

Chapter 7

Although human language is thought to be at least 200 000 years old (Mithen, 2005), precisely when and how it emerged remain largely a mystery. Unlike other human achievements such as the use of tools, there is no archaeological trail to follow; instead, the evolution of language can only be inferred (Olsen, 1998). As a result, contemporary theories of language evolution range from proto-speech (Steklis & Raleigh, 1979) through to proto-sign models (Zlatev, 2008). Although it remains a process of educated guesswork, it has traditionally been informed through studies of modern infant language acquisition (Young, Merin, Rogers & Ozonoff, 2009) or animal communication systems (Bonatti, Peña, Nespors & Mehler, 2005). More recently, the development of neuroimaging technologies such as MEG and fMRI has allowed a vastly improved understanding of how the modern human brain functions, while concurrent advances in computing and analysis techniques have allowed older technologies such as EEG to enjoy a research renaissance (e.g. Klimesch, 2011, 2012; Nyström, Ljunghammar, Rosander & von Hofsten, 2011; Sauseng, Klimesch, Schabus & Doppelmayr, 2005). Despite these advancements, there is still a lack of agreement on both when and how human language evolved.

To this end, the purpose of the current thesis was to examine grammatical class processing (nouns versus verbs) in mature language speakers. By comparing the one and two path models of such processing, it was proposed that results could be interpreted within an evolutionary context, providing support (albeit inferential) for either the protosign/protospeech or the mixed model (coevolution) of language. This specific feature or function of language processing was chosen for a number of reasons:

- (1) It is unlikely that language emerged as a complete system; that is, it is improbable that the first thing ever uttered by an early human was along the lines of “Hey guess what? I can talk!!”. A more reasonable suggestion, and one that is mirrored by infant language acquisition, is that proto-signs and/or proto-speech emerged as single entities (akin to a modern language *word* or *sign*) which, over time were joined together to form two-entity utterances (e.g. “Lion! Run!”) that in turn, eventually developed into modern language;
- (2) Nouns and verbs are the only two *necessary* word classes for human language; all other grammatical class types (e.g. adjectives, conjunctions) and function words

(e.g. *the*) facilitate value-adding in terms of speed of transmission or information capacity, but none are *essential* to human language. Although this view is not necessarily supported by all (e.g. Gil, 2000), if nouns are considered the surface manifestation of thing/object concepts (i.e., subjects and objects - *space*) and verbs as representative of actions/movements (*time*), it is difficult to conceive how a language could function effectively without the two classes of word (or sign);

- (3) The use of nouns and verbs is one of the few established language universals found in all modern human languages whether spoken or signed (although for argument against this, see Gil, 2000);
- (4) Previous lesion studies have identified a double dissociation between noun and verb processing; that is, lesions in one set of cortical areas disrupt noun but not verb processing while lesions in another set of areas produce the opposite dysfunction. This suggests separable, independent processing pathways which may indicate separable, independent evolution; however,
- (5) Although numerous studies have provided results supporting such separable processing, numerous studies have reached the opposite conclusion; this may, however, be due more to methodological/technological constraints than proof of existence either way.

Comparison of the one and two path models (1PM and 2PM) was then undertaken by: (i) addressing previous methodological issues in the research literature; (ii) establishing if, at an unconscious neural level, human speech is processed differently to other types of communicative sound strings and thus has language-specific early components; (iii) examining early neural responses to nouns and verbs to identify the presence or otherwise of differential processing; and (iv) examining the role, if any, of mirror neurons in mature language processing and/or learning.

7.1 Summary of Results

To firstly address methodological concerns in previous studies, two corpora of experimental stimulus words were created (See Appendix A). The words within each corpus were then matched across a number of linguistic features including the number of syllables, word length and stress typicality; i.e. there were equal numbers of disyllabic English language nouns and verbs, with equal numbers of typically and atypically stressed words within each

grammatical class, and all were of approximately equal length. In the case of the second corpus, equal numbers of real and nonsense words were matched on length and first-syllable onset with all nonsense words of approximately equal phonotactic legality and probability.

The first corpus was then used to examine (i) the validity of the reliance on normative databases to control for the potentially confounding effects of cognitive constructs such as concreteness/abstractness, familiarity, imageability; and (ii) whether mode of presentation (spoken versus written) influences the perception of these variables. As demonstrated in Chapter 2, the use of normative databases for speech perception research is questionable, as is the practice of presenting stimuli in written rather than spoken form. The two corpora of stimulus words were then examined from an acoustic perspective, examining such features as amplitude, pitch and voicing. Although such features are not normally reported as being controlled for in speech perception research, differential grammatical class processing, especially if occurring early in the processing stream, must be related to a physical stimulus property for language to be able to occur in real-time. As described in Chapter 3, none of the acoustic measures examined could adequately explain early differential grammatical class processing in a general sense. Although significant differences between nouns and verbs were observed, these were both corpus and voice specific. As a result, it was clearly identified that acoustic measures need to be considered as potential confounds.

Human spoken word stimuli were then compared with animal vocalisations. At an acoustic level, some animal vocalisations (primates and birds) were significantly different to human speech but not significantly different to each other on a sub-type basis (i.e. birds versus primates versus general mammals versus whales/dolphins). Contrary to predictions, however, there were various differences identified at a neural level which could not be attributed to acoustic measures; most notably, that whale/dolphin vocalisations elicited significantly more lower alpha ERD activity than human speech stimuli over the left pre-motor cortex and that primate vocalisations elicited significantly more lower alpha ERD activity than human speech over the right middle temporal gyrus, an area associated with the perception of some suprasegmental speech aspects. As reported in Chapter 4, the results support a functional role for lower alpha in processing responses to animal vocalisations that goes beyond the more limited role of *tau* in sound perception; that is, differences in lower alpha ERD responses to human speech and animal vocalisations depend upon whether the speech consists of real or nonsense words even without acoustic differences between these sets of speech stimuli. This suggests an as yet unidentified functional response to higher order language features. More

specifically: suprasegmental features (e.g. prosody) can be found in both spoken and signed languages; if, as is proposed in Chapter 4, the elevated ERD response in the right middle temporal gyrus is indicative of a gating mechanism that filters out *potentially meaningful* from *not meaningful* sound sequences on a suprasegmental basis, then this takes the function of lower alpha from a purely sound domain to the threshold of higher order language processing.

Given that the results presented in Chapter 4 suggest a previously unidentified dimension in language processing, lower alpha and upper alpha ERD responses were then compared across grammatical class (noun versus verbs) and real-ness (i.e. real versus nonsense) dimensions. As reported in Chapter 5, only the processing of real English language nouns recruits significantly more change in lower than upper alpha over the course of the first 500 ms of a stimulus word's presentation. This not only demonstrates a difference between noun and verb processing but suggests a functional role for lower alpha specifically related to noun processing. Although the two sub-bands (lower and upper alpha) were not identified as being significantly different by sLORETA analysis, there were obvious differences between noun and verb responses in both the maximum voxel statistic by time wave forms and the focus of changing cortical activity at the turning points (local maxima and minima) of the processing response identified by sLORETA. Of particular note, the left frontal eye field (BA8) was strongly implicated in real verb processing for the first 250 ms post-stimulus onset. As well as being involved in vision perception, this area has also been proposed as being the site of a *fast brain network* and, being a motor region, contains populations of mirror neurons (Murray, Camen, De Lucia & Clarke, 2008). Although this was only noted in lower and not upper alpha, and mirror neuron activity is more generally associated with the latter, it remains possible that the results obtained reflect lower *mu* activity (Pfurtscheller, Neuper & Krausz, 2000) and thus may indicate mirror neuron activity. Also of note, a clear peak for real verb processing was identified in lower alpha from approximately 22 – 150 ms post-stimulus onset. Allowing that the fast brain network has been proposed as being influenced by auditory stimuli from as early as 24 ms, the results obtained here further support fast brain or *on-the-fly* (Damasio & Tranel, 1993) processing of verb stimuli. The results further suggest that from a system input perspective, sub-audible as well as acoustic measures may need to be considered. Although mildly absurd to suggest that speech perception includes elements that cannot be consciously heard, there are clear perturbations in any word's sound wave form for the first 50 – 100 ms of that wave form. Further research is obviously needed on this, although it is beyond the scope of the current thesis.

Chapter 6 focussed exclusively on upper alpha ERD to specifically look for possible mirror neuron involvement in language processing or learning. Allowing that Chapter 5 had identified possible lower mu ERD in the left frontal eye field directly related to verb processing, it was still considered that there would be significantly more upper alpha ERD in response to verbs. Furthermore, it was predicted that if mirror neurons have the capacity to function as a part of a language acquisition network (or device), then this ERD would be greater after hearing a nonsense verb in context (T3), rather than simply hearing a nonsense verb in isolation (T1). Although verbs (both real and nonsense) resulted in significant source activity changes in upper alpha this was interpreted as higher ERS at T3 than T1 rather than as increased ERD at T1 relative to T3. Nouns, by comparison, showed no significant changes in the upper alpha responses analysed by sLORETA. Also of note in this chapter was that the upper alpha processing changes related to the learning of nonsense verbs was, again, localised by sLORETA to the left frontal eye field (fast brain network location) for at least the first 200 ms post-stimulus presentation.

Taken together, the results presented in the current thesis thus provide support for a two-path model of grammatical class perception, with this separable processing of nouns and verbs beginning early in the speech stream. This early separation is likely related to the sub-audible, early components of any given speech string (e.g. word) and the processing paths appear distinctly different both in timing and cortical topography. A fast brain network involving the left frontal eye field also appears to be involved with the real time processing of verbs, most likely adopting an on-the-fly approach, potentially with mirror neuron involvement; although it's functional response in the lower and upper alpha band is diametrically differently.

7.2. Interpreting Results within an Evolutionary Context.

Having supported a two path model of grammatical class processing, in then becomes a case of working backwards from output to system to input; that is, adopting a black-box modelling approach. In this case, the *output* is considered to be single word utterances, both noun and verb. This reflects both the stimuli used in the current thesis, and the apparent language capabilities of human infants aged approximately 12 - 18 months. The *system* is considered to be the modern human brain's ability to perceive grammatical class based on a two-path model which differentiates early in the processing stream. The *inputs* are the various linguistic, acoustic, and sub-audible features of the sound string itself. See Figure 7.1.

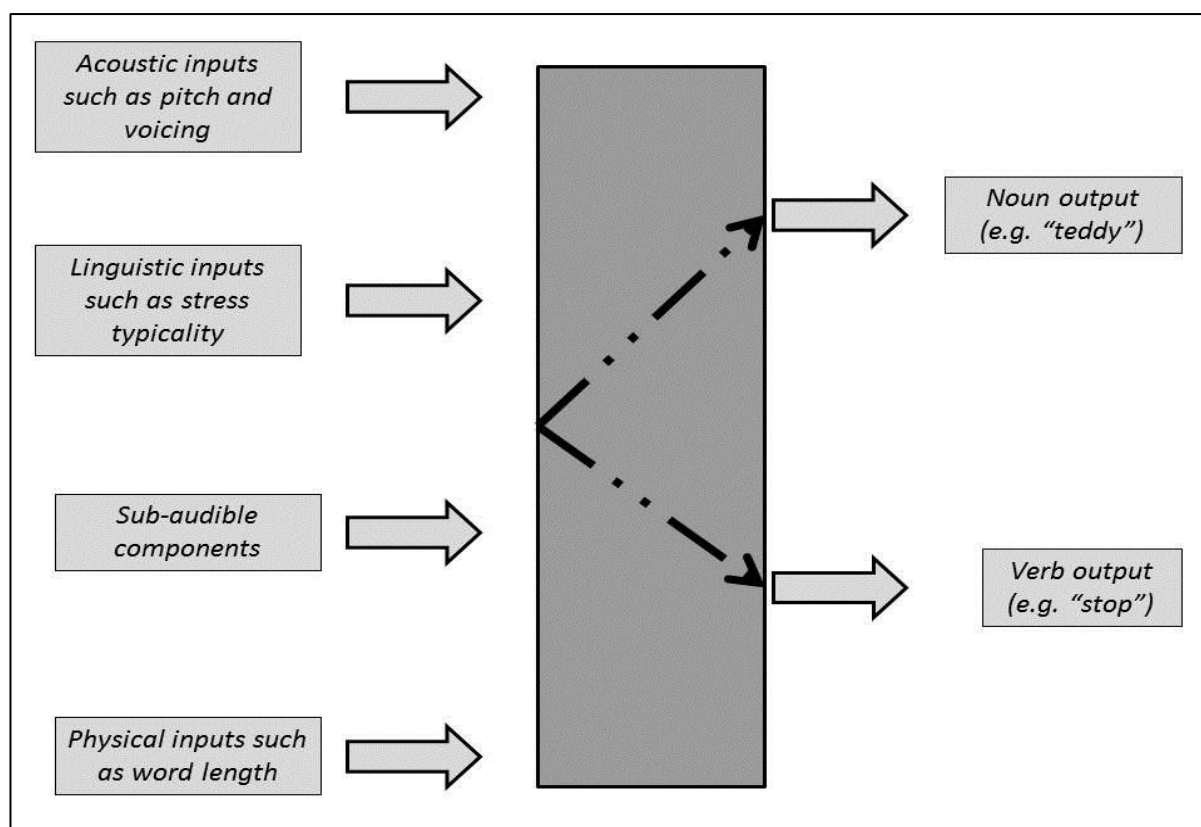


Figure 7.1: Black-box modelling of speech.

To fill in the gaps (large as they may be) between the emergence of life on Earth and the development of the system inputs outlined above, involves connecting the evolutionary dots. In the case of the emergence of life, it is widely believed that it was as single cell organisms, nurtured in a warm, liquid and dark/turbid environment. Such an environment provides little in the way of perceptual clues beyond chemical, water pressure and temperature features. As a result, there are few environmental pressures to force evolution; only self-propulsion (movement) and a refinement of cell diffusion mechanisms (in itself a type of movement albeit very slow) to allow “good” molecules such as simple sugars in and keep “bad” ones such as toxins out, would be of any practical evolutionary advantage to a single cell organism.

Over time, however, single cell organisms evolved into multi-cell organisms which allowed the development of structurally-contained functional specialisations, first gross then fine-grained. Again, this is believed to have occurred in a warm, liquid and turbid environment. Allowing for the still-restricted perceptual clues available in this environment, increased functional specialisation could have allowed for more specialised perception; that is, rather than one cell attempting to monitor everything in the environment, different cells in a multi-cellular organism could focus on specific, different aspect of the environment. The organisation of these

cells, and the communication between the different cells would then precipitate the emergence of cognition in its most primitive form; essentially, the emergence of the first *small world* networks (Watts, & Strogatz, 1998). See Figure 7.2.

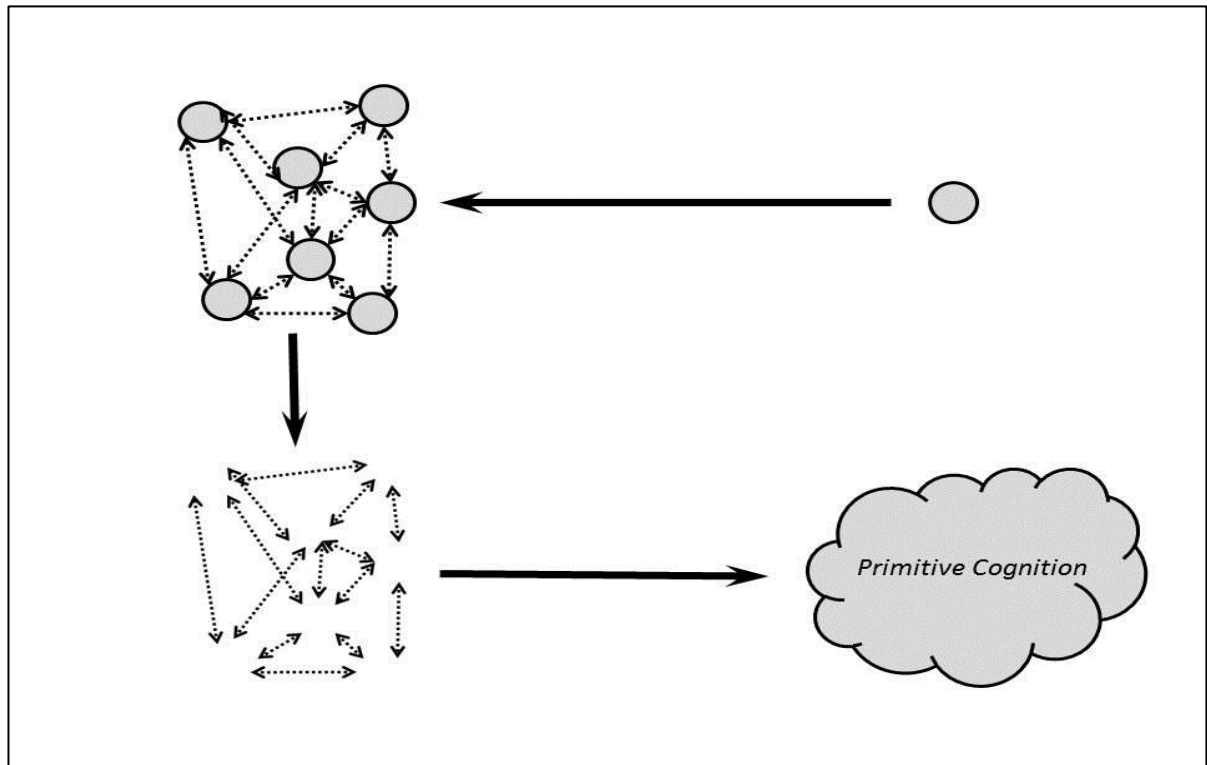


Figure 7.2: Emergence of primitive cognition.

As functional specialisation increased at a structural level, the communication between areas of speciality would also increase, thereby increasing cognitive capacity and, by extension, allowing cognitive ability to increase. This, in turn, would allow for ever-increasing specialisation by the underlying communication networks which would allow for the transmission of more fine-grained, higher quality information. Although the environment would also have been changing during this time, with the liquid becoming less and less turbid, there would still be very few perceptual clues contained within this environment to drive the development of vision beyond needing to differentiate degrees of light/dark. By comparison, sound waves are based on the vibration or *movement* of molecules and carry extremely well in water (Ladefoged, 2005); a functional specialisation based upon such movement (primitive hearing) would have provided a clear evolutionary benefit. See Figure 7.3.

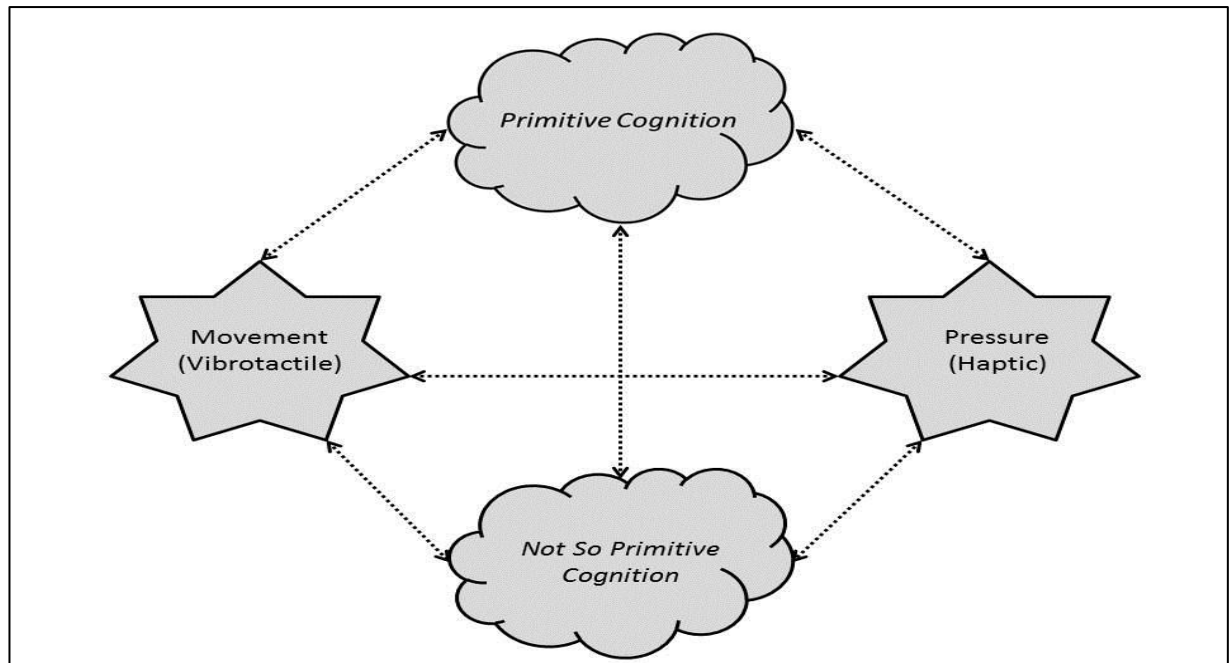


Figure 7.3: Evolution of primitive cognition.

By the time a sense of vision was of any real advantage, primitive cognition would not necessarily have been overly primitive; thus vision (in a perceptual sense) may have emerged from early cognition rather than vision driving the early development of cognition. This is, in part, supported by the way modern human vision works; unlike other perceptual processing, visual *movement* is not perceived directly from the environment; instead, information (such as brightness) encoded by retinal cells needs higher level perceptual processing that computes “...time-dependent brightness patterns...” (Borst & Egelhaaf, p. 297, 1989). More simply, the human visual system needs to add both a third (depth) *and* fourth (time) dimension to visual stimuli, whether an isolated stimulus or more general visual scene.

Sound, alternately, does not need a temporal dimension added at a processing level; instead this is encapsulated within the stimulus itself as the sound string unfolds. Even the diffusion of molecules across a cell membrane inherently contains temporal information; again, this dimension does not need to be computed by perceptual processes. This suggests then, that visual processing may be a more complex perceptual process than other forms of sensory processing, involving computations that are top-down rather than bottom-up in nature. More importantly, if primitive cognition did indeed pre-date visual perception, and this cognition was primarily based on the perception of movement, then the essential basic cognitive substrates for the later development of movement related language (i.e. verbs) would have been laid down.

See Figures 7.4 and 7.5

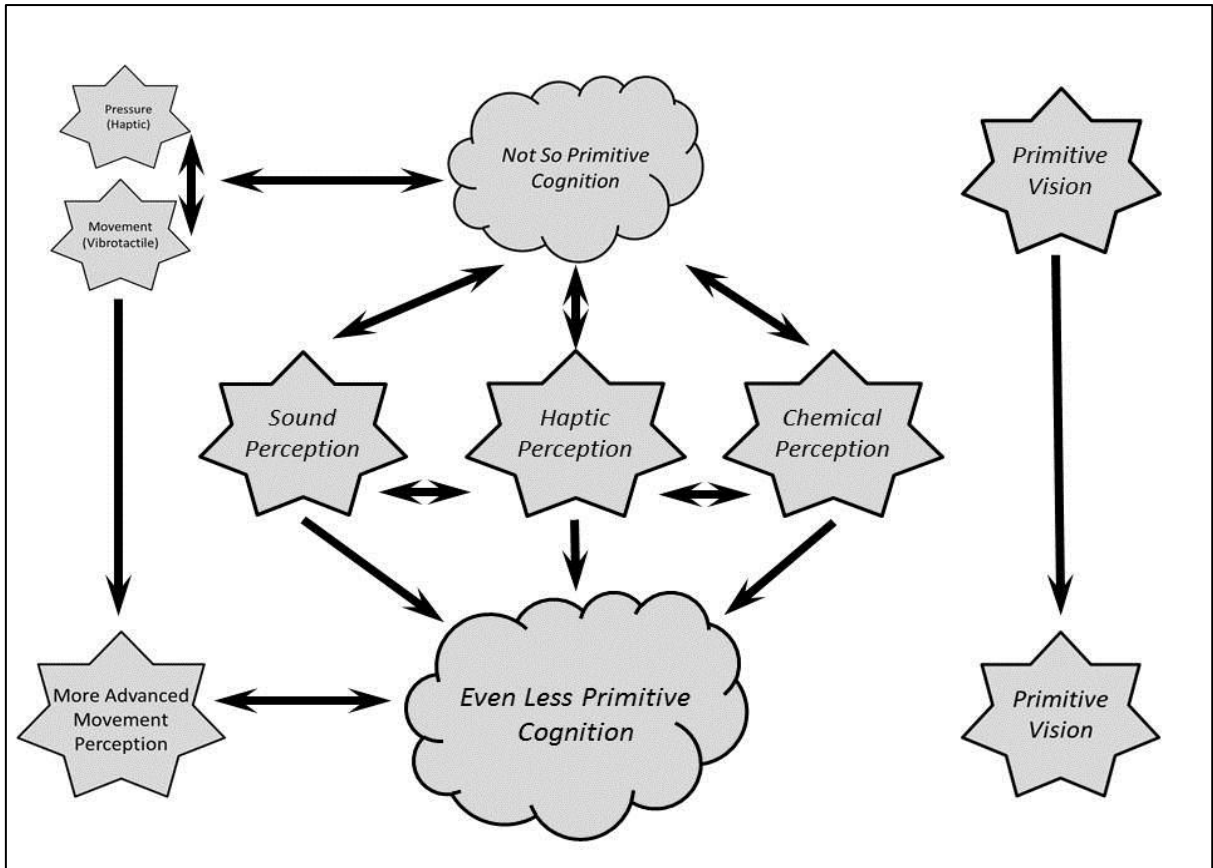


Figure 7.4: Substrates of language emerge

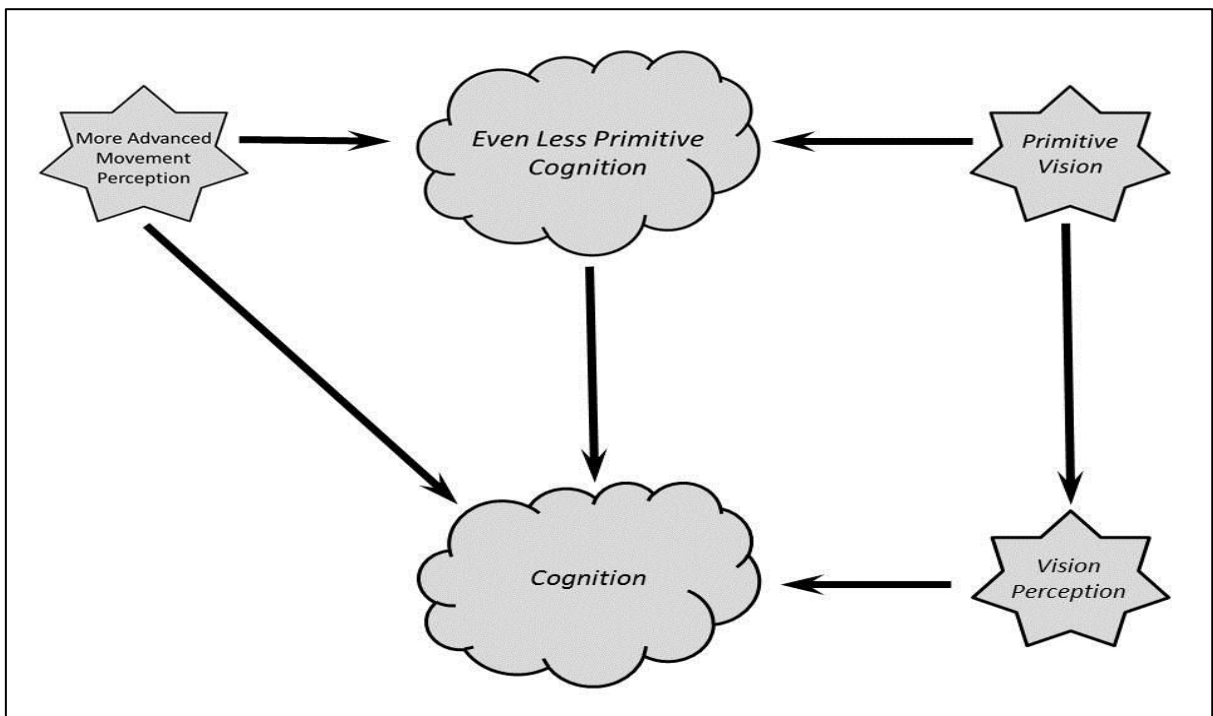


Figure 7.5: Emergence of advanced cognition

As evolution continued, some neurons developed the ability to endogenously mimic exogenous movement; that is mirror neurons evolved. Given that birds have been demonstrated as possessing mirror neurons (Prather, Peters, Nowicki & Mooney, 2008), this development likely occurred in the early stages of vertebrate evolution. This thus refines the basic cognitive substrates needed for the later development of verbs. Similarly, the ability to self-generate sound likely occurred during the early vertebrate stage, although given that some insects use sound to communicate, this ability may well have emerged earlier.

As vertebrates evolved into various different sub-groups, increasing brain sizes (relative to invertebrates) allowed mammals to develop *need/want* communicative systems; that is, self-generated sounds (vocalisations) were harnessed to convey basic emotional states (e.g. fear, hunger) firstly in a reactive, then in an intentional manner. Being subject to anatomical constraints, the evolution of such communicative systems would vary widely between species depending partly upon ecological niche. In the case of primates, however, brain evolution increased exponentially, most notably within frontal lobes (Mithen, 2005). At some point in this development, perhaps with *Homo sapiens*, perhaps earlier, the combination of increased frontal lobe capacity with mirror neuron activity saw the emergence of a *fast brain network* (Kirchner, Barbeau, Thorpe, Régis and Liégeois-Chauvel, 2009) in frontal eye fields. This fast brain network thus provided the neural mechanism to process complex perceptual information in real-time, functioning, in essence, as a type of super computer. It was only with the evolution of this network that language was finally able to emerge, combining elements of both visual perception and vibrotactile perception; that is, vibration (movement) and touch perception. It should be noted that sound perception per se is not necessarily a requirement of this network; as demonstrated by Levänen, Jousmäki and Hari (1998), vibrotactile information is processed by deaf individuals in the same cortical areas that sound is processed by hearing individuals. Furthermore, this vibrotactile information processing is highly sensitive, reported to have discriminatory power of ≤ 1 Hz in the frequency range tested. Similarly, haptic stimulation (e.g. Nanayakkara, Taylor, Wyse & Ong, 2009) works on the basis of amplifying and transforming sound vibrations into tactile vibrations so that deaf individuals are provided with the opportunity to perceive a greater range of musical features. Similarly, it is not vision but rather the neural substrates underlying the *process* of visual perception that contribute to human language; were it not, congenitally blind individuals would not master language. Taken together then, the emergence of human language would look something like Figure 7.6.

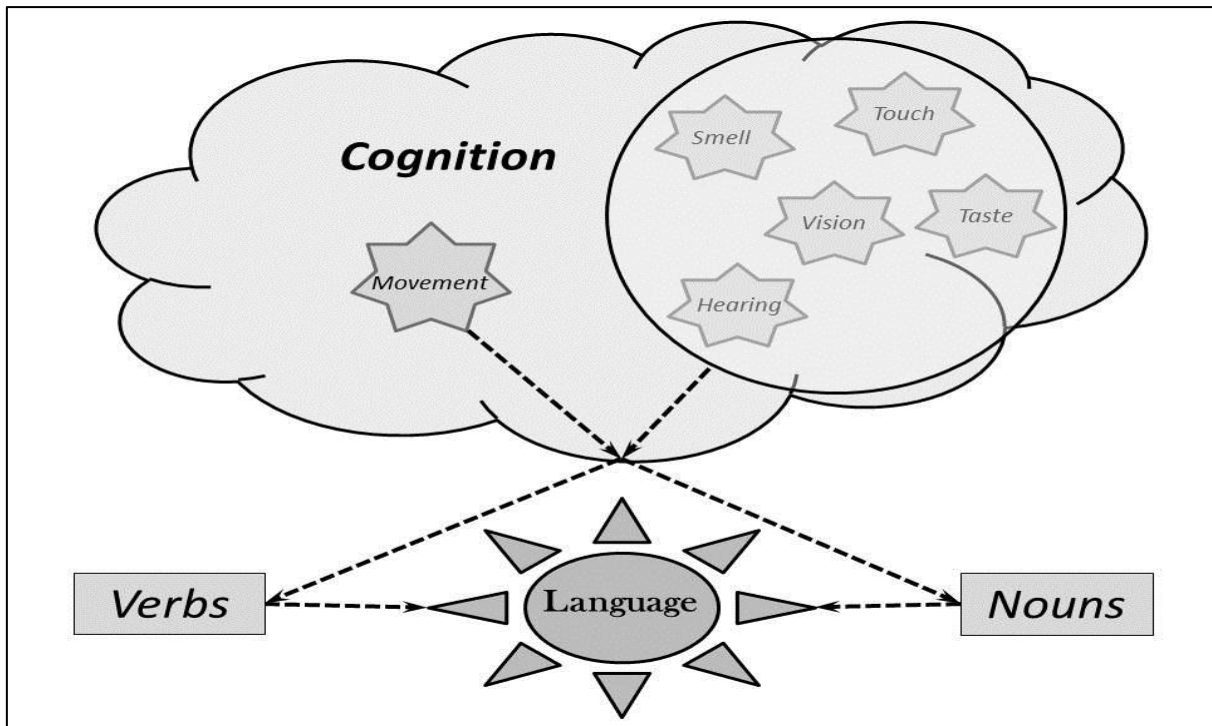


Figure 7.6: Emergence of language.

Perhaps coincidentally (or perhaps ontogeny does sometimes reduplicate phylogeny), this is very much what is seen in human babies.

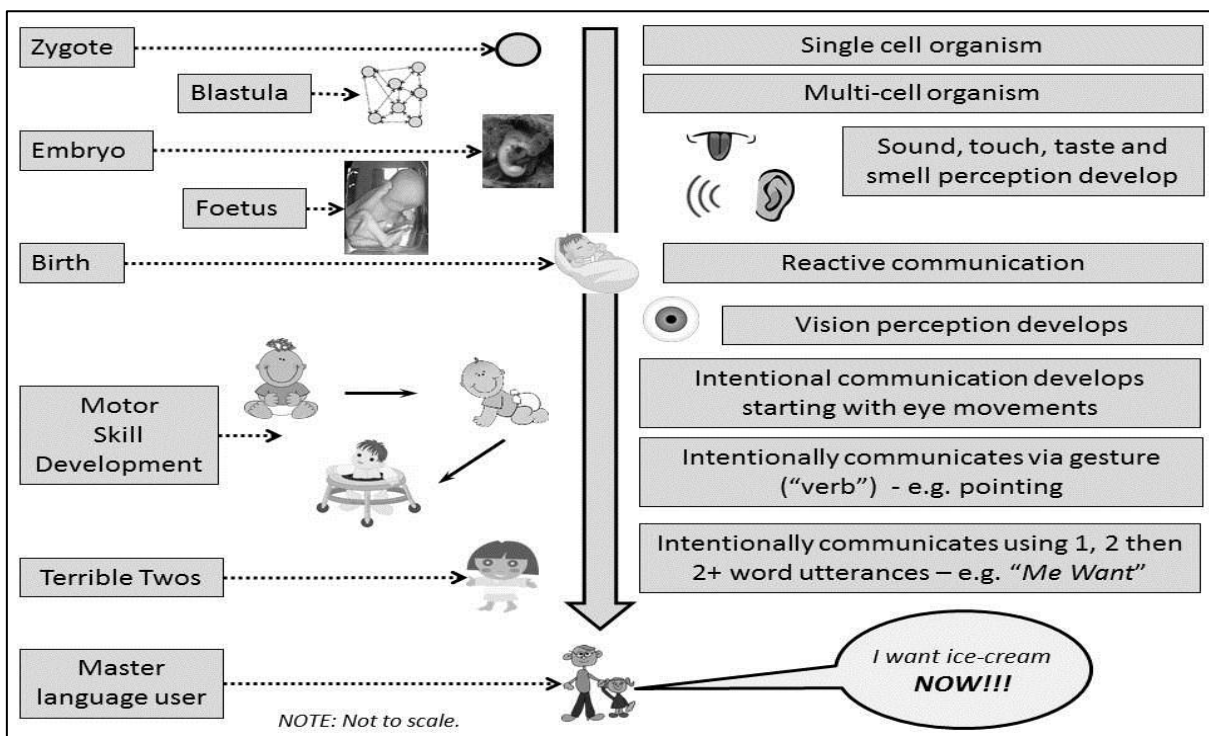


Figure 7.7: Parallels with modern human development.

7.3. Similarities/Differences to Existing Contemporary Models of Language Evolution.

Of the various contemporary theories of language evolution, the model proposed here most closely resembles Arbib's (2002, 2005) theory of co-evolution. There are, however, at least two fundamental differences. Firstly, Arbib (2002, 2005) confers a special role for mirror neurons in language evolution. Although the proposed model also incorporates mirror neurons as being *necessary* for language evolution they are not proposed as being *sufficient*; that is, the development of mirror neurons, in isolation, will not lead to the development of language. Instead, the proposed model suggests a less specific role for mirror neurons related exclusively to movement perception of which the *process* is co-opted by language faculties, specifically verb processing. The second primary difference between the proposed model and Arbib's co-evolution model (2002, 2005) involves the parsing of complex movement sequences into simpler components; while Arbib (2002, 2005) suggests this occurred relatively late in the evolutionary process after the development of mirror neurons, the proposed model places this much earlier in the evolutionary sequence, most notably before the development of both mirror neurons and higher-order visual perception.

Although the latter proposition is obviously speculative, it has some circumstantial support. Recent work (results under preparation) by the current author at the Cognitive Neuroengineering Lab (CNeL) at the University of South Australia has identified that visual processing generates greater global cognitive load (Cocks et al., 2013, 2014) than either audio processing or combined audio-visual processing, with or without cognitive distraction. This effect has been observed on both behavioural (most notably reaction times) and neural measures; in the case of the latter, the effect has been quantified using normalised transfer entropy, TVAR modelling and normalised mutual information approaches, each producing the same result. Of particular note, the effect was also seen across different experimental paradigms including the use of both language and non-language stimuli and using different participant groups. Although an unexpected and counter-intuitive outcome, it can be explained within the context of the proposed model. Specifically, if sound perception is an evolutionarily older sense, it is likely a more *trusted* sense from a neural perspective than vision. It is also a less cognitively taxing sense given that the temporal information is contained within the sound stimulus and does not need to be computed by cognitive processes. As a result, sound (or more generally vibrotactile) perception, is the brain's default setting for environmental monitoring (e.g. for potential threats). In itself this is not an overly original proposal; for example, it is known through the phenomena of the *cocktail party effect* that (in hearing individuals) sound perception forms part of a larger

attentional network that continuously monitors the environment (Pollack & Pickett, 1957). When a personally salient sound string is detected (e.g. your own name), attentional resources are re-directed or *hijacked* to more closely examine that sound string and its relevance to you. This is the same system that monitors your environment during sleep states such that a partner's snoring will not bother you, but the barely audible gnawing of a mouse will have you instantly awake. In the former, it is a *known* non-threatening sound string; in the latter, it is *unknown* and therefore a potential threat. In the case of the CNeL results, if sound processing is considered the default state for monitoring the environment for potential threats, and this default state is compromised (visual only processing forced by experimental task demands), then another sense (vision) must assume the monitoring load normally undertaken by sound processing which would be in addition to the normal load associated with that modality's perception. This would thus explain the reduced global processing when both sound and vision processes are recruited – the default state reasserts its dominance.

7.4. Limitations to the Current Thesis

Beyond the believability constraints inherent in the previous wild speculation, the current thesis and the empirical studies contained within are subject to a variety of limitations. The first of these is the sLORETA (Pascual-Marqui, 2002) approach adopted; this is the first time that sLORETA analysis has been conducted to identify cortical source changes corresponding to ERS/ERD data. Similarly, the plotting of the processing sequence mapped out by focal differences in lower or upper alpha event related changes is a unique albeit conceptually coherent approach. Despite this, the cortical regions identified by sLORETA where upper and lower alpha activity is modulated by language perception related closely match those of previous lesion studies (e.g. Damasio & Tranel, 1993; Shapiro, Moo & Caramazza, 2006; Shapiro & Caramazza, 2003).

A second limitation involved the nonsense word stimuli, both nouns and verbs. While participants were naïve to the nonsense word's grammatical class type at the first presentation of the stimulus, the speaker was not. It is normal practice in professional sound recording studios for the talent (speaker) to pre-read the script to be recorded. This allows the speaker to get a "feel" for how the script should be read as well as giving them the opportunity to identify difficult or unknown pronunciations off-microphone (so as to avoid the Christmas bloopertape). In the current study, the nonsense words were obviously unknown to the speaker thus required both pre-reading and practice. This process thus gave the speaker sufficient grammatical class

information, such that they could no longer be considered naïve. If, as suggested in Chapter 6, grammatical class information is contained in the sub-audible components of a speech string (i.e. in the first 50 - 100 ms where sound wave perturbations can be seen even if not heard), then the speaker's lack of naivety may have unconsciously modulated these components such that they were not truly nonsense when uttered; that is, some grammatical class information may have been embedded within the nonsense stimulus word prior to it being presented to the participants in context.

An inability to more closely examine such sub-audible components is another limitation to the current study. Neither PRATT (Boersma & Weenink, 2001) nor its contemporaries such as KayPENTAX (KayPENTAX Inc., Lincoln Park, NJ) can provide usable information on the first 50ms of a speech string despite there being obvious differences in the sound signals' wave forms; even at 100 ms the amount of useable information is limited. While it may be possible to extract useable data using advanced signal processing techniques such as transfer entropy, this is beyond the scope of both the current thesis. The gender bias in the studies' participants is also an obvious limitation with females outnumbering males by 2 to 1. There are various examples of differences in both brain structure and cognitive ability in different domains between males and females (e.g. Lee et al., 2002; Li, Huang, Constable & Sinha, 2006); whether this amplified or attenuated the results reported in the current thesis remain unknown.

Finally, this thesis is based solely on the results of native Australian English speakers listening to Australian English speech; it is possible that other language types such as tone or click languages do not function in this manner. Given, however, that discriminating results were seen in <100 ms of stimulus onset, primarily within the sub-audible range of the sound string, it is considered unlikely that the results would be language-specific.

7.5. Future research

Until such time that the author gets her hands on an MEG machine, there are two avenues of investigation which will be further examined. The first of these involves identifying and developing a means of extracting relevant, usable information from the sub-audible components of sound waves in a simple, user-friendly manner. Once such data is able to be obtained, it will be examined using both traditional statistical techniques and more advanced signal analysis techniques for any mathematical evidence of an early (<100ms) noun/verb dissociation.

The second research avenue would be to attempt to replicate the grammatical decision/learning task used in the current thesis using both non-English speaking participants and non-speaking (i.e. deaf) participants in their specific native language (spoken or signed). Although adapting the experimental design to use sign language could prove challenging, adapting it for use in another language such as Hindi or Mandarin would be relatively easy. By comparing results between languages it would then be possible to identify if the results reported here are English or more general spoken language related.

7.6. Conclusion

A mysterious sound, the sound of creation; in the beginning was the word.

Was it a sound or a movement?

Nah – ‘twas both!

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Appendix A

Animal Vocalisation Types

Animal Group	Specific Animal	Call type (if known)
General Mammals	Lamb	
	Jaguar	Low growl
	Hippopotamus	
	Cat	
	Bengal tiger	Low growl
	Camel	
Birds	Cougar	High scream
	Penguins	
	Butcher bird	
	Willy Wagtail	
	Magpie	
	Kookaburra	
Cetaceans	Fairy Wren	
	Beluga	
	Dolphin	clicks
	Humpback	song
	Humpback	clicks
	Orca	song
Primates	Orca	clicks
	Capuchin	
	Chimpanzee	hoot (?)
	Chimpanzee	scream
	Gorilla	
	Gorilla	
	Howler monkey	
Monkey (unnamed)	chatter	

Grammatical Descision/Learning Task Stimuli

<p>Artrog. Please artrog those records. Artrog. Archive. Please archive those records. Archive. Artrog. Please check the artrog. Artrog. Archive. Please check the archive. Archive. [Ar-trog]</p>	<p>Fladwick. Some people fladwick their bosses. Fladwick. Flatter. Some people flatter their bosses. Flatter. Fladwick. That looks like fladwick. Fladwick. Flannel. That looks like flannel. Flannel. [flad-wick]</p>
<p>Alork. Their opinions alork a lot of people. Alork. Alarm. Their opinions alarm a lot of people. Alarm. Alork. Bring your alork. Alork Alarm. Bring your alarm. Alarm. [a-lork]</p>	<p>Gathra. The horses gathra every time. Gathra. Gallop. The horses gallop every time. Gallop. Gathra. She has a gathra in her house. Gathra. Galley. She has a galley in her house. Galley. [gath-ra]</p>
<p>Brasdun. Boys brasdun swords every day. Brasdun. Brandish. Boys brandish swords every day. Brandish. Brasdun. The recipe uses a lot of brasdun. Brasdun. Brandy. The recipe uses a lot of brandy. Brandy. [braz-dun]</p>	<p>Grudley. They always grudley in the morning. Grudley. Grumble. They always grumble in the morning. Grumble. Grudley. He was having a grudley about that. Grudley. Grumble. He was having a grumble about that. Grumble. [grud-lee]</p>
<p>Boprub. Boprub that book at once. Boprub. Borrow. Borrow that book at once. Borrow Boprub. I found a boprub. Boprub. Bobbin. I found a bobbin. Bobbin. [boh-prub]</p>	<p>Hebrod. Don't hebrod the performer. Hebrod. Heckle. Don't heckle the performer. Heckle. Hebrod. He wants to go to hebrod. Hebrod. Heaven. He wants to go to heaven. Heaven. [heh-brod]</p>
<p>Colarp. Dogs colarp at the oval. Colarp. Collapse. Dogs collapse at the oval. Collapse. Colarp. He sensed colarp. Colarp. Cologne. He sensed cologne. Cologne. [coh-larp]</p>	<p>Hartroob. Dirty showers hartroob germs. Hartroob. Harbour. Dirty showers harbour germs. Harbour. Hartroob. Hartroob the vegies now. Hartroob. Harvest. Harvest the vegies now. Harvest. [har-true-b]</p>
<p>Checkrit. Girls checkrit their friends. Checkrit. Cherish. Girls cherish their friends. Cherish. Checkrit. Don't touch my checkrit. Checkrit. Cherry. Don't touch my cherry. Cherry. [Check-writ]</p>	<p>Imsup. I imsup you to try harder. Imsup. Implore. I implore you to try harder. Implore. Imsup. She acted on imsup. Imsup. Impulse. She acted on impulse. Impulse. [im-sup]</p>
<p>Dawpint. Students sometimes dawpint. Dawpint. Dawdle. Students sometimes dawdle. Dawdle. Dawpint. He saw his dawpint. Dawpint. Daughter. He saw his daughter. Daughter. [daw-pin-t]</p>	<p>Jigung. Children jigung when they are bored. Jigung. Jiggle. Children jiggle when they are bored. Jiggle. Jigung. Add one jigung of rum. Jigung. Jigger. Add one jigger of rum. Jigger. [jig-mlung]</p>
<p>Elart. They will elart together. Elart. Elope. They will elope together. Elope. Elart. The child drew an elart. Elart. Ellipse. The child drew an ellipse. Ellipse. [ill-lart]</p>	<p>Kreedaw. They kreedaw chaos. Kreedaw. Create. They create chaos. Create. Kreedaw. They made an interesting kreedaw. Kreedaw. Creature. They made an interesting creature. Creature. [cree-door]</p>

Grammatical Descision/Learning Task Stimuli (continued)

<p>Lanvit. Amateurs lanvit the wrong stock. Lanvit. Lasso. Amateurs lasso the wrong stock. Lasso. Lanvit. Girls are sometimes called lanvit. Lanvit. Lassie. Girls are sometimes called lassie. Lassie. [lan-vit]</p>	<p>Queerlik. They queerlik their results every time. Qeerlik. Query. They query their results every time. Query. Queerlik. Please respond to the queerlik. Queerlik. Query. Please respond to the query. Query. [kweer-lick]</p>
<p>Maylack. Maylack the property if you don't want to be evicted. Maylack. Maintain. Maintain the property if you don't want to be evicted. Maintain. Maylack. The knight saw the maylack. Maylack. Maiden. The knight saw the maiden. Maiden. [may-lack]</p>	<p>Renoo. Hardly any people renoo old cats. Renoo. Rescue. Hardly any people rescue old cats. Rescue. Renoo. Hardly any people knew of the renoo. Renoo. Rescue. Hardly any people knew of the rescue. [wren-noo]</p>
<p>Minkip. Many people minkip at social functions. Minkip. Mingle. Many people mingle at social functions. Mingle. Minkip. Many people would like to keep a minkip. Minkip. Minnow. Many people would like to keep a minnow. Minnow. [min-kip]</p>	<p>Snorquiz. These shoes snorquiz my feet. Snorquiz. Snorkel. These snorkels hurt my head. Snorkel. Snorquiz. The sun wrecked my snorquiz. Snorquiz. Snorkel. The sun wrecked my snorkel. Snorkel. [snore-kwiz]</p>
<p>Nodlim. Only desperate people nodlim favourites. Nodlim. Nobble. Only desperate people nobble favourites. Nobble. Nodlim. The doctor found the nodlim. Nodlim. Nodule. The doctor found the nodule. Nodule. [nod-limb]</p>	<p>Traknok. I traknok for work. Traknok. Travel. I travel for work. Travel. Traknok. I like to traknok. Traknok. Travel. I like to travel. Travel. [track-knock]</p>
<p>Orcrim. Bus drivers orcrim passengers around. Orcrim. Order. Bus drivers order passengers around. Order. Orcrim. The driver saw the boy eat an orcrim. Orcrim. Orchid. The driver saw the boy eat an orchid. Orchid. [or-crim]</p>	<p>Upronk. That upronk the owner. Upronk. Upset. That upronk the owner. Upronk. Upronk. That caused an upronk. Upronk. Upset. That caused an upset. Upset. [up-ronk]</p>
<p>Progump. Banks progump many requests. Progump. Process. Banks process many requests. Process. Progump. Time to check your progump. Progump. Progress. Time to check your progress. Progress. [pro-gump]</p>	<p>Vamund. Doctors vamund nurses. Vamund. Value. Doctors value nurses. Value. Vamund. That has great vamund. Vamund. Value. That has great value. Value. [vam-ind]</p>
<p>Paslow. Ducks paslow in dams. Paslow. Paddle. Ducks paddle in dams. Paddle. Paslow. I lost my paslow. Paslow. Package. I lost my package. Package. [paz-low]</p>	<p>Wilcark. Please wilcark that song. Wilcark. Whistle. Please whistle that song. Whistle. Wilcark. Don't wilcark in class. Wilcark. Whistle. Don't whistle in class. Whistle. [will-cark]</p>