LLD 270

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Child first language acquisition

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5 December 2013

Contents

1. Introduction

In a 'do-it-yourself' speech-therapy book aimed at helping parents "correct" their children's speech, the author admonishes parents about the seriousness of their responsibility for helping their children 'learn how to speak,' stating "speech[1] is one of the most complicated achievements of mankind; it must be learned, slowly and sometimes painfully." (Jones: 40-41). As we've learned this semester, nothing could be further from the truth when it comes to child's first language acquisition. Unlike adult second-language learning, which *does* require a great deal of motivation and perseverance, "…language learning is not really something that the child does; it is something that happens to the child placed in an appropriate environment, much as the child's body grows and matures in a predetermined way when provided with appropriate nutrition and environmental stimulation" (Chomsky:41). Even those linguists who disagree with Chomsky on many details of syntactic theory do not argue with the notion that linguistic ability is innate, an ability that humans are born with (part of our "genetic endowment," Chomsky says[2]). For example, linguists such as Tomasello, Langacker, and Van Valin (the school of cognitive linguistics and conceptual semantics) "do not deny that humans are biologically pre-specified to acquire language," although they "reject the hypothesis that there exists a specialized and innate cognitive system that equips us for linguistic knowledge." Rather, such theorists believe "that humans employ generalized socio-cognitive abilities in the acquisition of language" (Evans & Green: 134).

For Chomsky, the language module is an *autonomous* module—that is, it is separate from and does not necessarily interact with other cognitive skills (at least, insofar as language acquisition and early development of language in childhood is concerned).

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[1] Of course, speech is really just one aspect of what's under discussion when linguists talk about 'language.' Nonetheless, it's a prominent and fairly easily observable metric, and the book provided a fascinating look at American culture at that time (1960). I really think the focus the book (*Baby Talk)* was on ensuring that little boys didn't sound too 'effeminate,' but that's a topic for a completely different paper.

[2] Quoted from Michel Gondry's film *Is the Man Who is Tall Happy?* (thank you for suggesting this film—as of last week, it's been available on Amazon streaming for $6.99).

Contrary to Chomsky's view, the cognitive/conceptual linguists suggest that the language system (module) is stimulated or developed (in part, at least) through its interaction with the other cognitive abilities that are developing in the brain (Clark 2004: 472), including the ability to conceptualize. This perspective also seems to include the idea that, as the infant or child is beginning to try out different bits of language, those utterances further help develop the language within in the infant or child.

The competing viewpoints are fascinating, but beyond the scope of this paper. I mention this only because as you've pointed out all semester, the theories are many yet none can be actually proven. (On the other hand, in a textbook for speech-language pathologists, Chomsky *is* cited as one of "the two towering figures in speech-language theory" the other being the neurologist Norman Geschwind, who focused attention "on the study of language and its disorders" as an important area of inquiry from a neurological-medical perspective (Webb & Adler: 3), suggesting that Chomsky's theories are respected in the field of speech-language pathology, thus beyond 'linguistics' as a purely academic pursuit).

Discussions of child first language acquisition, even in more recent texts (Carroll 2008, Herschensohn 2007, O'Grady et al, for example) refer to Lenneberg (1967) and Penfield (1959) when discussing neuro-anatomy and function of the brain, vis-à-vis language, promulgating the ideas of lateralization, brain plasticity, and the critical period hypothesis. I was curious if any of the techniques and technologies from neuroscience are shedding any more light on some or all of these concepts, and furthermore, how are technologies from neuroscience being use to explore child first language acquisition. As far as the first question, it seems the neuro-imaging has done a lot to fine-tune medical science's understanding of the connections made between different areas of the brain, such as the arcuate fasciculus[3]—the bow-shaped nerve bundle that runs between Broca's and Wernicke's areas (Webb & Adler: 260-262)—and the role such connections play in various

[3] The dictionary definitions shed greater light on these words derived from Latin: "arcuate" means "having the form of a bow; curved" (AHD: 96) and "fasciculus" means "a bundle of anatomical fibers, as of muscle or nerve" (AHD: 663).

types of aphasia, for example. On the other hand, it appears that although we have a more 'granular' view of the brain through imaging, the findings have not radically altered the perspective: "…our notions of the biological foundations of language and the localization of supporting perceptual and motor skills, derived from clinical observation and the BWL (Broca-Wernicke-Lichtheim) framework, have been augmented but not fundamentally changed by functional imaging data derived from online language processing by normal language users." (Ingram: 42)

Nonetheless, the remainder of this paper is devoted to the second question—how are studies from neuroscience being used with infants and children to study language acquisition? To start, let's review some of the chief milestones—the products of the outwardly observable development process that is revealed as the infant grows.

2. Overview of Child First Language Acquisition

The time course of child first language acquisition is well-documented and follows certain observable characteristics.

GENERAL TIME COURSE OF SPEECH PRODUCTION

The milestones of infant and child language acquisition are well known and have been documented over the years by parents as well as researchers across various fields (psychology, biology, linguistics, among others). These milestones are naturally achieved by healthy infants in the language environment into which they are born (Lenneberg (1967), Scovel (1997), Webb & Adler (2008).

At some point around week 12, a baby's cries apparently become more "communicative" (Scovel: 11), and this 12-week benchmark is the first one noted by Lenneberg as the stage when the infant begins to engage with the world around him or her, as the baby supports his own head (demonstrating motor development and smiles when talked to or nodded at (Lenneberg: 128).

By the end of the second month, infants begin to vary their output; this stage and the sounds made are referred to as "coos." Given their acoustic variation, coos show that the infant is exerting some control over his or her articulatory apparatus (Carroll: 262)

At around 6 months, cooing becomes babbling, which resembles "one-syllable utterances" (Lenneberg: 128) or consonant-vowel clusters, "almost a vocalic play" (Scovel: 10) referred to as "reduplicated babbling" because various CV patterns are repeated (bababa, etc). The babbling becomes more variegated by around 11 to 12 months, meaning that rather than simple reduplication, the infant verbally 'tinkers with' the configuration, intermixing various CV patterns from his or her inventory of such 'syllables' (Carroll: 262).

By about 12 months, the infant/toddler generally utters his or her first word by about 12 months, although there's "lots of latitude about when this occurs and precisely what a word is" (Scovel: 15). From anywhere between about 12 and 18 months, the infant begins developing and using syntactic structures, one-word 'holophrases' that take on "sentence-like intonational contours" of (what will become his or her) native language. That is, the child begins using single words as commands, questions, and other communicative devices—the word "milk" as a request for milk, for example.

This is only a brief sketch of some of the milestones in the infant's first year. One of the many interesting questions that has been pursued by researchers for over 20 years, and a question to which neuro-imaging techniques have been applied, involves development of phonology and the role of categorical perception. The changes in the babbling stages of infants, particularly as the babbling evolves from simple reduplicated pattern ($C_1V_1C_1V_1$), to variegated babbling pattern ($C_1V_1C_nV_n$) has been interpreted as one sign that infants are acquiring the phonology of their native language, and that this is "accompanied by a decline of categorical perception of nonnative contrasts (Carroll: 262). Before turning to the research, a brief discussion of deafness in relationship to these outward manifestations of language acquisition, because these provide proof of the dimension of language acquisition beyond the use of speech alone.

IMPACT OF DEAFNESS

One of the core issues in terms of innateness and also the 'input' question—is speech a necessary catalyst to learn language? Deaf children, it turns out, follow this same general timeline, which disputes some of the notions (mentioned earlier, made by the cognitive linguists for example), that "motoric mechanisms for the production of speech *determine* the time course, sequence and linguistic and semantic content of early language acquisition (Petitto: 51; italics original). Petitto's work in the early and mid-1990s with deaf children provides some interesting insight into language acquisition in multi-lingual and multi-modal environments.

In several bilingual (French-English) and bimodal (hearing-deaf[4]) studies, Petitto provides compelling evidence that "speech-deprived but sign-exposed hearing children achieved every linguistic milestone in signed language on the identical time course as has been observed for hearing children acquiring spoken language (as well as deaf children acquiring signed language—that is, manual babbling, first signs, first two-sign combinations, and so forth)" (Petitto: 50) Petitto's point was to prove that "speech and sound are not critical to the language acquisition process" (Petitto: 51) and I mention it in this paper because I think it provides an interesting counterpoint to some of the studies of feral and neglected children (which I haven't mentioned in here, but which I'd like to look at further) that have suggested lack of input as the cause of language deficit; Petitto's work also provides further substantiation of the innateness theory. (Today, Petitto is at Gallaudet, heading up a new research laboratory that will be investigating (among other things) the role that vision plays in the language acquisition process for deaf and hearing impaired individuals.)

Although both hearing and deaf infants progress through the crying and cooing stages, and although as Petitto found, infants and children acquiring sign do so in the same

[4] The bimodal studies were conducted cross-linguistically, French-English, in which one parent spoke French while the parent signed LSQ (Langue des Signes Québécoise), and with an analogous group of subjects, one parent speaking English, the other signing ASL (American Sign Language) (Petitto: 48).

time course, one difference that does emerge in the babbling stage (difference between hearing and deaf infants) is that when the babbling stage begins for hearing children, their babbling includes the prosodic features of the (what will become) their first (native) language. For example, the babbling of an infant in an English-speaking home has the prosody of English, while an infant at the same age in Chinese-speaking home babbles "with the tones and melodies of Chinese" (Scovel: 11). The suprasegmental features accompanying babbling (or lack of suprasegmental features) is a clue that that infant's hearing is impaired (Scovel: 11).

3. Research into Child First language acquisition

Research into child first language acquisition has included, broadly speaking, three distinct approaches: 1) diary keeping and observation; 2) psycholinguistic studies and experiments; and 3) neurolinguistic studies.

DIARY DOCUMENTATION

The most basic approach to gathering data about an infant and child's linguistic behavior is simply documenting what happens, and when it happens. This has a long history that goes back centuries (and perhaps even to the caves of France—after all, what parents don't pay attention to the important milestones of their children?) , but in the nineteenth-century diary practice gained 'scientific' credibility thanks to Darwin's record-keeping of his son's linguistic development—"in one swoop it [Darwin's 10-page *Biographical sketch* of his son William's development, which included observations on the William's language skills] made the study of language development a respectable branch of human biology" (Levelt: 98). In the 20th century, the diary practice becomes firmly rooted as a means of investigating child language acquisition by William and Clara Stern, who documented the language development of their three children (Hilde, Gunther, and Eva) from birth through the ages of 12, 10, and 7, respectively (Levelt: 309-312); the publication of the Stern's *Die Kindersprache* ("child language") "transformed the nineteenth-century diary practice into a modern objective database approach…" (Levelt: 509). The tradition of documenting children's language development continues today, perhaps most notably in the CHILDES (Child Language Data Exchange System) which has evolved over the past three decades into a web-based, database backed repository of not only cross-linguistic monolingual data but also bilingual data. (Although access to the data is open to contributors as well as researchers, using CHILDES involves learning a custom database-access mechanism, beyond the scope for this paper, but given the breadth of languages covered, looks like something worth exploring in the future.)

PSYCHOLOGICAL/PSYCHOLINGUISTIC EXPERIMENTS

This type of study has been around since the late 1960s and 1970s; these non-invasive experiments basically involve observing an infant or child's 'behavior' in response to some stimulus, be it visual or acoustic. One such technique used with infants is the high-amplitude sucking (HAS) procedure (developed in 1971, discussed a bit further below); this has been used for decades in experimental studies of infants (Gerken 2008: 47-48), some as young as 4 days old. Gerken cites several studies, including pre-natal studies involving mothers reading a Dr. Seuss story to their developing fetus (in utero), for a period of time, whenever they sensed that the baby/fetus was awake and active. Expectant mother would sit in a quiet room and read aloud. The study conducted after babies were born involved using the HAS procedure and monitoring the baby's sucking rate as the mother read the same or different story, vs. another woman (not the mother) reading the same story. From the changes in the sucking rates of the tested infants, researchers surmised that infants can distinguish the sound of their own mother's voice.

The high-amplitude sucking procedure involves giving the infant a 'non-nutritive pacifier' which is hooked up to a device (a pressure transducer) that measures the sucking rate and strength of the infant in response to some stimulus. (This is oversimplifying the details, but briefly, a base rate is recorded, then the infant is 'habituated' to a stimulus, meaning the infant is exposed to an auditory stimulus until such time as the infant appears to lose interest in the stimulus, then the test phase ensues in which the infant is exposed to various other stimuli (depending on the focus of the study or experiment—such as the pre-natal study mentioned previously). Gerken's discussion of the details of the various studies is interesting, but I wonder about the validity of the conclusions—in some cases, the researchers attribute causality or motivation to the infant, for example, suggesting that a 4-month old infant increases his or her sucking rate in order to hear his/her mother's voice (Gerken: 44-45).

Despite my skepticism about some of the psycholinguistic research, some of the more interesting studies involve research in the area of categorical perception. "Categorical perception can be loosely defined as a tendency to perceive contrasts on sensory continua more sharply at category boundaries that distinguish discrete objects of perception" (Ingram: 117-118). In simple terms, it means we perceive certain acoustic and visual signals in terms of clusters of discrete categories, rather than as distinct individual items. For example, what we identify in a sound stream as [b] falls within a certain range—not every [b] we've ever heard has the exact same sound profile, in fact, it's likely we've never been exposed to precisely the same set of frequencies more than once. But we identify a [b] as a [b] because it falls within a certain set of frequencies in contrast to other, somewhat similar frequencies which different by one or more cues—specifically, for English, we identify [b] in the context of how the sounds cluster relative to [p]—and vice versa. Despite many studies in the 1970s and 1980s, it seems that the researchers have yet to conclude that this capability is specific to language (rather than general auditory processing). (Gerken: 52) So we are back to another question about innateness and development—does the categorical perception develop during infancy and childhood, or is it there all along?

This highlights one of the problems with psycholinguistic research methods, in general, and leads us to the benefits of neurolinguistic studies.

NEUROLINGUISTIC STUDIES

To determine how an ability changes over time from infancy through childhood to adulthood, psycholinguistic research methods focus on behavior (sucking, head-turn tasks, and so forth for infants), and thus are limited in their scope to a specific age group (there would be little point in trying to give an adult a 'head-turn task' for his own mother's voice). On the other hand, neurolinguistic techniques such as "the electrophysiological method of event-related brain potentials… can be successfully used with infants, children, and adults" (Friederici: 481). Many of these techniques have emerged just in the past 15-20 years, and allow researchers to 'see what's going on in the brain' in real-time, during what's referred to as 'online' processing .

These sophisticated neuro-imaging techniques, include magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI), both of which are expensive (according to Kuhl: 714) but can be used with infants and children to record different types of brain activity. For example, a study of infants using MEG involves putting the MEG helmet on the infant's head and exposing the infant to some stimulus, during which time sensors in the helmet record the magnetic fields associated with electrical currents that the infant's brain produces as it listens or responds during that time; that is, while the infant is "performing the specific sensory, motor, or cognitive task" (Kuhl:713).

Another method of research, one that is inexpensive[5] (according to Kuhl: 714), is electroencephalography/ event-related potential (EEG/ERP) is a measure EEG records all activity in the brain, which means that a number of irrelevant (irrelevant only to the researcher) background brain activity is also recorded. The ERP is a derived measurement based on averaging several in a series of recordings and extracting the measurement related to the stimulus only. The result of this averaging and extraction is a wave form known as the ERP (O'Grady et al: 438). In Figure 1 shows an example ERP that demonstrates the response of adults hearing various sentences that begin with the phrase "the pizza was too hot to…", and completed in three different ways ("eat", "drink", "cry"). The voltage line shows negative values above the line and positive values below the line; the line represents time in milliseconds. The spike labeled N400 in Figure 1 is a measure commonly known to capture lexical-semantic incongruity; that is, 400 milliseconds after the incongruous element in the utterance is said, the test subject's ERP reading spikes to a

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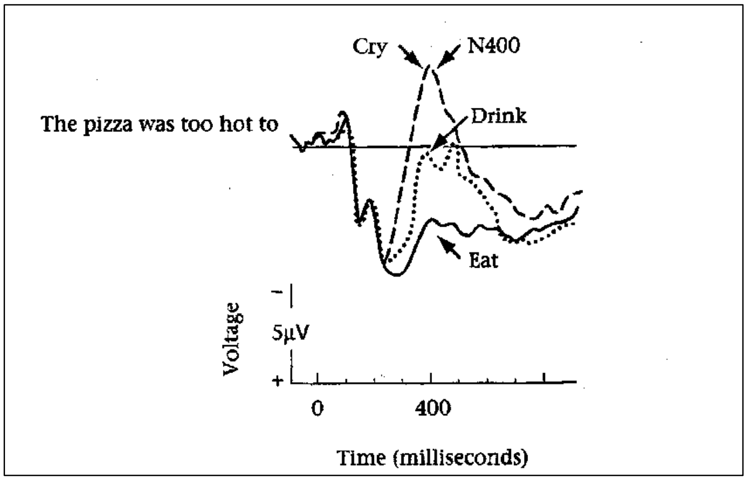
[5] The expense of these techniques may be related to how long they've been around. I think EEG has been around for almost 100 years (since about 1924), while MRI is more recent (from the 1970s, I think). MEG has been around longer than I thought, since about 1968.

negative polarity. The larger the spike in relationship to the rest of the utterance, the greater the degree of incongruity (O'Grady et al: 438-440)

Figure 1. Example ERP (O'Grady et al: 439)



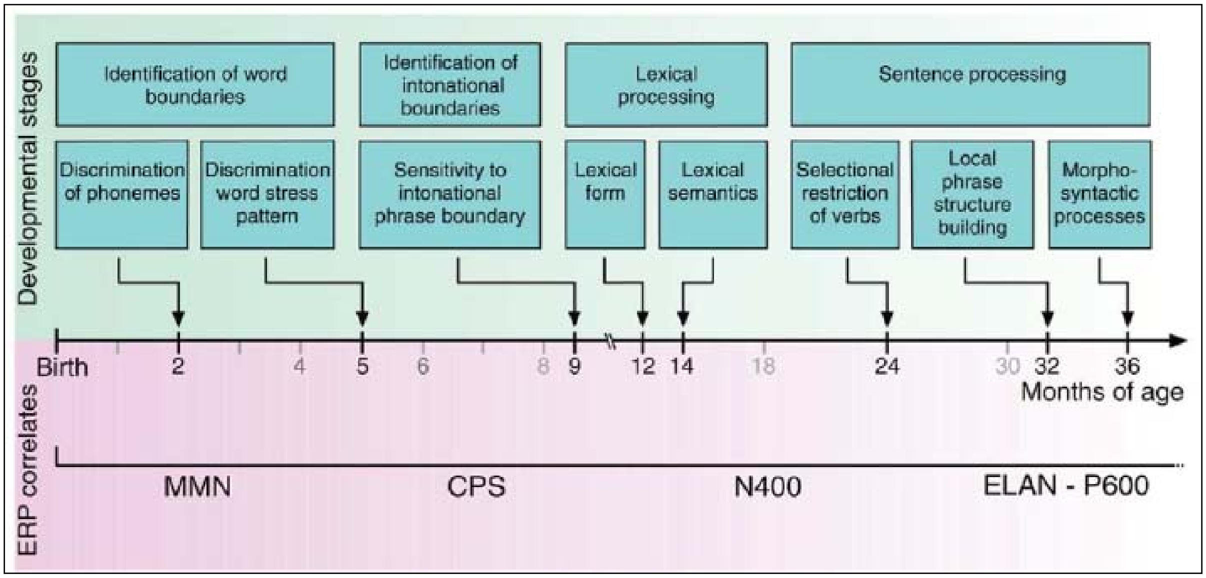
The ERP is being used in various ways to examine other aspects of linguistic knowledge, and it turns out that there's more to the ERP than just the type of metric shown in Figure 1. Researchers have correlated different components of the ERP to phonological, semantic, and syntactic processes in adults, and these same measurements can be used with infants and children to see how these capabilities evolve over time (Friederici: 481). Specifically, these ERP components are derived from or correlated to specific linguisic processes, summarized in Table 1.

Table 1. Components of ERP that correlate to linguistic processes (derived from Friederici: 481-487)

Linguistic processes	Component of the ERP	
Phonetic/phonology	MNN	Mismatch negativity. Measures the 'mismatch' in a 'deviant stimulus' (basically, this is another derived measurement in which one aspect of the wave being recorded is subtracting from the ERP—my interpretation of Friederici: 482)
Lexical-semantic	N400	Negative polarity at 400 msec after stimulus.
Syntactic processes	E/LAN	Left anterior negativity.
	P600	Positive polarity at 600 msec after stimulus.
Prosodic processes	CPS	Closure positive shift.

Figure 2 (Friederici: 483) consolidates some of the key findings from studies using the measurements from Table 1 and plots them to the developmental landmarks ("stages") of infant and child language acquisition.

Figure 2. Schematic overview of developmental stages and ERP correlates (Friederici: 483)



Friederici's paper provides neuro-scientific evidence for one important principal of language acquisition and development (something I should have mentioned earlier), and that is, that it's the *sequence* of the milestones that most important. That is, the basic sequence follows this course:

sucking→crying→cooing→babbling→phonetic/phonological comprehension/production→vocabulary building→syntax

One of main goals of Friederici's paper was to demonstrate that this sequence is demonstrable based on the consolidated research of various neuro-imaging studies conducted using infants, children, and adults, and is an attempt to identify whether the brain mechanisms at work in infants and young children are qualitatively or quantitatively different from those same mechanisms in adults. Friederici's correlation of the neuro-imaging study results to the developmental stages (Figure 2) is but the beginning of her paper, but is the place I will have to end my own, with the note that I will simply keep reading and exploring this topic long after this class is over.

4. Conclusion

Child first language acquisition follows a fairly well-documented time frame in terms of output, production, and some of the neurolinguistic and neuroscientific research that is examining the inner workings of infant and children's "mind/brains" as they sense various stimuli are providing evidence of the neural substrates that correlate to the output. What does this tell us? I had hoped that I would find some neuroscientific research that neatly identified the 'language module' in the brain, but that's not the case. We have no end of data about what infants, toddlers, and children do and when they do it, yet despite the various psycholinguistic studies and even these neurolinguistic studies, as you've said all semester long, all of the research is based on speculation. Even these neurolinguistic-based studies involve a certain amount of extrapolation. For example, the ERP is really a generated metric based on the mathematical difference between one brain wave at a certain point in time extracted from the overall EEG component—in other words, it's a derived measurement. On the other hand, it *would* be interesting to find out what the ERP correlates might be for sign language, or for bilingual children, during online processing scenarios.

As for how to use understanding of child first language acquisition in the classroom, I don't see any direct relevance for adults other than perhaps understanding the major role of *motivation* for the adult learner. Unlike the infant, toddler, and young child perhaps oblivious to the 'acquisition' that's taking place in its mind/brain, without any apparent conscious effort, most adults trying to learn a new language will have stress factors, anxieties, and insecurities, as well as jobs, time pressures, and so forth, so it is incumbent upon the language teacher to do whatever she or he can to make their student's time in the classroom engaging, stimulating, and as stress-free as possible.

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