Garden path model and the constraint based model

Theories into sentence processing can be viewed from two main accounts; a modular account or an interactive account. Garden path model proposed by Fraizer and Rayner (1982) supports the modular account, arguing sentence processing involves the analysis of each individual unit or module of a sentence, with little or no feedback, thus inhibiting correction. Whereas an interactive account supported by the constraint based theory, (McDonald, 1994) argues sentence processing involves immediate incorporation of all available information in creation of the final output. This essay will explore principles of both Garden Path Model and Constraint Based Theory of sentence processing, highlighting their similarities and differences as well as major strengths and weaknesses associated with both models. This essay will continuously compare and contrast both models on issues such as; minimal attachment and late closure, reanalysis, sentence length, contextual properties, working memory capacities and evidence from event related potentials in an attempt to answer the question in focus.

The Garden path model proposed by Frazier and Rayner (1982), argues readers only consider initially one syntactic structure for any given sentence and meaning is not involved in the selection of preliminary syntactical meaning. Thus, readers and listeners can be misled by ambiguous sentences (i. e. garden path sentences). Whereas Constraint based theory proposed by MacDonald (1994), argues all relevant information is available immediately to the parser during reading and listening. The incoming information is analysed and all possible constraints or outputs are activated and ranked according to the strength of the subsequent activation. The syntactic structure receiving the most support from the constraints will be highly

activated and thus chosen. In essence, activated constraints are in competition with one another and when two constraints are equally activated ambiguity arise. These two theories propose conflicting, basic ideologies; Garden Path model argues only one syntactic structure is initially considered and meaning is not involved in selection of syntactic meaning, whereas, constraint based theory argues all relevant information is used and several syntactical meanings are initially considered before the most appropriate is selected.

Frazier and Rayner's Garden Path Model proposes that listeners and readers chose the simplest syntactical structure by implementing two general principles; minimal attachment and late closure. The principle of minimal attachment states the grammatical structure producing the fewest nodes is preferred. Rayner and Pollatsek (1989) provided partial experimental support for minimal attachment. They used the sentences; " The girl knew the answer by heart" and " The girl knew the answer was wrong." Rayner and Pollatsek observed the principle of minimal attachment led to a grammatical structure in which " the answer" is regarded as the direct object of the verb " knew", this is appropriate for the first sentence but leads to ambiguity in the second sentence. Therefore it can be argued the principle of minimal attachment may not work for all sentences, highlighting a weakness. Altmann et al (1998), argue all possible meanings of a sentence are considered during, and at the end of a sentence and principles of minimal attachment are inadequate in sentence processing, thus supporting the constraint based theory. Frazier and Rayner (1982) argue minimal attachment and late closer attempt to reduce pressure on working memory

during sentence processing, making it less economically taxing, a strength of this theory. They recorded participants' eye movements whist they read sentences like; " since Jay always jogs a mile seems like a short distance." If readers construct both or all possible syntactic structures, there should be additional processing time at the point of disambiguation. Eye movement data provided support for the predictions of the garden path model. These finding are in opposition with the Constraint based theory that argues several constraints are activated before the output is chosen, thus making this method of sentence processing more taxing than the Garden Path model in which no interpretation is considered until the end of sentences (Clifton, 1993). Fodor and Inoue (2000) argue the parser works on the method of minimal processing and will do the minimum amount of analysis possible, supporting the Garden Path Model. Minimal attachment is argued to be universal to all languages (Frazier and Rayner (1982). However several studies contradict this argument. Cueto and Mitchell (1988), Carreiras and Clifton (1993, 1999) and Traxler et al (1998) found a low attachment preference within the English language but found a high attachment preference within the Spanish language. Thus meaning minimal attachment would not be applicable in the Spanish language. Thus conflicting the assumptions of the Garden Path Model. Mitchell et al (1995) argued attachment preferences may be different between languages due to the fact that in some languages, high relative clause attachment is most frequent, whereas in other languages such as English, low clause attachment is most frequent. As a result of these findings, cross-linguistic differences in clause attachments present a problem for the Garden Path Model as the principles

of minimal attachment and late closure assume a universal preference for low attachment. Highlighting a weakness

The principle of late closer proposes new words encountered in sentences are attached to the current phrase or clause if grammatically permissible. This principle conflicts assumptions of the constraint based theory as meaning is assigned as new words are attached rather than when all information is available. Alternatively supporting the Constraint based theory Carreiras and Clifton (1993) provided evidence that readers do not follow the principle of late closure. They presented participants with sentences such as " The spy that shot the daughter of the colonel who was standing on the balcony." According to late closure, readers or listeners should perceive this sentence as meaning the colonel, rather than the daughter, was standing on the balcony, however this was not observed.

Principles of minimal attachment and late closure within the garden path model determine peoples initial analysis of sentences, however if initial analysis is inconsistent due to ambiguous sentences, a process of reanalysis must occur (Frazier and Rayner 1982). Reanalysis occurs when initial analysis is inconsistent with later information encountered. According to VanGompel and Pickering (1999) within the constraint based theory all possible analyses are activated with most appropriate being selected, thus meaning reanalysis does not take place. According to MacDonald's (1994) constraint based theory, processing difficulty only arises when two or more constraints have approximately equal activation resulting in competition. Constraints at the beginning of the sentence strongly activate one analysis but, disambiguating information encountered later on activates an

alternative analysis, both possible analyses having equal activation competition results. This disambiguating information increases time taken for the incorrect analysis to be inhibited and results in processing difficulties, a weakness of this theory. Ferreira and Henderson (1991) argued the further the head noun is from the point of disambiguation, the stronger readers or listeners will commit to a thematic analysis, thus making reanalysis more difficult. Another conflicting argument to Frazier and Rayner's reanalysis principle was put forward by Sturt et al (2002) who showed that during reanalysis, attachment to a recent phrase is preferred to attachment to a more distant phrase, arguing reanalysis and reattachment of more distant phrases are more costly. However reanalysis does not always occur when disambiguation is encountered, highlighting a weakness of this theory. Christianson et al (2001) argued people do not always successfully discard their initial analysis after syntactic disambiguation is experienced, which is in contrast to most models of reanalysis and the garden path model. Participants read the sentence; " while Anna dressed the baby that was small and cute spit up on the bed." Participants correctly identified who " spat up on the bed", suggesting they had correctly analysed the baby as the subject of " spit up". When asked if Anna dressed the baby, most participants answered yes. This finding led Christianson et al to conclude that readers adopted the baby as the subject, whilst maintaining the incorrect analysis where the baby was the object of the preceding verb " dressed". Findings from this study provide arguments in contrary to principles of successful reanalysis.

Sentence length can have an influence in the process of reanalysis, but it has also been argued that sentence length can have an effect on overall initial processing of sentences prior to any reanalysis. Ferreira, Christianson and Hollingworth (2001) argued longer phrases are harder to process and using minimal attachment more errors are likely to be made, showing a weakness of this theory. It has been found that disfluencies (including filled and silent pauses) lengthen sentences and make them harder to process. Bailey and Ferreira (2003) investigated the effects of sentence disfluencies, observing that disfluencies allowed parsers to linger on the initial parse and commit to an incorrect interpretation via minimal attachment and late closer, indicating a weakness of this theory. Christianson et al (2001) support this argument, concluding; the longer a parser lingers on an incorrect parse, the more likely they are to maintain an incorrect interpretation. Maxfield, Lyon and Silliman (2009) investigated the effects of disfluencies on garden path processing. They found disfluencies resulted in more incorrect interpretations, suggesting sentence processing is not an all or none process, therefore discrediting the constraint based theory.

Effective contextual properties have been found to provide supportive evidence for the constraint based theory. Spivey et al (2002) looked at eye movements in response to auditory garden path sentences within the context of visual arrays. They asked participants to " put the apple on the towel in the box". They recorded participants' eye movements to assess how the sentence was interpreted. According to the garden path model " on the towel" should initially be understood as the place where the apple should be put because it is the simplest syntactical structure. In the absence of visual

context this is what was found. When the visual context consisted of two apples, one on a towel and the other on a napkin, participants rapidly interpreted " on the towel" as a way of identifying which apple was to be moved. Results show that visual contexts reduce ambiguity and prevent garden path effects.

Event related potentials (ERP) have provided influential evidence in sentence processing. ERPs measure brain responses as the direct result of thought or perception. Osterhout and Nicol (1999) established an ERP of N400 following perception of semantic anomalies. Osterhout and Nicol (1999) found a syntactic anomaly produced an ERP of P600, As syntactic analysis only is involved in the garden path model, observing an ERP of P600 would indicate this model of processing. Osterhout, Holcomb and Swinney (1994) suggested that P600 is the marker of a garden path effect. However Maxfield, Lyon and Silliman (2009) found that fluent garden path sentences resulted in P600 but garden path sentence containing a filled or silent pause activated an ERP of N400, this would suggest that these sentences are perceived as having a semantic anomaly which would discredit the garden path model of processing which claims semantic analysis is not involved in initial sentence analysis. P600 has been hypothesised to indicate memory updating and processes of reanalysis (Friederia 2001 and Frisch et al 2002), therefore being unique to the garden path model. Osterhout and Nicol (1999) have found a sentence containing both semantic and syntactic violations activate an ERP of both N400 and P600, suggesting semantic and syntactic processing work independently, supporting the garden path model rather than the constraint based theory.

In conclusion the garden path model and the constraint based theory of sentence

processing argue fairly conflicting ideologies', thus making these models very different. The garden path model argues the principles of minimal attachment and late closure, which is in contrast to the constraint based theory. The constraint based theory argues all possible interpretations of sentences are activated with the most appropriate being selected, arguing the absence of reanalysis; again this is in contrast to the garden path model. The garden path model only initially considers syntactical information whereas constraint based theory considers all available information but is very taxing on working memory. Both models have been shown to have many strengths and weaknesses. In relation to the title question it has been shown that both models offer reasonably contrasting arguments of sentence processing and no sole conclusive model of sentence processing has yet been established.

Word Length= 2013

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