Context Effects on Spoken and Written Word Recognition

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Abstract

There has been a long-standing debate as to how the individual stages of language processing function and what their relational structure is. At one extreme are the widespread models of interactive activation allowing for higher level influences on lower level operations in the system. At the other are the proponents of the modular system of autonomous stages allowing only for unidirectional flow of information. In this paper I will argue for the position that context effects are the result of a top-down spread of activation. Discussing various studies on spoken and written word recognition, I show how context helps the word recognition process.

Keywords: context effects, spoken word recognition, written word recognition

1. Introduction

The issue of the internal brain processing underlying the phenomenon of context effects on word recognition has drawn much attention in the literature on cognition and psycholinguistics as it bears direct implications for the overall structure of the cognitive architecture. There has been a long-standing debate as to how the individual stages of language processing function and what their relational structure is. At one extreme are the widespread models of interactive activation allowing for higher level influences on lower level operations in the system. At the other are the proponents of the modular system of autonomous stages allowing only for unidirectional flow of information. In this paper I will argue for the position that context effects are the result of a top-down spread of activation and show how they help the word recognition process with reference to both written and spoken language.

2. Word context effects on letter recognition and phoneme perception

2.1 *Letter recognition*

Perhaps one of the earliest evidence for context effects on letter recognition comes from Reicher's experiment in 1969 (McClelland & Rumelhart 1981, Rumelhart & McClelland 1981). Using target letters in words, unpronounceable nonwords and single letters, he shows that context has influence on perceptual processing. His results suggest that letter recognition is facilitated by the context of the word because letter perception is better for letters in words than for letters in nonwords or in isolation. The interactive activation model (McClelland & Rumelhart 1981) allowing for bidirectional communication between upper and lower levels of the language process system accounts very well for these occurrences. According to McClelland & Rumelhart letters in words are more easily perceptible than isolated letters or letters in nonlexical contexts due to the higher level of activation they receive from the 'active word detectors' (1981:376).

Johnson & Pugh's experiment (in Williams 2003a, *Visual Word Recognition*. Lecture Handout) offers further illustration of how context influences lower, sublexical level processing. Namely, due to intense hypothesising going on at the lexical level, the recognition time for words for which there are more similar words in the mental lexicon is longer. This indicates that the identification of a word depends not only on the information about that particular word but also on the information about other words because only in that way can the proper candidate emerge from among the competitors (Marslen-Wilson 1989:7). The slowing down of the recognition process resulting from the hypotheses competition taking place at word level illustrates that there is parallel hypotheses building in higher and lower levels with the word level feeding information back to the letter level before letters are fully perceived.

2.2 *Phoneme perception*

2.2.1 *Evidence for context effects*

Another influential evidence showing how the top-down spread of activation helps recognition comes from the domain of auditory word recognition, in particular phoneme perception. Cole & Jakimik's and Marslen-Wilson & Welsh's studies on mispronunciation during listening suggest that stimulus factors interact with contextual ones (in Levy 1981:9). In Cole & Jakimik's experiment, where subjects were asked to detect errors, subjects detected mispronunciations faster and more frequently in words related to the topic of the passage they appeared in. In Marslen-Wilson & Welsh's experiment of shadow reading, where subjects were asked to repeat exactly what they hear, subjects corrected the pronunciation of mispronounced words. In both experiments the 'thematic constraints' of the context induced predictions about the forthcoming word (Levy 1981:9), thus resulting in faster rejection of the mispronounced stimuli and phoneme restoration, respectively, which indicates that the lexical level feeds information back to the sub-lexical level very early in the recognition process.

There have been other studies conducted which seem to support this view. Magnuson *et al* (2003a:286) report the so called 'Ganong' effect as indicating that lexical knowledge influences categorical perception. Namely, they explain the shift in the category boundary towards the endpoint of the continuum that forms a word by the lexical feedback affecting phoneme processing. In their view, the ambiguous phoneme activates candidate phonemes, which in turn activate relevant lexical representations. When one phoneme makes a word and the other does not, there is a feedback of activation which activates the corresponding phoneme (Magnuson *et al* 2003a:286). They also add that lexical feedback compensates for noise occurring in speech by constraining the interpretation of the bottom-up signal.

Having observed changes in the category boundary for consonants varying along a continuum after subjects have adapted to the restored phoneme originally replaced with white noise, Samuel, too, concludes that the adaptation results from the perceptual restoration of phonemes, i.e. phonemes are prompted by lexical activation (1997:121). He also mentions Elman and McClelland's results as one of the strongest evidence available for top-down lexical effects (1997:122). They demonstrated that lexical information affects phoneme perception, which in turn produces compensation for coarticulation (subjects heard an ambiguous sound between /t/ and /k/ as /k/ after /s/ and as /š/ after /t/). Thus, being a low-level process, especially as it also operates across word boundaries, compensation for coarticulation is triggered by a restored phoneme which is itself yielded by a lexically driven process. Accordingly, Samuel points that in both studies, the result of lexical processing (a particular phoneme) produces a sublexical effect (1997:122).

2.2.2 *Challenges*

However, Pitt and McQueen (1998) challenge this conclusion providing evidence for a different interpretation of the effect. They test their transitional probabilities (TPs) hypothesis (the thesis that the occurrence of an upcoming phoneme is assumed based on the context established by its preceding counterpart) in nonword contexts allowing for high likelihood of occurrence of a certain phoneme and word contexts allowing for equal probability of occurrence of particular phonemes, thus arriving at results that show compensation for coarticulation for the former while none for the latter. Furthermore, Norris et al in 2000 (in Norris et al 2003) explain the data by offering a model with a completely feed forward architecture. They make a distinction between phonetic percepts and phonetic decisions concluding that there are lexical activation influences on the decision on a phoneme, but not on its perception (Samuel & Pitt 2003).

In order to defend their position Magnuson et al (2003a) repeat Elman & McClelland's experiment but use contexts of phonemes in which the most likely phoneme to follow is the one that in Elman & McClelland's set was the least likely one to follow. Aware that TPs could influence perception, they argue that words are more predictive due to the powerful effects and the redundancy information afforded by lexical status.

Their conclusions are again challenged by Norris et al (2003). They interpret the results of their experiment in the light of what they call 'perceptual learning'. Namely, in their view, listeners adjust their category judgments as a result of the adjacent speech setting and that adjustment has a long-term effect. They account for that by building a model of simple feed forward networks of layers functioning independently, like modules, and passing information in one direction only. However, there is an error-correcting signal going back into the network via separate feedback pathway, thus unaffecting the on-line processing and providing feedback for learning only.

McQueen (2003) also attacks Magnuson et al's results saying that contextual bias could have prompted the compensation process, and, thus, rejects the possibility of having on-line feedback during speech recognition. Magnuson et al (2003b), on the other hand, taking parsimony as their cornerstone, respond that on-line lexical feedback can only account for perceptual learning and compensation for coarticulation effects. Therefore, it seems that the arguments interactionists offer by far outweigh those offered by proponents of the modular view.

3. Context effects on word recognition

3.1 *Visual word recognition*

When it comes to visual word recognition the issue is rather complicated. According to Harley (2001:156), the evidence for automatic associative priming is pretty clear-cut, i.e. words that are associatively related are recognised faster than those that are not (e.g. the reading time for *teacher* as a response to *school* is quicker than that for *bell* as a response to *school*). However, there have been mixed results regarding the priming of non-associative words. This has led some to conclude that the basis of priming are the associative links between frequently congruous words and therefore priming is an automatic process not influenced by the conceptual network's responses (Fodor, Forster in Lucas 2000). These arguments are refuted by many other studies and, particularly, by the meta-analysis of those studies done by Lucas (2000), which has shown that semantic non-associative priming is automatic as the strength of the semantic priming effect is not affected by processes of strategy building and, therefore, strongly support the lexico-semantic interaction, i.e. the influence of context on recognition.

There have been similar disagreements as to the question of sentence context effects on word recognition. Experiments investigating this issue have had mixed results. Forster's analysis (in Williams 2003a, *Visual Word Recognition*. Lecture Handout) shows that even congruous contexts do not appear to facilitate the recognition of predictable words, while Balota et al's one (1985) seems to indicate that context, nevertheless, has some effect on word recognition. Investigating the interaction of contextual constraints and peripheral visual information during reading, Balota et al show that the more predictable from the sentence context the items are, the more peripheral visual information is used. On the other hand, when the information in the visual field is degraded, it provides very little evidence for an effect of context. This seems to be contrary to what Stanovich & West have found out. Their analysis of sentence context effects reported in 1983 confirms their previous findings that more difficult and degraded words display larger context effects than easier words, even when the difficult words are less predictable. This is so because inefficient bottom-up processing makes readers use contextual information more. In their view this accounts for why poor readers display very large contextual effects on word recognition, which is not the case with fluent readers. The implication they make is that they are not in favour of the interactive model, limiting it only to marginal cases. But, however marginal they are, these cases still support the top-down processing model, although the researchers analysing them do not seem to favour it.

3.2 *Auditory word recognition*

The case with spoken word recognition is not very straightforward either. This is particularly so as it is difficult to find evidence for context effects on phoneme perception. Although there have been several studies (Connine 1987, Samuel 1981 reported in Williams 2003b, *Spoken Word Recognition*. Lecture Handout) investigating hearers' perception of phonemes found in different contexts, none seems to have found reliable evidence. This makes one conclude that phoneme recognition is not affected by sentence context.

However, this is not the case. The analyses of the effects of sentence context on word recognition have proved fruitful. Assuming that phoneme identification occurs after word recognition, Morton and Long (in Levy 1981) find that initial phonemes are detected better in target words that are predictable from the prior sentence context. Their argument is that the context of the sentence facilitates access to lexical representations for expected words.
Another experiment done by Marslen-Wilson & Tyler (in Eysenck & Keane 2000) using the word monitoring task in normal prose, syntactic prose and random word order seems to show that semantic and syntactic constraints influence word recognition. Nevertheless, in his later writings Marslen-Wilson (1989) argues that phoneme perception is not affected by context effects very early in processing, concluding that contexts effects are the result of other mechanisms which do not involve top-down activation. However critical his arguments are, they are not devastating for the whole line of argument in favour of the interactive activation model, i.e. the view that context helps word recognition.

4. Conclusion

In this paper I discussed the role of context in the word recognition process. From what I presented above it is clear that there is no simple and straightforward answer to the question of context effects on word recognition. Yet, considering the evidence available on both spoken and written word recognition, I showed how context helps the word recognition process. The data for word context effects on letter and phoneme perception are pretty revealing in this respect, whereas those for sentence context effects on both written and spoken words, while being less so, still support the view that context helps word recognition. These complicated issues are subject of much current discussions between interactionists and modularists as they have direct implications for the organisation of the language processing architecture as a whole.

5. Bibliography

Balota, D.A., Pollatsek, A. & Rayner, K. (1985) The Interaction of Contextual Constraints and Parafoveal Visual Information in Reading. Cognitive Psychology, 17, 364-390

Eysenck, M. W. & Keane, M. T. (2000) Cognitive Psychology. Psychology Press Ltd.

Harley, T. A. (2001) The Psychology of Language. Academic Press

Levy, B. A. (1981) Interactive Processing during Reading. In (eds.) Lesgold, A. M. & Perfetti, C. A. Interactive Processes in Reading. Lawrence Erlbaum Associates

Lucas, M. (2000) Semantic Priming without Association: A Meta-analytic Review. Psychonomic Bulletin and Review, 7, 618-630

McClelland, J. L. & Rumelhart, D. E. (1981) An Interactive Activation Model of Context Effects in Letter Perception: Part 1. An Account of Basic Findings. Psychological Review, 88, 365-407

Marslen-Wilson, W. (1989) Access and Integration: Projecting Sound onto Meaning. In (ed.) Marslen-Wilson, W. Lexical Representation and Process. MIT

McQueen, J. M. (2003) The Ghost of Christmas future: didn't Scrooge learn to be good? Commentary on Magnuson, McMurray, Tanehaus, and Aslin. Cognitive Science, 27, 795-799

Magnuson, J. S., McMurray, B., Tanehaus, M. K. and Aslin, R. N. (2003a) Lexical effects on compensation for coarticulation: the ghost of Christmas past. Cognitive Science, 27, 285-298

Magnuson, J. S., McMurray, B., Tanehaus, M. K. and Aslin, R. N. (2003b) Lexical effects on compensation for coarticulation: a tale of two systems? Cognitive Science, 27, 801-805

Norris, D., McQueen, M. J. & Cutler, A. (2003) Perceptual learning in speech. Cognitive Psychology, 47, 204-238

Pitt, M. A. & McQueen, M. J. (1998) Is Compensation for Coarticulation Mediated by the Lexicon?. Journal of Memory and Language, 39, 347-370

Rumelhart, D. E. & McClelland, J. L. (1981) Interactive Processing Through Spreading Activation. In (eds.) Lesgold, A. M. & Perfetti, C. A. Interactive Processes in Reading. Lawrence Erlbaum Associates

Stanovich, K. E. & West, R. F. (1983) On Priming by a Sentence Context. Journal of Experimental Psychology: General, 112, 1-36

Samuel, A. G. (1997) Lexical activation Produces Potent Phonemic Percepts. Cognitive Psychology, 32, 97-127

Samuel, A. G. & Pitt, M. A. (2003) Lexical activation (and other factors) can mediate compensation for coarticulation. Journal of Memory and Language, 48, 416-434.