</b>	<b>Syntax</b>
<b>Overall</b>	$r=.55, p=.001$	$r=.38, p=.001$	$r=.25, p=.001$	$r=.41, p=.001$
<b>Age 3</b>	$r=.46, p=.001$	$r=.35, p=.01$	$r=-.06, p=.68$	$r=.26, p=.06$
<b>Age 4</b>	$r=.48, p=.001$	$r=.31, p=.001$	$r=.26, p=.01$	$r=.41, p=.001$
<b>Age 5</b>	$r=.34, p=.01$	$r=.12, p=.34$	$r=.08, p=.46$	$r=.08, p=.48$

*Table 2: Simple Regression Results*

### Multiple regression analyses

Although the factors given above are associated with number of animals named, it is possible that these associations reflect a monolithic linguistic ability. The fact that not all components of language were associated with number of animals named suggests that this is not the case. We performed multiple regression analyses to determine which, if any, of the four linguistic tests were significant independent predictors of lexical access at each age. When we include Naming Things as an independent variable, we find that Naming Things is a significant independent predictor at age 3 ( $p=.01$ ), age 4 ( $p=.001$ ), and age 5 ( $p=.01$ ). However, when we include Naming Things, the only other significant independent predictor is syntax at age 4 ( $p=.001$ ). Since both Naming Animals and Naming Things were designed to assess lexical access ability, it is not surprising that results on these two tasks were so highly correlated. We then performed another set of multiple regression analyses, this time without including Naming Things. Receptive vocabulary was a significant independent predictor of lexical access at ages 3 ( $p=.02$ ) and 4 ( $p=.02$ ). Syntax was a significant or nearly significant independent predictor of lexical access at ages 3 ( $p=.09$ ) and 4 ( $p=.01$ ). *See Table 3* for a chart showing the significance of each independent predictor of lexical access, both when Naming Things is and is not included.

	Things	Vocabulary	Articulation	Syntax
3	✓	X	X	X
4	✓	X	X	✓
5	✓	X	X	X

	N/A	Vocabulary	Articulation	Syntax
3	N/A	✓	X	(✓)
4	N/A	✓	X	✓
5	N/A	X	X	X

Table 3: Significance of Independent Predictors of RNA

## **EXPERIMENT 2: LEXICAL ACCESS IN ADULTS**

### **METHODS**

#### **Subjects**

In order to compare the demographic and linguistic factors affecting and comprising lexical access in children with those in adults, we tested Rutgers University students on the Name Animals task and several other linguistic and non-linguistic tests. 82 students participated: 72% female ( $N=59$ ) and 28% male ( $N=24$ ). The average age of participants was 20.39 years ( $SE=.19$ , range =19-28 years). All students were monolingual speakers of English until at least age 6, with 14 becoming fluent in a second language after age 6. We did not collect any data on birthweight, and none of our subjects had been diagnosed with a language disorder or non-language learning disability. We collected some additional information not applicable to our child subjects. The average GPA was 3.32 ( $N=78$ ,  $SE=.40$ , range = 2.50-3.97). The average verbal SAT score was 598 ( $N=53$ ,  $SE=10$ , range = 470-800), math SAT score was 636 ( $N=54$ ,  $SE=10$ , range = 480-800), writing SAT was 628 ( $N=27$ ,  $SE=16$ , range = 490-780). 51 were psychology majors and 30 were not.

#### **Stimuli**

##### **Lexical Access**

This task was exactly like the child task with two exceptions. 1. Subjects wrote their answers. 2. Participants had 60 seconds instead of 30 seconds, in order to allow for the time it takes to write. The instructions on the top of the page read: *This next part will be timed. You will have 60 seconds. When I say go, I want you to write down as many animals as you can.*

### Other Linguistic Tasks

In addition to the lexical access test, students completed tests of vocabulary (synonyms and antonyms) syntax, and spelling. Since this test was given in writing instead of orally, there was no expected articulation component; therefore, we did not give an articulation test and instead gave a test of spelling.

### **Vocabulary**

For both the **synonyms** and **antonyms** tests--designed to test vocabulary--subjects were given 10 words and four multiple choice answers. They were also given the following instructions: *Two words are synonyms if they mean the same thing. For each of the following 10 words, circle the word that is the best synonym for the word in bold* and *Two words are antonyms if they have the opposite meanings of each other. For each of the following words, circle the word that is the best antonym for the word in bold.*

### **Syntax**



Subjects were presented with 16 sets of the words *plausible* and *implausible* and heard the following instructions: *I am going to play some sentences. Your job is to listen to each sentence and decide whether the sentence describes something that could plausibly happen. If you think the event described makes sense, circle the word PLAUSIBLE. If you think the event described doesn't make sense, circle the word IMPLAUSIBLE. Listen carefully because I will only play the sentences once and some of them are tricky.* The sentences used in the test were spoken by a native New Jerseyian who was unaware of the goals of the study. Each sentence contained a relative clause that was either center-embedded or right-branching. An example of a plausible sentence with a right-branching relative clause is *The thorn pricked the girl that applied the band-aid.* An example of an implausible sentence with a center-embedded relative clause is *The rug that the juice stained was spilled by the child.*

### **Spelling**

Subjects were given ten pairs of words, each containing a correctly-spelled and incorrectly-spelled version of a word. Subjects were given the following instructions: *For each of the following pairs of words, circle the word in the pair that is spelled correctly.*

## Results

### Analyses I: Demographics

Sex was not a significant predictor of lexical access ( $F(1, 77) = 2.08, p = .15$ ), with females naming a mean of 18.5 animals, and males naming a mean of 17.0 animals. See Figure. Simple regression analyses revealed that GPA ( $r = .31, p = .01$ ) is a significant predictor of lexical access ability, (*See 11*), while verbal SAT scores ( $r = .16, p = .27$ ), math SAT scores ( $r = .20, p = .16$ ), and writing SAT scores ( $r = .29, p = .15$ ) are not. Psychology students did not name significantly more animals than non-psychology majors (18.2 animals and 18.1 animals, respectively, ( $F(1, 79) = .02, p = .89$ )).

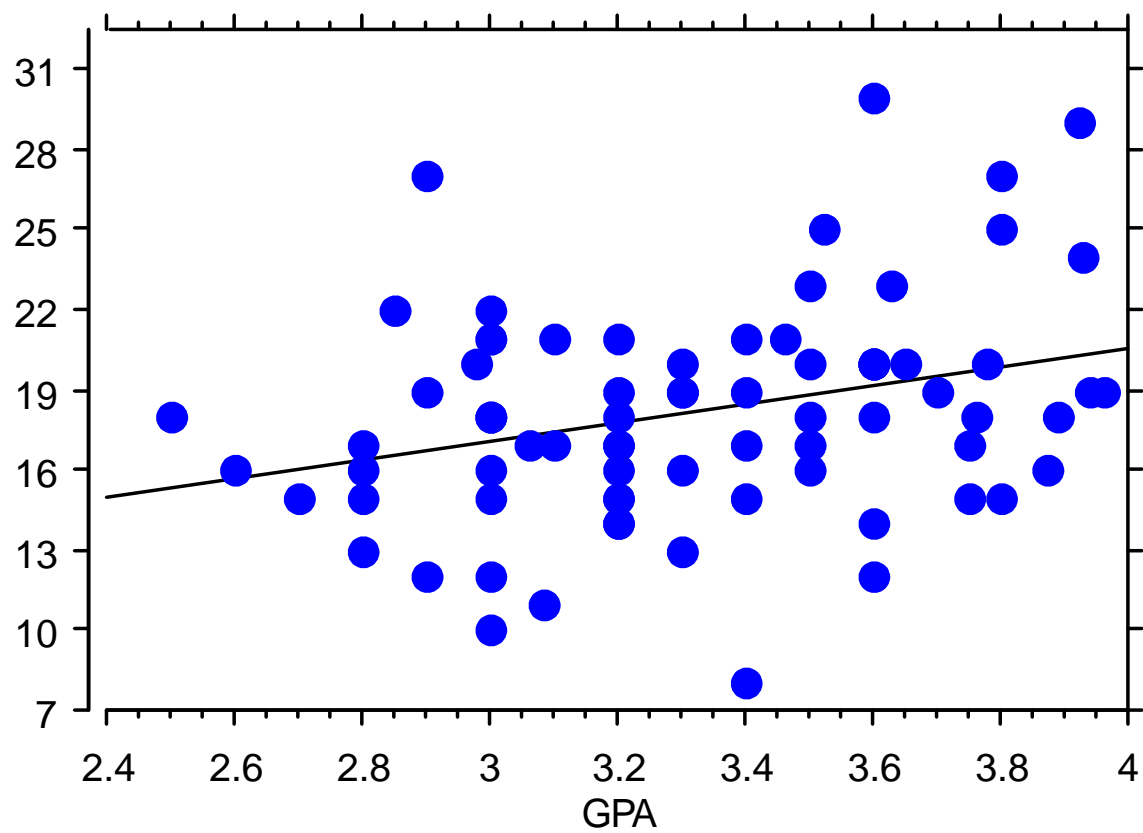


Figure 11: Simple GPA and RNA

## **Analyses II: Factors Associated with Lexical Access**

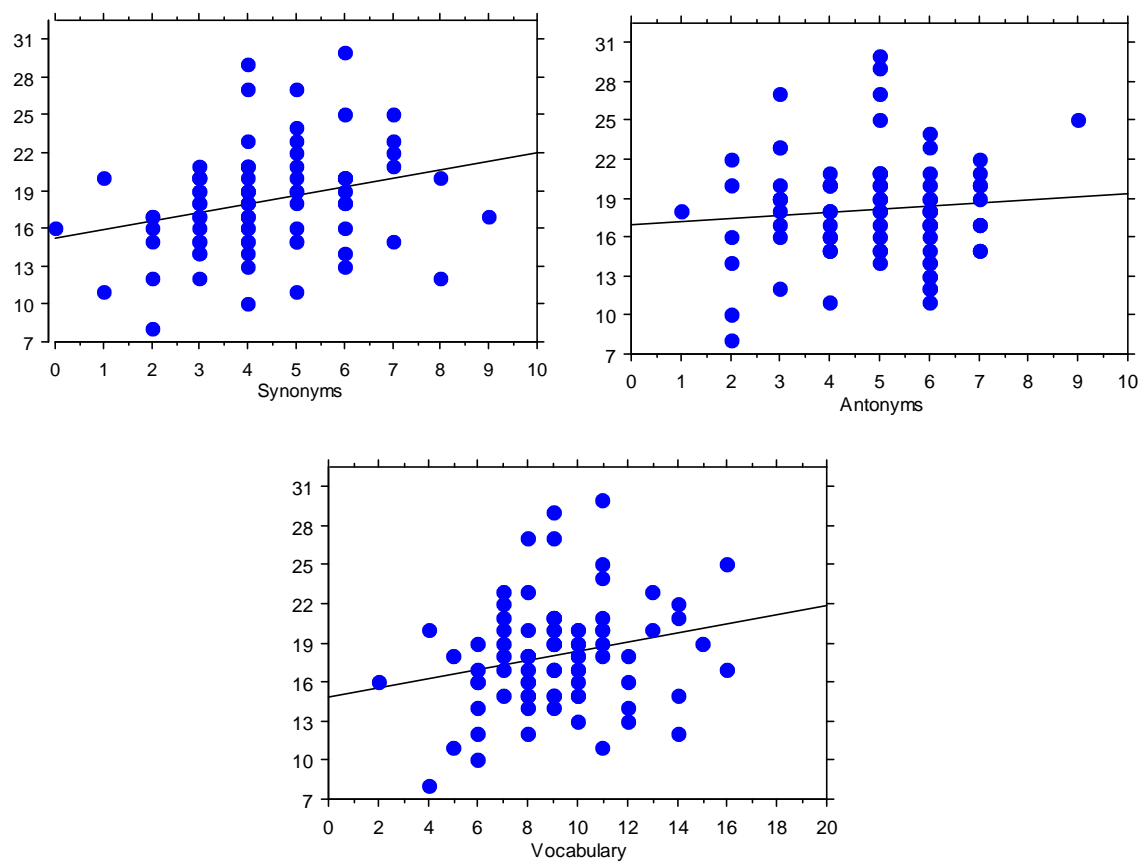
Just as we did with the children in experiment one, we performed simple regression analyses to determine what linguistic factors are associated with lexical access ability. *Table 4* shows the mean scores and standard errors for each task, as well as the maximum possible score for each task.

	<b>Animals</b>	<b>Synonyms</b>	<b>Antonyms</b>	<b>Syntax</b>	<b>Spelling</b>
<b>Mean</b>	18.11	4.31	4.88	10.79	7.45
<b>SE</b>	0.45	0.18	0.18	0.30	0.18
<b>Maximum Possible Score</b>	N/A	10	10	16	10

*Table 4: Mean scores for adult linguistic tasks*

### Simple Regressions

Simple regression analyses revealed that lexical access was moderately correlated with synonyms ( $r=.28$ ) and modestly correlated with antonyms ( $r=.10$ ). When synonym and antonym scores were combined as a vocabulary composite score, lexical access and vocabulary were modestly correlated ( $r=.23$ ). *See Figure 11.* Analyses revealed that number of animals was not correlated with syntax ( $r=-.05$ ) but that number of animals and spelling were modestly correlated ( $r=.17$ ). *See Figure 12.* A summary of all simple regression results can be found in *Table 5*.



*Figure 12: Vocabulary & RNA*

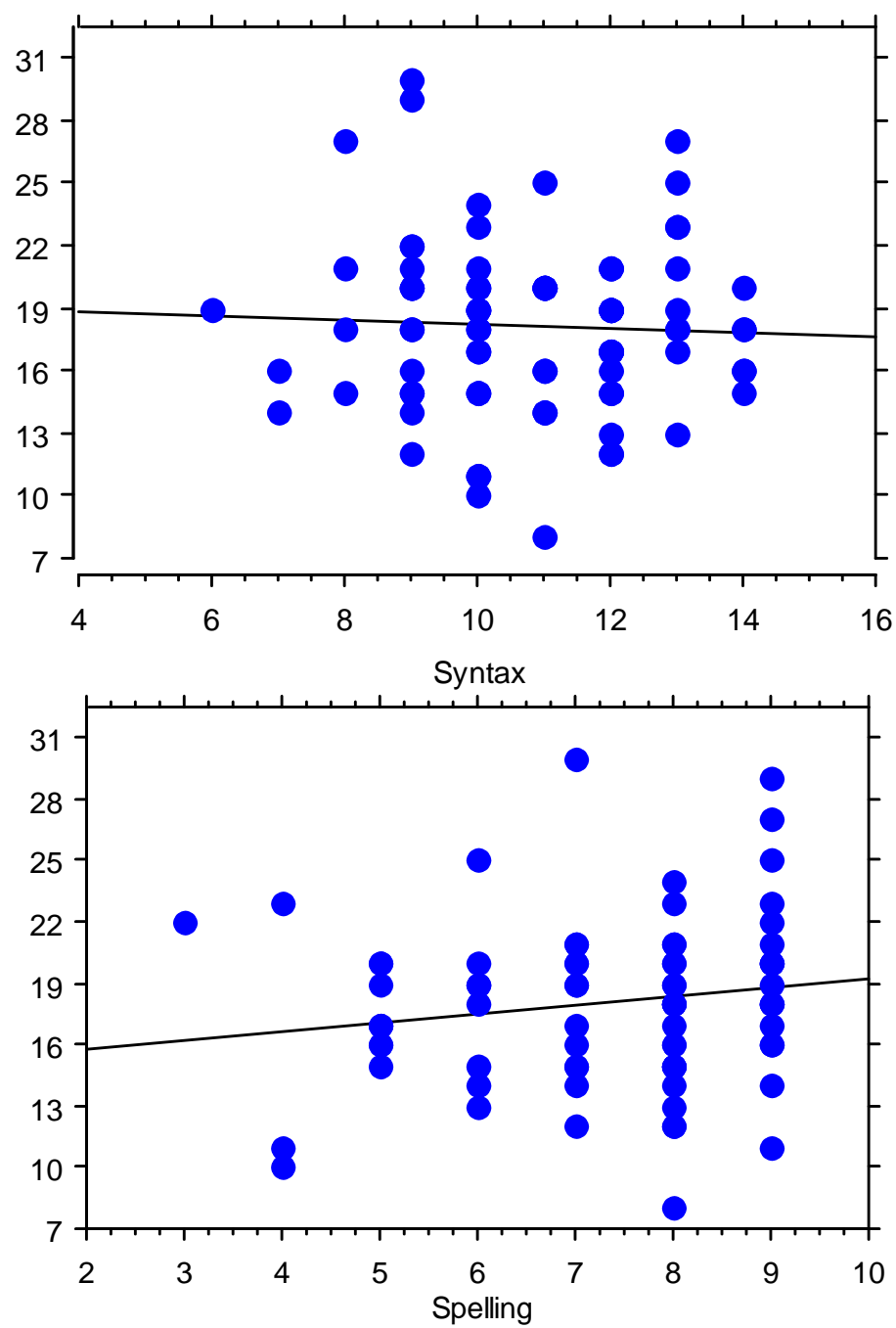


Figure 13: Syntax and RNA & Spelling & RNA



	<b>Synonyms</b>	<b>Antonyms</b>	<b>Vocabulary</b>	<b>Syntax</b>	<b>Spelling</b>
<b>Animals</b>	$r=.28, p=.01$	$r=.10, p=.39$	$r=.23, p=.04$	$r=-.05, p=.68$	$r=.17, p=.14$

*Table 5: Simple Correlations*

### **Multiple Regressions**

When we performed a multiple regression analysis using composite vocabulary, syntax, and spelling as the independent variables, none of these appeared as significant independent predictors of lexical access. However, when breaking up vocabulary into synonyms and antonyms, synonyms ( $p=.02$ ) was a significant independent predictor of lexical access. A summary of all multiple regression results, both with vocabulary included as a composite score and with vocabulary broken up into synonyms and antonyms, can be found in *Table 6*.

	Vocabulary (Synonyms Antonyms)	& Syntax	Spelling
Animals	X	X	X

	Synonyms	Antonyms	Syntax	Spelling
Animals	✓	X	X	X

Table 6: Multiple regression results

### **EXPERIMENTS 3 & 4**

Whereas previous analyses looked at factors that affect number of animals named and associated linguistic factors, these previous analyses did not address the question of how lexical access is performed. To address this question, we analyzed patterns in order of animals named. Our goal was to look at whether subjects in our rapid naming tasks in Experiment 1 & 2 were consecutively naming animals that have the same semantic features at a level above chance, which would suggest that the lexicon is organized around a semantic hierarchy, with intermediary features between ANIMAL and each individual animal. However, in order to determine whether subjects were using the same features consecutively, we needed to know what these features are. And of course, if we knew what these features were, then this wouldn't be a research question at all.

In order to circumvent this problem, in Experiment 3 we used a categorization task in which a separate group of subjects gave us our list of features. Then, in Experiment 4, we used these explicit features to analyze the order of animals named in our rapid naming tasks.

## EXPERIMENT 3: EXPLICIT CATEGORIZATION TASK

### METHODS

#### Subjects

The Categorization Task subjects included 71 Rutgers University undergraduates, all adult monolingual speakers of English. These participants were not aware of the Rapid Naming of Animals task.

#### Stimuli

We found the twenty most frequently named animals provided by the Rapid Naming of Animals group. The Categorization group saw the following instructions:

*Consider the following list of animals:*

*deer, tiger, lizard, elephant, dog, cat, zebra, squirrel, snake, fish, bird, monkey,*

*lion, bear, giraffe, mouse, horse, cow, pig, hamster*

*Please make up categories in which you could group these animals. Make a list of these categories, and write the appropriate animals next to each category, using only the animals on this list. You can write an animal in more than one category.*

***THERE IS NO RIGHT OR WRONG ANSWER.***

By random assignment, half of the group saw the list of animals in the order shown, and half of the group saw the list in reverse order. Note that we gave no indication of what types of categories to use, the number of categories to use, or the size of the categories.

## Results

The 71 subjects cumulatively produced 45 distinct categories<sup>3</sup>. *Figure 14* shows a histogram of the distribution of the number of subjects who produced a given category. Twenty-three of the categories were produced by only one subject, but this means that there was a great deal of overlap among subjects. Twenty-two categories were produced by more than one subject, and in fact, 12 categories were produced by 10 or more subjects. Of these 12 categories, 5 were biological in nature (MAMMAL, REPTILE, CARNIVORE, HERBIVORE, QUADRUPED); 4 were based on location (AFRICA, FARM, WATER, PET), and 3 were arguably more primitive (WILD, SCARY, LARGE).

Recall that we did not specify which sorts of categories to use. However, nearly all of our subjects used semantic categories. Only one subject used orthographic categories (NUMBER OF VOWELS), and one subject used a grammatical/phonological category (animals that SOUND THE SAME SINGULAR OR PLURAL, e.g. *fish* and *deer*). Although speech errors suggest that people might categorize items phonologically, not one subject used truly phonological categories.

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<sup>3</sup> We combined category names that seemed essentially the same, e.g. *big* and *large* or *quadruped* and *4 legged*

For example, subjects could have categorized animals by onsets, number of syllables, stress patterns, and so on.

Subjects also did not use overt perceptual categories. For example, no subject used color to categorize animals. From a perceptual science perspective, this is quite surprising, since color is extremely perceptually salient. Additionally, no subject used smell as a category. Only one subject used sound (DISTINCT SOUND) and even this category is too broad to be perceptually-based.

Experiment 3 suggests that in terms of explicit categorization, people use semantic features.

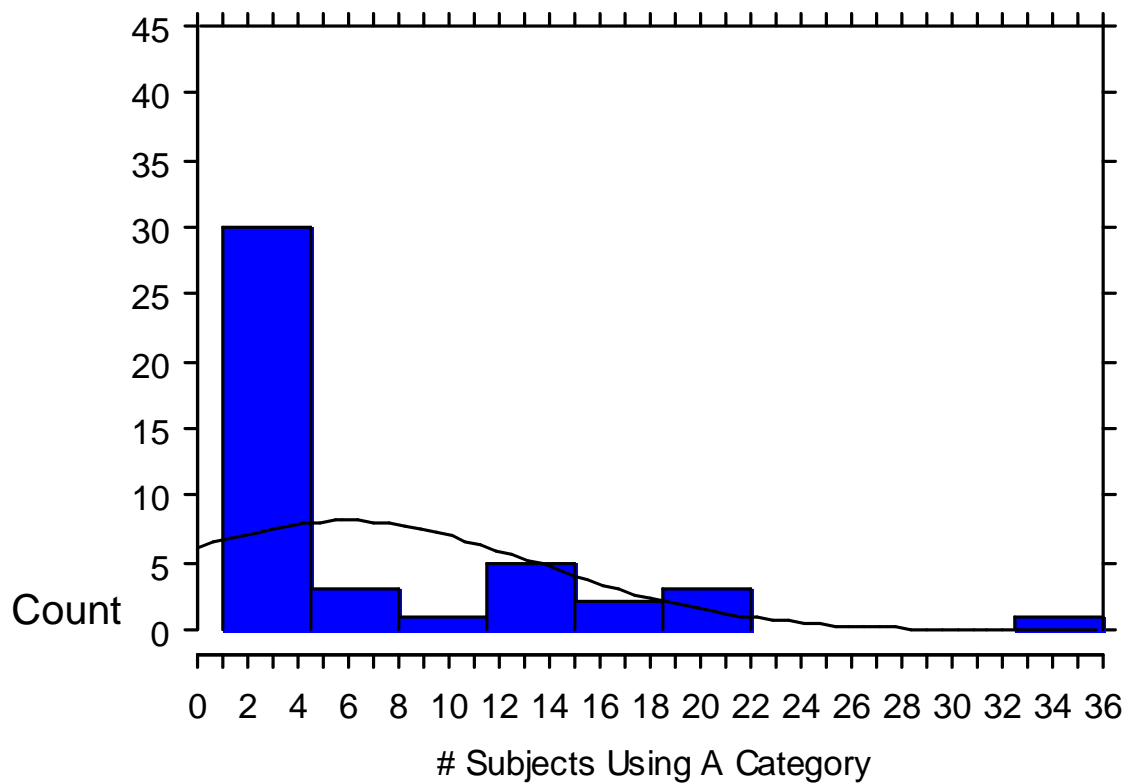


Figure 14: Histogram of Distribution of Categories



## **EXPERIMENT 4A: LEXICAL REPRESENTATION IN ADULTS**

### **Subjects**

The subjects were the same adults as in Experiment 2

### **Procedure**

We looked at the categories provided by subject in Experiment 3 and eliminated any categories provided by less than 2 subjects<sup>4</sup>. We used these categories as a set of binary features (e.g. 1 for + MAMMAL, 0 for – MAMMAL) corresponding to each animal named by the RNA group. The result was a list of 1's and 0's corresponding to each animal name.

Next, we substituted each animal in each RNA subject's list for a list of features (represented by 1's and 0's). We then counted the number of consecutive 1's for each feature for each subject. By definition, a subject who was using semantic clustering—consecutively naming several animals containing a given feature—would have more consecutive 1's for that feature than a subject who was not using semantic clustering. To test whether our subjects were using semantic clustering, we randomized each subject's list of animals and substituted these for feature lists. We repeated this process 1000 times and determined the mean number of consecutive 1's for each feature for each subject. We then compared the number of consecutive 1's in each actual list to the number of consecutive 1's in each corresponding averaged randomized list.

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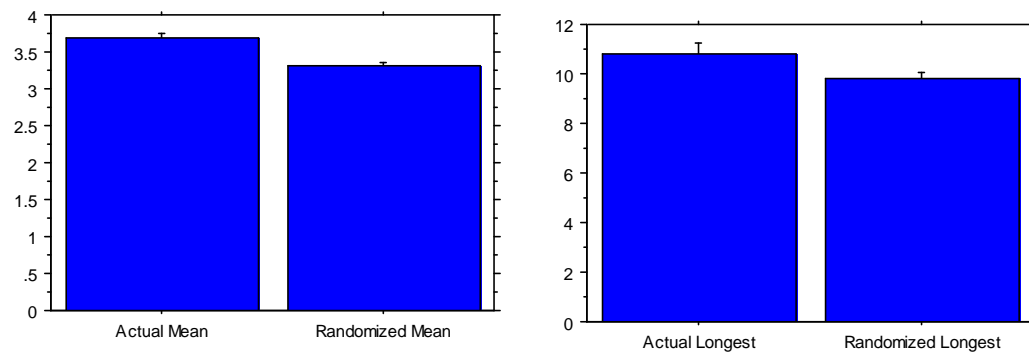
<sup>4</sup> Although CANINE was only provided by one subject in the Categorization task, it appeared that some subjects might have been using this category, so we included CANINE in our Experiment 4 analyses. Doing so did not affect the results for the other features.

## Analyses

We defined cluster size as the number of consecutive 1's for a single feature for a single subject. We performed several t tests comparing actual subject clusters and randomized subject clusters.

## Results

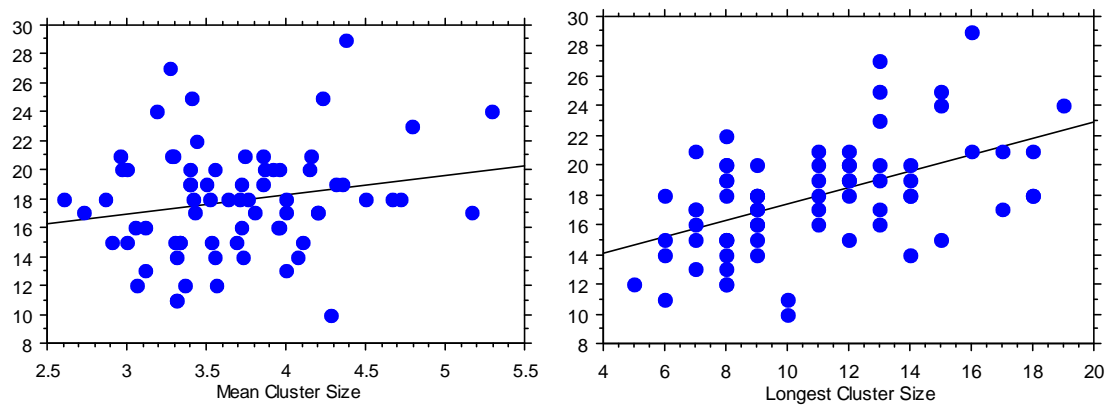
Firstly, the mean cluster size for actual trials was 3.7 (range=2.6-5.3). The mean cluster size for the randomized trials was 3.3 (range=2.8-.4.0). A paired t-test indicated a significant difference between actual mean cluster size and randomized mean cluster size ( $p=.001$ ,  $t=5.7$ ). Secondly, we found the longest cluster size for each subject. The mean longest cluster size for actual trials was 10.8 (range=5-19). The mean longest cluster size for randomized trials was 9.8 (range=6-18). A paired t-test indicated a significant difference between actual mean longest cluster size and randomized mean longest cluster size ( $p=.001$ ,  $t=3.5$ ). *See Figure 15.*



*Figure 15: Actual and Randomized Feature Clusters for Adults*

**Effect of using clustering on number of animals named**

We tested the effect of using clustering on number of animals named by individual subjects. The mean number of animals named by adults was 17.85 (range 10-29). Once again, we compared the number of animals named by an individual subject to that subject's mean cluster size ( $r=.20$ ,  $p=.10$ ) and the subject's longest cluster size ( $r=.52$ ,  $p=.001$ ). *See Figure 16.*



*Figure 16: Correlation Clustering & Number Animals Named*

### **Clustering of Individual Semantic Features**

The previous results show that adults do use semantic features in accessing lexical items; however, they do not show whether adults use all features equally or some more than others. To address this question, we used t-tests to compare the amount of clustering used for a given feature on actual verses randomized lists. We compared clustering in 2 ways: mean of each subject's mean cluster size for each given feature and mean of each subject's longest cluster size for each given feature.

We then used Cohen's  $d$  as a measure of effect size. Our two methods of analyzing clustering yielded nearly identical results. *See Table 6.* Using mean of each subject's mean cluster size, we determined that 2 features had a large effect size ( $d \geq .8$ : WILD, LARGE); 7 features had a moderate effect size ( $d < .8 - \geq .5$ : PET, FELINE, AFRICA, RODENT, SCARY, FAR, FOOD, REPTILE); 11 features had a modest effect size ( $d < .5 - \geq .2$ : REPTILE, DISGUSTING, APE, WATER, CARNIVORE, INSECT, BACKYARD, TRANSPORT, HERBIVORE, MAMMAL, BIRD); 4 features had no effect size ( $d < .2$ : QUADRUPED, FLIES, CANINE, CIRCUS).

	Cluster Size	Longest Cluster
wild***	0.9	0.77
large***	0.86	0.72
pet***	0.79	0.77
feline***	0.78	0.71
Africa***	0.74	0.73
rodent***	0.61	0.5
scary***	0.58	0.7
farm***	0.57	0.54
food***	0.5	0.57
disgusting***	0.49	0.31
reptile**	0.49	0.36
ape**	0.48	0.28
water***	0.47	0.53
carnivore**	0.37	0.32
insect*	0.36	0.18
backyard**	0.3	0.28
transport*	0.29	0.17
herbivore*	0.28	0.21
mammal	0.2	0.32
bird	0.2	0.32
quadruped	0.19	0.31
flies	0.07	0.18
canine	0.05	0.08
circus	0.04	0

Red = large effect size  
Blue = medium effect size  
Green = small effect size  
Black = no effect size

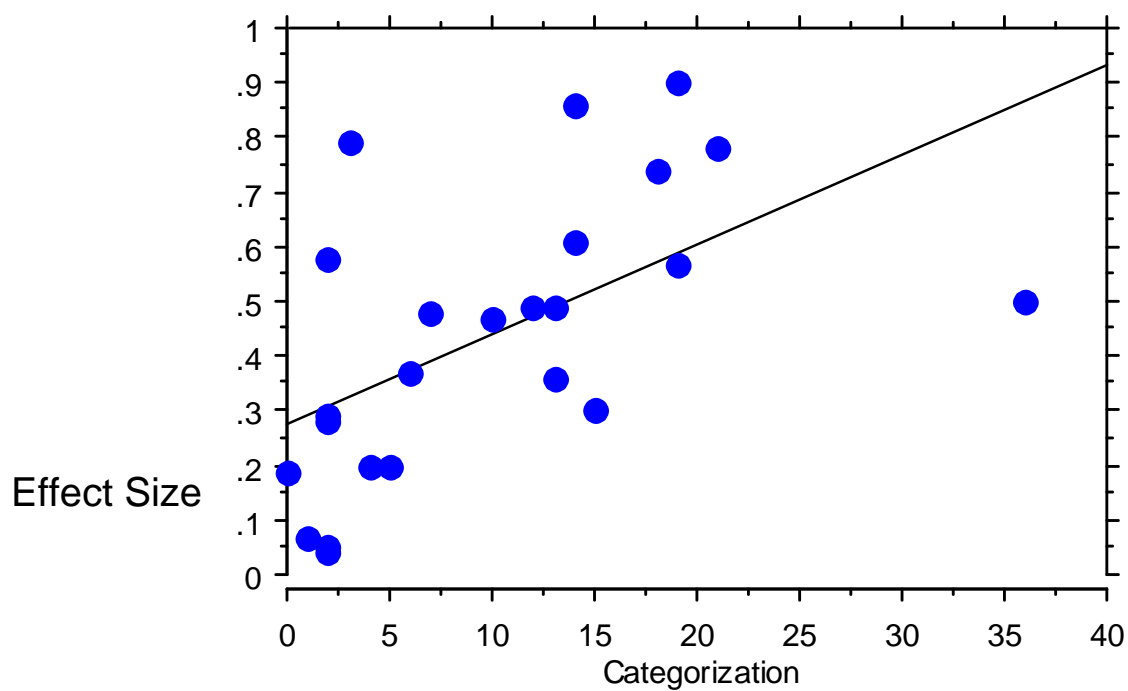
\*\*\*  $p=.001$   
\*\*  $p=.01$   
\*  $p=.05$

Table 6: Effect size of Individual Features

### **Correlation between features explicitly named and features implicitly used**

In order to determine the overlap between how much a feature is used in an explicit categorization task verses an implicit naming task, we performed a simple correlation between the number of times a category was named in the Categorization task and that feature's effect size in the adult RNA. As shown in *Figure 17*, we found that the two were highly correlated, ( $r=.56$ ,  $p=.01$ ). In *Table 7*, we show the number of people who used a feature in the Categorization Task and the instances of a feature cluster in the RNA.





*Figure 17: Correlation Naming of Features in Categorization Task and Use of Features in RNA*

<b>Features</b>	<b>Categorization</b>	<b>Rapid Naming</b>
mammal	19	113
reptile	14	12
bird	3	24
wild	21	101
farm	18	14
scary	14	57
disgusting	2	27
large	19	78
pet	36	36
herb	12	112
carnivore	13	118
flies	7	26
quadruped	10	110
food	6	24
water	13	34
Africa	15	26
circus	2	9
backyard	2	34
rodent	5	15
feline	4	18
insect <sup>5</sup>	0	9
canine	1	11
ape	2	9
transport	2	11

*Table 7: Colum 2 shows number of people who used a feature in the Categorization Task. Column 3 shows instances of a feature cluster in the Rapid Naming Task*

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<sup>5</sup> INSECT was not provided by the Categorization group. However, this group only saw the top 20 most named animals, which did not include multiple insects, so it would not have been possible for them to include these features. It did appear that some subjects in the RNA were using these features, so we included them to see how much they were used.

## EXPERIMENT 4B: LEXICAL REPRESENTATION IN CHILDREN

### Methods:

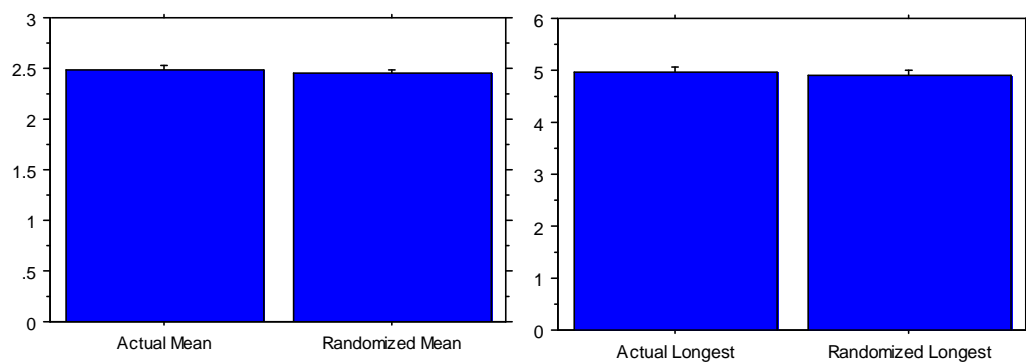
The methods were identical to those in Experiment 3, except we compared the features from the categorization task to those used in the children's rapid naming task. We included the 375 children from the PEGI study (described in Experiment 1) who had completed the rapid naming task. There were 182 three year olds, 102 four year olds, and 91 five year olds. For children who completed the task at more than one age, we only included their results at last administration. We included the results of all children who named three or more animals.

### Results:

The mean cluster size for actual trials was 2.49 (range=0-4.86). The mean cluster size for the randomized trials was 2.46 (range=.53-3.99). A paired t-test indicated there was no significant difference between actual mean cluster size and randomized mean cluster size ( $p=.33$ ,  $t=.97$ ). *See Figure 18*. More specifically, there was no significant difference for any age group: three year olds ( $p=.22$ ,  $t=1.22$ ), four year olds ( $p=.90$ ,  $t=-.13$ ), or five year olds ( $p=.83$ ,  $t=.21$ ).

The mean longest cluster size for actual trials was 4.97 (range=2-13). The mean longest cluster size for randomized trials was 4.91 (range=2-12). A paired t-test indicated there was no significant difference between actual mean longest cluster size and randomized mean longest cluster size ( $p=.13$ ,  $t=2.29$ ). *See Figure 18*. Furthermore, there was no significant difference at any age: three ( $p=.93$ ,  $t=-.08$ ),

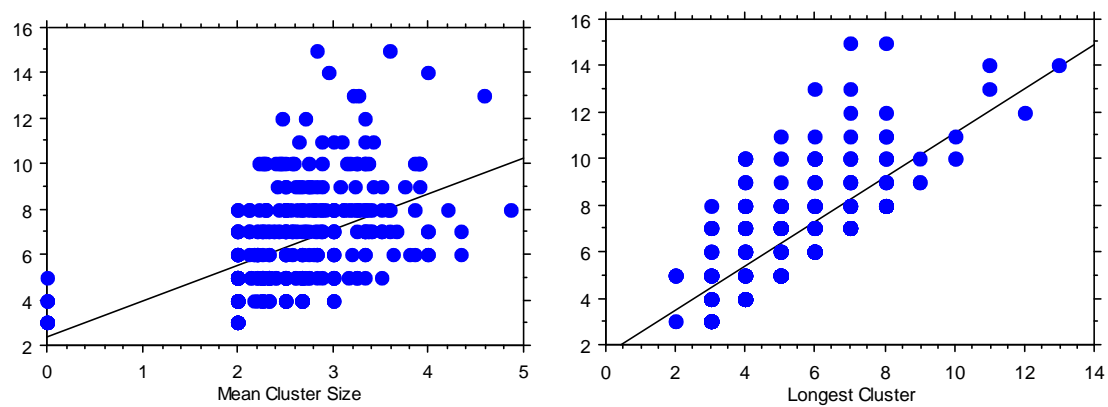
four ( $p=.41$ ,  $t=.83$ ), or five ( $p=.11$ ,  $t=1.60$ ).



*Figure 18: Actual and Randomized Feature Clusters for Children*

**Effect of using clustering on number of animals named**

We tested the effect of using clustering on number of animals named by individual subjects. The mean number of animals named by children was 6.29 (range 3-15). Once again, we compared the number of animals named by an individual subject to that subject's mean cluster size ( $r=.55, p<.001$ ) and the subject's longest cluster size ( $r=.71, p=.001$ ). *See Figure 19*. These results indicate that although children overall are not using semantic clustering, the children who do use semantic clustering name significantly more animals than those don't. These results present further evidence that using semantic clustering aids in efficient lexical access.



*Figure 19: Correlation Clustering and Number Animals Named*

**Effect size of individual features**

We compared actual verses randomized lists in two ways: mean of each subject's mean cluster size and mean of each subject's longest cluster size, and found that no feature had an effect size for the children. *See Table 8.* This finding is not surprising given that it did not appear that the children were using clustering overall.



	<b>Cluster Size (d)</b>	<b>Longest Cluster (d)</b>
<b>wild</b>	0.11	0.03
<b>large</b>	0.04	0.02
<b>pet</b>	0.04	0.03
<b>feline</b>	0.03	0.02
<b>Africa</b>	0.1	0.07
<b>rodent</b>	0	0
<b>scary</b>	0.05	0.11
<b>farm</b>	0.13	0.11
<b>food</b>	0.03	0.08
<b>reptile</b>	0.06	0.02
<b>disgusting</b>	0.11	0.13
<b>ape</b>	0.14	0.03
<b>water</b>	0.05	0.03
<b>carnivore</b>	0	0.07
<b>insect</b>	-0.18	0.02
<b>backyard</b>	-0.1	0.04
<b>transport</b>	-0.05	-0.02
<b>herbivore</b>	0.08	0.04
<b>mammal</b>	0.09	0
<b>bird</b>	0.15	0.06
<b>quadruped</b>	0.17	0.05
<b>flies</b>	0.09	0.07
<b>canine</b>	0.01	0

Black indicates no features had  
an effect size

All  $p$ 's > .05

*Table 8: Effect Size of Features for Children*

### **Correlation between Features Explicitly Named and Features Implicitly Used**

Not surprisingly, since the children were not using features, there was no correlation between the categories named by the adults in the Categorization task and the amount these features were used by the children in the RNA ( $r=.09$ ,  $p=.69$ ). See *Figure 20*.

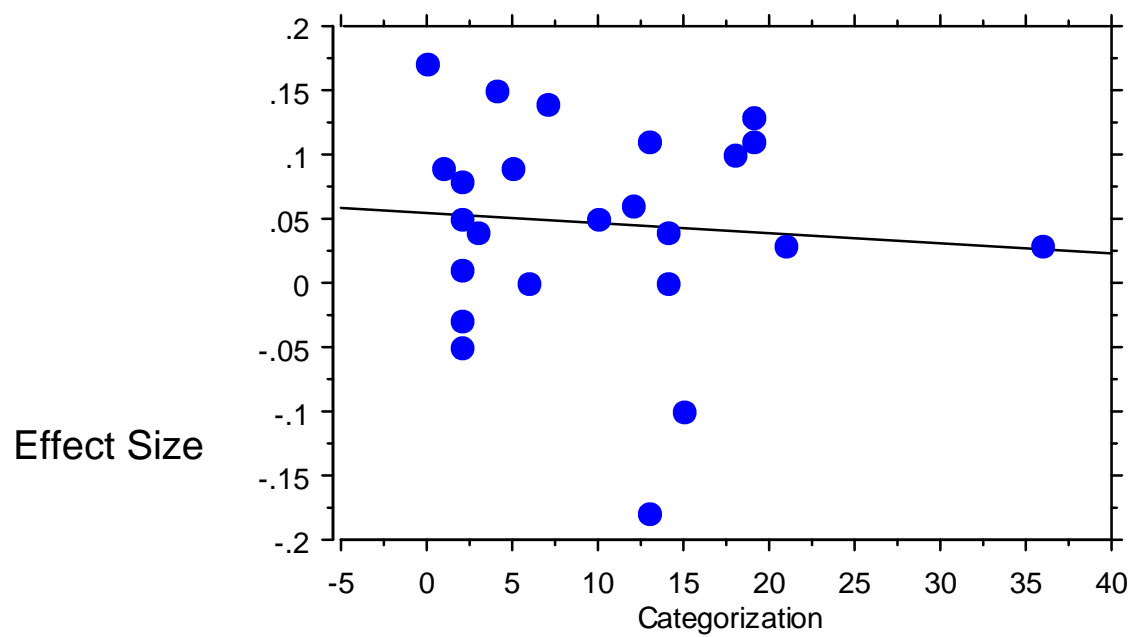
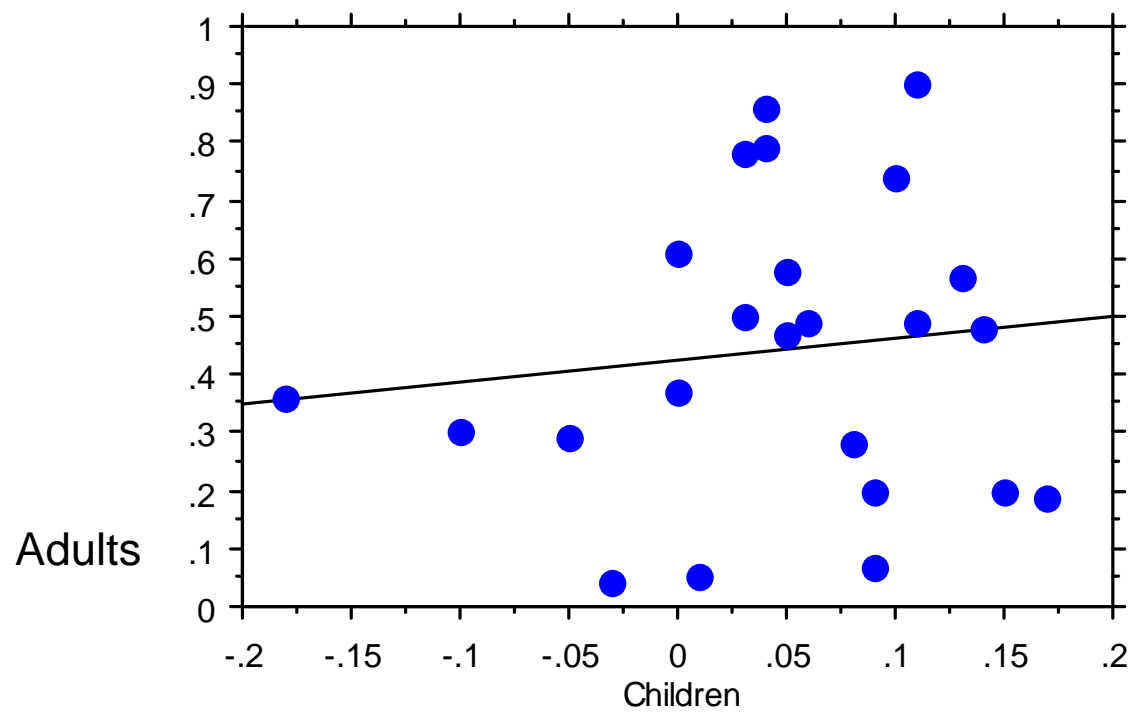


Figure 20: *Correlation Naming of Features in Categorization Task and Use of Features in RNA*

**Correlation between Features Used By Adults and Children**

There was a very small, statistically non-significant correlation between the effect sizes of the features used by the adults and the children in the RNA ( $r=.12$ ,  $p=.57$ ), shown in *Figure 21*.



*Figure 21: Correlation Adult & Child Features in RNA*

## VII. DISCUSSION

**Demographic Factors:** We investigated the role of demographic factors in predicting performance on the RNA, our main test of lexical access ability. We found that children born at an extremely low birthweight named fewer animals than all other children. This result is consistent with previous findings that prematurity is highly correlated with birthweight, and that the negative effects of low birthweight persist into middle childhood (Barlow & Lewandowski, 2000, Luoma et al., 1998). Secondly, as expected from previous studies (Weckerly, Wulfeck & Reilley, 2001) we found that children who had received speech or language therapy (a proxy for having a speech or language disorder) named fewer animals than children with normal language abilities.

Studies on gender effects on children's language development have yielded conflicting results, with some studies finding no sex differences (Hyde, 2005) and others finding that girls are linguistically precocious compared to boys (Bornstein, Hahn & Haynes, 2004, Wolf & Gow, 1985-86). Although the girls in our study did name more animals than the boys, the difference was not significant. Why didn't we find an effect of sex? One explanation is that there is a sex effect for lexical retrieval, but our test is not sensitive enough to detect it. A second possible explanation is that we assessed lexical access, whereas studies that have shown a sex effect assessed vocabulary. In other words, it is possible that there is a sex effect for vocabulary size, but not for the ability to access vocabulary items from the lexicon. The fact that the girls in our study did not do significantly better than the boys on our receptive vocabulary tests suggests that this is not the correct explanation. A third possible

explanation for our not having found a sex effect for lexical retrieval is that most studies that have found gender effects on vocabulary have used parent-completed vocabulary checklists such as the MacArthur Inventory for which parents check the words that they think their children know. Since the idea that there are sex differences for language (“women are verbal, men are mathematical”) is so ingrained in our culture, it is possible that parents unconsciously inflate the number of words their daughters say and underreport the number of words their sons use. Our data may be less susceptible to such a bias because it is derived from a test. Our failure to find a significant effect of sex on either the lexical access or receptive vocabulary test is consistent with this third account.

Just as among the children, among the adults, neither sex named more animals. As is the case for the children, it could be that the reason we didn’t find a sex effect is that there are no sex differences for lexical retrieval; that our test is not sensitive enough; or that our test is less susceptible to unconscious bias. The fact that we found no significant sex effect for either adults’ lexical retrieval or vocabulary is consistent with this last account.

We found that college students who are doing well academically have higher lexical access abilities, but that SAT score--verbal, math, and composite--was not correlated with number of animals named. Additionally, college major was not a significant predictor of number of animals named. It is possible that the reason GPA and number of animals named was correlated was because highly motivated and focused students are more likely to earn high grades and also to take the lexical

access task seriously. It is also possible that the same skills necessary for academic success are necessary for success on the RNA.

**Developmental Factors:** Our studies also shed light on the development of lexical access abilities. Our study reveals that the ability to retrieve lexical items improves with age: adults named more animals than five year olds, who named more animals than four year olds, who named more animals than three year olds. These two findings-- that children's lexical access ability at one age is a good predictor of lexical access ability, and that age is an important factor in lexical retrieval—are consistent.

Children's scores on our two tests of lexical access--RNA and Naming Things--were highly correlated, which lends support to the validity of the RNA test as a measure of lexical access skill. The correlation between RNA and Naming Things scores is notable because there are some major differences between the two tasks. For RNA, subjects had the opportunity to self-prime. For example, they could consecutively name several animals with the same semantic feature (e.g. name multiple pets), phonological similarity (e.g. those beginning with /k/), those that were associated (e.g. lion, tiger, bear), or those that are very frequent. For Naming Things, self-priming was far less likely. Semantic and associative self-priming would have been extremely difficult for Naming Things, because subjects were only asked to name one item from each category. Phonological self-priming was less likely for Naming Things, because subjects heard a new question after each item named, breaking up the phonological flow. Despite these differences, the high correlation



between tasks is not surprising. Both measure the ability to access lexical items efficiently.

**Associated Linguistic Skills:** For three and four year olds, vocabulary and syntax were significant independent predictors of lexical access ability, as measured by number of animals named. For five year olds, there were no significant independent predictors of performance on the RNA test. One possible explanation for why performance on receptive vocabulary and lexical retrieval are related at younger ages but not older ages is that vocabulary size only plays an important role when vocabulary size is so small that it is a limiting factor. If a three year old child only knows the names of three animals, he or she only has three animals to access, and so vocabulary size and lexical access ability will be highly correlated. However, for a five year old who knows the names of perhaps thirty animals, vocabulary size might have less of an effect on lexical access ability. In terms of syntax, there were animals used in the syntax task. Although all children were prescreened to make sure they could recognize and name all of the animals used in the syntax task, it is possible that some of the younger children's knowledge of the animal names was somewhat tenuous and they had difficulty retrieving animal names from their lexicon during the experiment. If so, this would account for the correlation between syntax and RNA in the younger children.

It is noteworthy that articulation was not a significant predictor of number of animals named at any age. This is somewhat surprising as one might expect that children who had poorer articulatory skills would say words more slowly and hence would name fewer animals on the RNA test. Additionally, it could have been the case

that children with particularly high scores on the articulation task would have used this skill towards phonological self-priming in the RNA, as suggested by previous studies supporting the existence of phonological priming (Slowiaczek & Hamburger, 1992). The lack of correlation between articulation and RNA scores suggests that lexical access and articulation are distinct abilities, and suggests that articulatory ability neither hinders nor aids children on the RNA task.

For adults, simple regression analyses revealed that the only language test scores that were significantly correlated with number of animals named was synonym test scores and vocabulary test scores (which was the sum of synonym and antonym scores). Furthermore, multiple regression analyses revealed that the only independent predictor of number of animals named was score on the synonyms test. Taken together, the simple and multiple regression analyses indicate that lexical access ability is related to size of the lexicon. Even though one could argue that the RNA test has a hierarchical component (as is suggested by the fact that there was feature clustering) and syntax is inherently hierarchical, RNA and syntactic performance were functionally independent. As discussed in the Introduction, some studies suggest that there are phonological and orthographic routes to lexical access. Thus, it is conceivable that, in the RNA test, adults could have used some sort of orthographic self-priming (e.g., with *giraffe* priming *goat*). If they had done so, we might have predicted spelling scores to correlate with RNA scores. The fact that we did not find this suggests that spelling is functionally independent of RNA, and people did not orthographically self-prime.

A priori, one would expect that knowledge of both synonyms and antonyms would be equivalently good, reasonable measures of vocabulary size. Why then were RNA scores correlated with performance on the synonym test but not the antonym test? One possibility is that the synonym test was simply a better test of vocabulary size. Although we cannot rule out this possibility the fact that the mean scores and standard errors of the synonym and antonym tests were virtually identical reassures us that there wasn't a ceiling or floor effect on the antonym test. Another possibility is that the extra task demand of determining a given word's opposite meaning added noise to the antonym scores and this depressed the antonym-RNA correlation. A third possibility is that because negation is a syntactic operation, perhaps our antonym measure conflates both syntactic and vocabulary skills and, hence, antonym scores are not as good a measure of "pure" vocabulary size. Contrary to this account, antonym scores and syntax scores were not correlated ( $r=.04$ ,  $p=.71$ ).

**Explicit Categorization Task:** In the second half of the paper we looked at semantic clustering. First we looked at features provided by subjects in the Categorization Task. Here we found that subjects almost exclusively provided semantic features, and no subjects provided truly phonological or perceptual categories. Subjects also did not suggest HIGHLY ASSOCIATED as a category. This suggests that at least in explicit categorization, people almost exclusively use semantic features. We also found that there was a great deal of overlap in the features provided. In other words, overall, subjects seemed to agree about which features were

important for categorization. This last finding has implications for understanding the degree to which individual's conceptual representations vary.

**Clustering Analyses:** Unlike in many previous studies in which it was impossible to distinguish between semantic and associative relationships (Meyer and Schvanevelt, 1971 Brown, 1960, Entwisle, 1966), we were able to focus on semantic rather than associative relations because we limited the domain to animals, eliminating all but a few associations (e.g. *dog* and *cat* and *lion* and *tiger*.) Most notably we determined that adults semantically cluster while children do not. There are two possibilities for why children might have behaved differently than adults. The first is that children might truly lack a semantically-organized lexicon. Adults seem to have an ANIMAL superordinate category subcategorized by semantic features (previously argued by Federmeier & Kutus, 1999), and children might not have subcategories.

A second possibility is that children might have a semantically-organized lexicon, but their lexicons might be organized around non-adult features. Recall that only adults completed the categorization task from which we drew our features. In the future, we would like to provide children with the opportunity to come up with categories, in order to see whether children are different than adults, both in terms of the categories they come up with in an explicit categorization task and to see whether they are using features in the rapid naming task.

Our finding that adults semantically cluster has implications for the debate about what counts as a semantic primitive: whole concept (e.g. *dog*) or features (e.g. *furry*). If each type of animal counted as a semantic primitive, as argued by Jerry

Fodor (2004), then in a given set of animals, the order of naming should have been completely random, which it was not. There is a possibility that subjects were not using features per se but rather, were naming animals that often appear together. However, firstly, if the animals that often appear together are those that share semantic features, then in a sense, this is still evidence in favor of the existence of semantic features; it just means that the co-occurrence of certain animal names exists both in the real world and in our study. Secondly, adult subjects named, on average, 18 animals. It is unlikely that subjects had mentally stored the relative co-occurrence frequencies for each pair of animals they named consecutively. Therefore, it truly does seem that adults use features, and that these features are semantic primitives.

**Which Features Were Important?** In terms of the adults, we have found that although there is a high correlation between the features named in the categorization task and the effect size of features used in the RNA, the features used in the RNA are somewhat surprising. People appear not to be relying on biological categories (e.g. MAMMAL, BIRD) nor on purely functional categories (e.g. TRANSPORT, CIRCUS) but rather on more of an instinctive reaction. WILD, LARGE, AND PET were the features most used. In terms of survival, it does seem of the utmost importance to know that that large, wild thing over there is a wolf, and this small pet thing over here is a dog.

It is especially surprising that children did not use the features given by adults in the categorization task because the features given are formally learned. If adults had primarily used biological, geographical, or functional categories, it would not be

at all surprising that children did not use these features, since many pre-school children will not yet have been exposed to this knowledge. However, SCARY and LARGE are exactly the types of features we would expect even a young child to possess, and most pre-school children know which animals are typical pets. It would be interesting to know whether children do explicitly classify certain animals as SCARY, LARGE, or PET even though these are not features children are using implicitly.

In terms of the adults, because there are so many possible semantic features, further studies will need to be conducted to pinpoint exactly which features manage lexical representations and how these features work to aid in lexical access. Two possibilities we did not account for are effects of frequency and recency in naming animals. In future analyses, we would like to use corpora to determine the correlation between the frequencies of animals in corpora verses in our study.

**Future Studies:** As described earlier, subjects did not use phonological categories in the explicit categorization task. We have not yet analyzed our RNA data to see whether subjects are using phonological features to self-prime. Semanticists do not have any agreed upon semantic features, so it was necessary to use the semantic features provided by subjects in the explicit categorization task. In contrast, phonologists have several generally accepted methods for classifying sounds.

Firstly, since there are priming studies suggesting that people can be primed by the first phoneme of a word (Slowiaczek & Hamburger, 1992), we could use initial phoneme as a “feature” (e.g. *kangaroo* and *cougar* both begin with /k/). Secondly we

could use articulatory features such as voicing, manner of articulation, and place of articulation. In terms of manner and place of articulation, we could look at each feature categorically or we could look at these features on a gradient, looking, for example, at increased sonorance for manner of articulation or at the inherent ordering from the front to the back of the oral tract for place of articulation. We could also look at suprasegmental phonological factors such as number of syllables and stress.

We plan to use these phonological features to analyze our RNA data in the same way as we analyzed this data to look for semantic features. Similarly, we could look at orthographic—spelling—based runs to see whether adults use these features. Thirdly, we would like to record subjects completing the RNA auditorily and measure the pauses between their words to see whether these pauses correlate with the beginning of new feature clusters, both semantic and phonological.

As mentioned earlier, we would like to have children complete an explicit categorization task both to look at those results directly and also to see whether children are using these non-adult features in the RNA. Finally, neuroimaging is a relatively new method for looking at semantic organization in the brain (Cato, Moore, and Crosson, 2001). We would like to use data collected from neuroimaging studies to see how closely our methods and neuroimaging methods reach similar findings. Future analyses aside, this technique has been successful at beginning to illuminate the great mystery that is lexical representation and access.

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## APPENDIX: ADULT & CHILD TESTS

Major \_\_\_\_\_

SAT Scores: Verbal \_\_\_\_\_ Math \_\_\_\_\_ Writing \_\_\_\_\_

GPA: Overall \_\_\_\_\_ Major \_\_\_\_\_

Expository English grade: \_\_\_\_\_

Mono or bilingual? Monolingual \_\_\_\_\_ Bilingual \_\_\_\_\_

Native speaker of English? Yes \_\_\_\_\_ No \_\_\_\_\_

If English is your second language:

What is your first language? \_\_\_\_\_

What age were you first exposed to English? \_\_\_\_\_

Do you have a history of written or spoken language impairment?

Please explain:

I am going to play 6 words. Just listen to the words and don't write anything down. At the end of the experiment I will ask you to recall as many words as you can.

CUP, SOFA, SHIRT, APPLE, BOOK, PEN

This next part will be timed. You will have 60 seconds. When I say go, I want you to write down as many animals as you can.

I am going to play some sentences. Your job is to listen to each sentence and decide whether the sentence describes something that could plausibly happen. If you think the event described makes sense, circle the word “Plausible”. If you think the event described doesn’t make sense, circle the word IMPLAUSIBLE. Listen carefully because I will only play the sentences once and some of them are tricky.

The thorn pricked the girl that applied the band-aid.  
The lightning that the golfer struck survived the incident.  
The toothache annoyed the woman that was seen by the dentist.  
The handcuff restrained the patient that bit the orderly.  
The rug that the juice stained was spilled by the child.  
The leak irritated the tenant that was harassed by the landlord.  
The snow that was shoveled by the janitor coated the sidewalk.  
The money aided the orphan that was donated by the millionaire.  
The diver that the weather hindered sought the treasure.  
The sheriff that the scandal involved investigated the crime.  
The wolf repelled the child that threatened the fire.  
The arsonist that destroyed the warehouse was set by the fire.  
The study that was commissioned by the man analyzed the company.  
The man consulted the expert that bewildered the computer.  
The teenager that the miniskirt wore horrified the mother.  
The hedge lined the driveway that was planted by the gardener.

**Synonyms.** Two words are synonyms if they mean the same thing. For each of the following 10 words, circle the word that is the best **synonym** for the word in bold:

- abstruse** (a) incomprehensible (b) irrespective (c) suspended (d) protesting (e) not thorough
- callow** (a) naïve (b) holy (c) mild (d) colored (e) seated
- denigrate** (a) refuse (b) belittle (c) terrify (d) admit (e) review
- penultimate** (a) second to last (b) last (c) best (d) most (e) second best
- assent** (a) rise (b) ponder (c) agree (d) construe (e) quarrel
- inimical** (a) antagonist (b) anonymous (c) ally (d) accurate (e) atypical
- ire** (a) fury (b) mildness (c) celebration, (d) sympathy (e) memory
- corpulent** (a) obese (b) lazy (c) thin (d) erythrocyte (e) nasty
- truant** (a) angry (b) absent (c) straight (d) support (e) confront
- rend** (a) tear (b) oppress (c) provide (d) repair (e) cherish

**Antonyms.** Two words are antonyms if they have the opposite meanings of each other. For each of the following words, circle the word that is the best **antonym** for the word in bold:

- enervate** (a) narrate (b) enrage (c) accomplish (d) invigorate (e) acquiesce
- nefarious** (a) lackadaisical (b) hypocritical (c) benevolent (d) exemplary (e) malevolent
- quixotic** (a) slow (b) abstemious (c) practical (d) grave (e) unpredictable
- churlish** (a) agreeable (b) upset (c) religious (d) rude (e) compressed
- morose** (a) gloomy (b) cheerful (c) sullen (d) easy (e) pensive
- propitious** (a) inauspicious (b) advantageous (c) pungent (d) qualified (e) inchoate
- ignominy** (a) deference (b) mettle (c) honor (d) servility (e) joy
- nascent** (a) descending (b) sanguine (c) mortal (d) moribund (e) minute
- pusillanimous** (a) mindful (b) brave (c) diminutive (d) mendacious (e) supercilious



**animated** (a) cartoon (b) lively (c) lifeless (d) worthy (e) realistic

For each of the following pairs of words, circle the word in the pair that is spelled **correctly**.

aquaintance	acquaintance
millennium	millenium
license	liscence
occasionally	ocassionnally
priveledge	privilege
relevant	relavant
harassment	harrassment
pronounciation	pronunciation
argument	arguement
marshmellow	marshmallow

I am going to play a series of numbers. Listen to the numbers carefully When I finish playing the numbers, write the numbers down in the order they were said.

5, 9, 8, 4, 1, 7, 3, 6, 2

Now I am going to say a series of nonsense words. Listen to the nonsense words carefully. When I finishing saying them, write down as many as you can in the order I said them.

PEV, BLAR, FILT, NIF, KRAT, GOOM, ANK, TUD

**Parent or Teacher Administered Language (PORTAL) test Age 4**

This is a parent or teacher-administered screening test for language development. Results obtained from this test may one day help us diagnose language delays and problems for all children. During the test, please do not to give your child hints about the answers. If your child needs encouragement to continue with the test, please respond the *same way* whether he or she answers *correctly* or *incorrectly*. For example, you might say "good job!" after each answer. This will help us to obtain the best information from your child. Thank you, and have fun!

**Child's Name (First & Last):** \_\_\_\_\_

**Today's Date:** \_\_\_\_\_ **Child's Birthdate:** \_\_\_\_\_

**Child's grade in school:** ☐ Not in school yet ☐ Nursery: \_\_\_\_\_ hours/day, \_\_\_\_\_ days/week

☐ Pre-Kindergarten ☐ Kindergarten ☐ Other \_\_\_\_\_

**Adult's Name:** \_\_\_\_\_ **Relationship to child:** \_\_\_\_\_

**SAYING SOUNDS:** Ask your child to repeat each of the words below, one-by-one. For each word, if your child says the underlined sound correctly, mark it "Correct." If your child does not say the underlined sound correctly, mark it "Incorrect". If incorrect, write the child's incorrect pronunciation on the line next to the box. Incorrect sounds might be your child omitting a sound (e.g., saying "tuck" for "truck") or substituting another sound (e.g., saying "dat" for "that"). If your child says nothing, write "no response" on the line. **Say each word only once.**

	Correct	Incorrect			Correct	Incorrect	
<u>R</u> at	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>T</u> hat	<input type="checkbox"/>	<input type="checkbox"/>	_____
<u>L</u> ip	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>T</u> hin	<input type="checkbox"/>	<input type="checkbox"/>	_____
<u>S</u> hip	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>S</u> pit	<input type="checkbox"/>	<input type="checkbox"/>	_____
<u>C</u> heek	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>T</u> rick	<input type="checkbox"/>	<input type="checkbox"/>	_____
<u>Z</u> ip	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>C</u> lock	<input type="checkbox"/>	<input type="checkbox"/>	_____
<u>J</u> eeP	<input type="checkbox"/>	<input type="checkbox"/>	_____	<u>F</u> rog	<input type="checkbox"/>	<input type="checkbox"/>	_____

List any sounds that your child regularly says incorrectly and give a typical mispronounced word.

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**NAMING ANIMALS:** For this section you will be timing how many animals your child names in 30 seconds. You will need either a stop watch, a clock with a "second hand" or a watch that lets you see when 30 seconds is up. Write down all the things your child says in 30 seconds (including things that are *not* animals). Do not give your child any examples besides the one example in the instructions. Start timing right after you say "Ready? Go!" to your child

**Instructions to read to your child:** "Now we're going to play a thinking game. Let's think of animals... A dog is an animal. Now it's your turn to think of as many other animals as you can. Ready? Go!"

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**REPEATING NONSENSE WORDS:** In this section, you will read a list of nonsense words. Please read them as if you were just talking to your child - not too fast and not too slowly. Right after you finish saying the list of words, ask your child to repeat as many as she or he remembers. Circle the words your child says. Do **NOT** repeat any of the words!

**Instructions to read to your child:** "I am going to say some silly words. I want you to listen carefully to all the silly words. When I finish saying them all, you say as many of the silly words as you remember."

PEV WUG MEEVE BLAP DABE KILK GOOM FISE

**NAME THINGS QUICKLY:** For this section you will be timing how many items your child answers in 30 seconds. You will again need either a stop watch, clock with a “second hand” or a watch that lets you see when 30 seconds is up. Begin timing right as you begin saying the first item. If your child does not respond to an item within a few seconds or says “I don't know”, mark the item “No response” and go to the next item. If you get through all of the items before 30 seconds are up, you can go back to items your child skipped. Mark any items that you don't get to in 30 seconds as "No response."

**Instructions to read to your child:** “Now we're going to play a game where I'll tell you what to name, and you'll tell me something as fast as you can. For example, if I say, “Name something cold”, you could say “ice.” Are you ready? Let's play!”

	Correct	Incorrect	No response		Correct	Incorrect	No response
1. Part of a face	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. A part of a car	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. A vegetable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7. A piece of clothing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. A number	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8. Something red	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. A drink	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9. A toy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Something round	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10. Something big	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**NAMING LETTERS:** Point to each letter and ask your child to name it. If your child gives the wrong answer or doesn't respond, circle the letter.

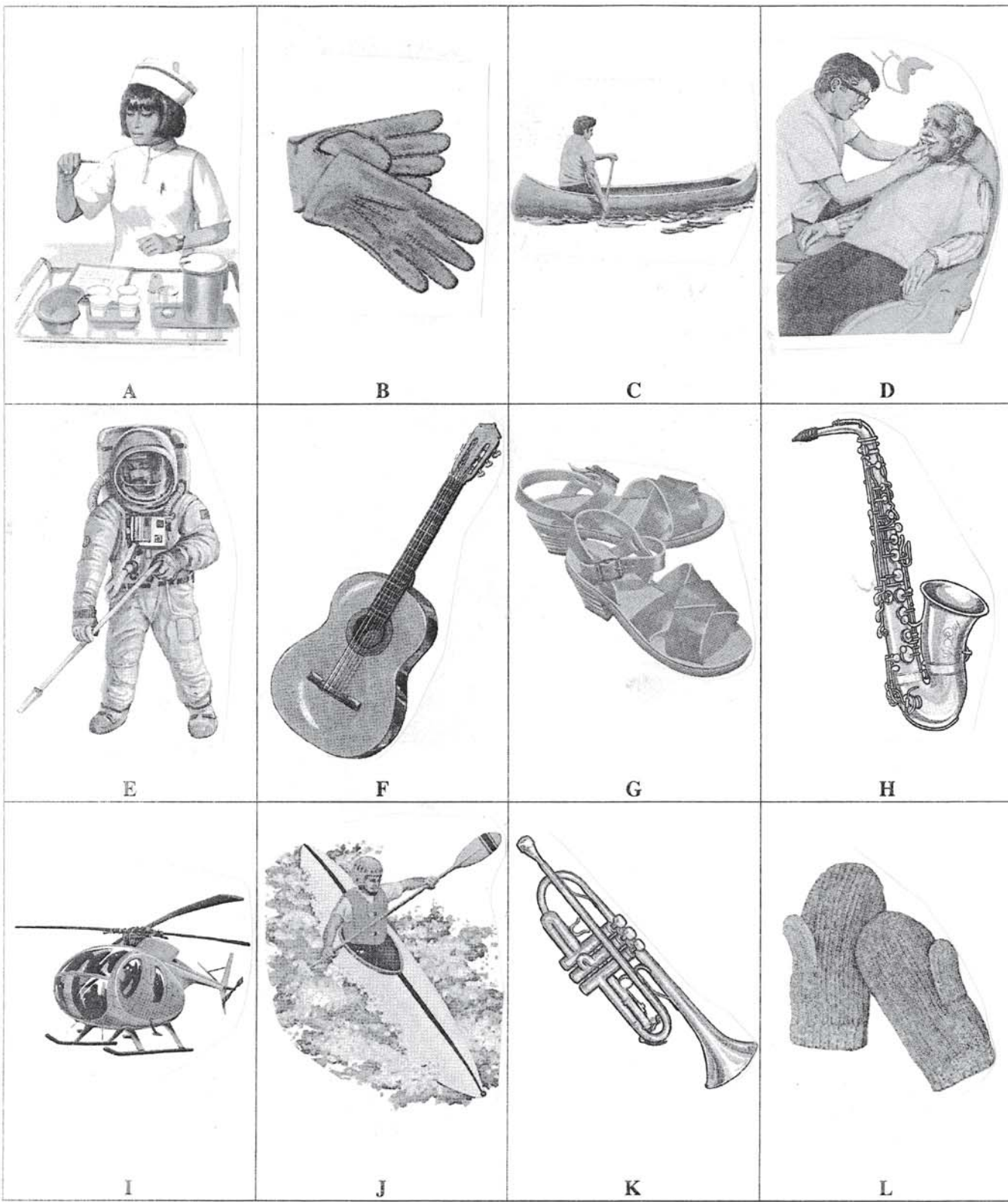
T	O	M	Z	S	A
E	H	C	L	p	b

**WHERE'S THE PICTURE?:** On the next page, there are twelve pictures labeled with the letters A, B, C, D, E, F, G, H, I and K. You will say the 8 words listed below and ask you child to point to the picture that the word means. Write the letter of the **FIRST** picture your child points to, even if he or she changes his or her mind and points to another. If your child doesn't point to a picture, write “No Response” on the blank.

**Instructions to read to your child:** “Now we're going to play a game where I say a word, and have to find picture for the word. Ready? Let's Play!”

1. Saxophone \_\_\_\_\_
2. Kayak \_\_\_\_\_
3. Nurse \_\_\_\_\_
4. Helicopter \_\_\_\_\_
5. Dentist \_\_\_\_\_
6. Mittens \_\_\_\_\_
7. Sandals \_\_\_\_\_
8. Trumpet \_\_\_\_\_

WHERE'S THE PICTURE?



**Individual Directions:** Place the Drawing Form in front of the child along with a pencil with an eraser. Say, “I want you to draw a picture of yourself. Be sure to draw your whole body, not just your head, and draw how you look from the front, not the side. Do not draw a cartoon or stick figure. Draw the very best picture of yourself that you can. Take your time and work carefully. Go ahead.”

# DRAW-A-PERSON

## Drawing Form

Name or ID number: \_\_\_\_\_



**PORTAL 4: UNDERSTANDING SENTENCES****UNDERSTANDING SENTENCES - INSTRUCTIONS**

In this task, you will read 12 sentences to your child, one by one. These sentences are listed below. Each sentence corresponds to a page in the “Understanding Sentences Picture Booklet”. For example, sentence 1 corresponds to page 1, sentence 2 corresponds to page 2, etc. Your child's task is to listen to the sentence you read and then point to one of the two pictures shown on that page.

**Familiarize your child with the animals:** All of the animals used in the picture booklet are shown on the next page of this packet. Introduce your child to the animals on this page. For example, for the first two animals, point to the fox and say, “This is a fox” Point to the lion and say, “and THIS is a lion.” Then ask, “Can you point to the FOX? Now, can you point to the LION?” If there are any animals that you are not confident your child can identify correctly *after* being introduced to them, please circle them.

**On to the task!** Now we are ready for the 12 sentences. Read each sentence to your child only once, and ask your child to point to the picture that matches the sentence. Say "I am going to read you a sentence, and you have to pick the picture that matches the sentence. Listen very carefully and think before you choose! Are you ready for the first one?"

Circle the picture your child points to. If your child does not respond, write "No response" next to the pair of pictures.

**Hint:** Some of the sentences are a bit tricky, so read each sentence silently to yourself before reading the sentence aloud to your child.  
**Remember, read each sentence to your child only once.**

1. The dog licked the bear.
2. The cat scratched himself.
3. The fox was tickled by the lion.
4. The pig scrubbed the sheep.
5. The bear slapped the dog.
6. The frog hid him.
7. The bunny was patted by the duck .
8. The mouse bit himself.
9. The sheep kissed the pig.
10. The duck was washed by the bunny.
11. The monkey splashed him.
12. The lion was combed by the fox.



Child's Name \_\_\_\_\_

ANIMAL INTROS



**FOX**



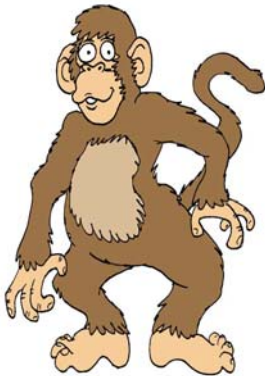
**LION**



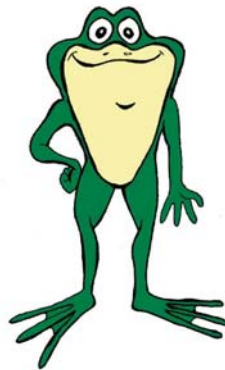
**CAT**



**MOUSE**



**MONKEY**



**FROG**



**DOG**



**BEAR**



**DUCK**



**BUNNY**



**SHEEP**



**PIG**