Title
What Happens When Experts Over- or Underestimate a Layperson's Knowledge in Communication? Effects on Learning and Question Asking

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 27(27)

ISSN
1069-7977

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Publication Date
2005

Peer reviewed

Form-priming of Language: Inhibition and Facilitation

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Abstract

In various priming paradigms, segmental overlap (i.e. phonological or orthographical overlap) between the target and prime word has been demonstrated to facilitate picture naming. But features extending over several segments are rarely controlled for in stimulus selection. Some attention has been paid to such suprasegmental features, but inconsistent findings have been obtained. The presented studies took up this issue and the combination of word stress and vowel quality was investigated in a picture-word task. In the picture-word interference task, pictures are named while attempting to ignore simultaneously presented distractors words. A series of three experiments presented Dutch target and distractor words of three possible suprasegmental patterns while controlling for a manifold of variables. Distractor words inhibited picture naming for picture targets of a fully related suprasegmental pattern. A fourth experiment obtained a facilitatory main effect of segmental overlap, whereas the suprasegmental effect dissipated when suprasegmental features are manipulated in the presence of segmental overlap. This observation clarifies results of Experiment 3 in which segmental overlap was an artefact of the manipulation of suprasegmental overlap. Inhibitory form priming has been observed in other picture naming paradigms and variants of the picture-word task. An account was extrapolated from these instances, as an attempt to cover both facilitatory, inhibitory, and null effects of suprasegmental overlap.

Introduction

Many theories have adopted a frame-content approach to speech production in which language structure ('frames') and content ('fillers') are distinguished as separate representations. In line with a frame-content approach, a phonological representation could comprise a separate suprasegmental representation that is independent of the segmental content and might be susceptible to priming.

Generally, segmental overlap between target and distractor word has been demonstrated to facilitate speech production in various paradigms, such as the picture-word interference task (e.g., Posnansky & Rayner, 1978), the translation naming task (e.g., La Heij et al., 1990), and the implicit priming paradigm (e.g., Meyer, 1990). Thus far, little attention has been paid to features extending over several segments, especially word stress and vowel quality, and suprasegmental features are rarely controlled for in stimulus selection. Nevertheless, some suprasegmentals are (reasonably) fixed word properties, such as word stress and vowel quality.

Attempts to prime the stress pattern of a word led to diverse findings and interpretations. Depending on the particular stress pattern, the effect of stress overlap ranges from facilitation to inhibition, or no effect is produced unless in combination with segmental overlap (Meijer, 1994; Roelofs & Meyer, 1998; Schiller, Fikkert, & C.C. Levelt, 2004). The picture word-interference task led to facilitatory effects of overlap in word-initial stress and inhibitory effects of overlap in word-final stress (Schiller et al., 2004, Experiments 1, 2, and 3).

Mixing both stress types, Meijer (1994, Experiment 1) obtained facilitatory effects of stress overlap and of segmental overlap, that did not interact. In a subset of Experiment 1 however, the stress effect was restricted to the conditions with segmental overlap. Using the word translation task, Meijer (1994, Experiment 2 and 3) confirmed the latter pattern, but the segmental overlap yielded inhibition instead of facilitation. Meijers (1994) Experiments 7 and 8 manipulated stress overlap within segmental overlap and mismatching syllable number: monosyllabic targets were combined with disyllabic primes carrying initial versus non-initial stress. A facilitatory effect of stress overlap was obtained in Experiment 8 only. Experiment 9 crossed stress overlap and segmental overlap within mismatching syllable number. A facilitatory effect of stress overlap was found regardless of segmental overlap whereas segmental overlap yielded inhibition within different stress and facilitation within same stress. Stress overlap in implicit priming experiments (Roelofs & Meyer, 1998) resulted in no effect (Experiment 5 with initial and non-initial stress targets put together) or an inhibitory effect (Experiment 2, using non-initial stress on second and third syllable). Experiment 2 crossed stress overlap with segmental overlap. A facilitatory effect of stress overlap was obtained in the conditions with segmental overlap, but only for the subset of targets bearing stress on the second syllable. Segmental overlap also facilitated production latencies but the effect was restricted to the conditions with stress overlap.

Summarizing, some experiments showed a facilitatory effect of stress overlap (Meijer, 1994, Experiments 1 and 9). But such facilitation could also be restricted to overlap in word-initial stress whereas overlap in word-final stress led to inhibitory effects (Schiller et al., 2004, Experiments 1, 2, and 3; see also Roelofs & Meyer, 1998, Experiment 2). Yet other experiments failed to obtain an effect of stress overlap (Meijer, 1994, Experiment 7; Roelofs & Meyer, 1998, Experiment 5; Schiller et al., 2004, Experiment 4). And some experiments seem to indicate the (facilitatory) effect of stress overlap appears only in combination with segmental overlap (Meijer, 1994, Experiments 1, 2, 3, and 8; Roelofs & Meyer, 1998, Experiments 2 and 5).

As an attempt to tackle the full scope of these findings, certain mechanisms have been suggested to restrict suprasegmental priming. Meijer (1994) proposed suprasegmental priming might occur only in the presence of segmental overlap (i.e. the parallel independence hypothesis). In addition, Levelt et al. (1999) assume no suprasegmental representation is composed when stress is default (and default is defined as stress assignment to the first stressable syllable of the word: Levelt & Schiller, 1998). Therefore, stress priming would be limited to non-default stress. And despite consistent stress effects in three experiments, Schiller et al. (2004) consider stress assignment to be fully computational and therefore unable to produce coherent stress priming. In general, the mechanisms of stress assignment remain unclear (e.g., Colombo, 1992; Daelemans, Gillis, & Durieux, 1994; Levelt et al., 1999; Rastle & Coltheart, 2000; Schiller et al., 2004).

Concluding, stress priming experiments yielded inconclusive evidence and the mechanisms of stress assignment remain unclear. The present study took up these issues and the combination of word stress and vowel quality were investigated as one possible component of a suprasegmental representation. Word stress was chosen because of the importance it has been awarded in the issues mentioned above. Linguistically, the assignment of word stress is influenced by other structural word properties such as vowel quality (Kelly, 2004): word stress cannot be assigned to a syllable with a reduced vowel (Chomsky & Halle, 1968). Vowel quality is either full or neutral, the latter stemming from reduction (i.e. mostly schwa). A neutral vowel defines a weak, unstressable syllable whereas a full vowel defines a strong, stressable syllable. As such, vowel quality was included in the definition of default stress ("first stressable syllable"), but also received attention in the study of visual and auditory word recognition (e.g., Norris, McQueen, & Cutler, 1995; Rastle & Coltheart, 2000).

Experiments 1, 2, and 3 examined whether either word stress or vowel quality, or both features are part of a suprasegmental representation in phonological encoding, and whether such representation can be primed. In the picture-word interference task, pictures are named as quickly as possible while attempting to ignore simultaneously presented distractors words. In one subject group, target and distractor onset coincided (0-ms SOA), and in another subject group target onset preceded distractor onset by 100 ms (+100-ms SOA). Picture naming would be more susceptible to form related distractor words at positive SOAs (Schriefers, Meyer, & Levelt, 1990).

Experiments 1 - 2 - 3

Method

Participants

A total of 68 undergraduate psychology students from the University of Leuven participated in each experiment as part of a curriculum-based credit system. All participants were native speakers of Dutch and had normal or corrected-to-normal vision. None of the participants said to suffer from reading disorders. Participants with prior experience with the stimulus set were excluded.

Materials

If a syllable carries word stress, its vowel cannot be reduced. As a consequence stressed weak syllables do not exist, and word stress (stressed, unstressed) and vowel quality (full, reduced) cannot occur fully crossed in a syllable, restricting the possible stress patterns in disyllabic words. Stressed strong syllables (and unstressed weak syllables) are common in Dutch. But also unstressed strong syllables occur frequently, which is not the case in English (Cutler & van Donselaar, 2001). The CELEX lexical database provided all Dutch disyllabic words whose two syllables contain the same number of characters. Four different suprasegmental patterns emerged according to stress position and vowel quality (see Table 1). For practical reasons, these four patterns will be referred to as ‘SS (trochaic stress with a strong unstressed syllable), S’S (iambic stress with a strong unstressed syllable), ‘SW (trochaic stress with a weak unstressed syllable), and W’S (iambic stress with a weak unstressed syllable).

Table 1: Stress patterns in disyllabic words with syllables of equal graphemic size.

1st syllable	2nd syllable	Occurrence	Example	Referred to as
‘strong	strong	5707	‘balpen	‘SS
strong	‘strong	519	bal’kon	S’S
‘weak	weak	NA		
weak	‘weak	NA		
‘strong	weak	2378	‘jongen	‘SW
strong	‘weak	NA		
‘weak	strong	NA		
weak	‘strong	25	ver’gif	W’S

The to be named pictures depicted ‘SS words in Experiment 1, S’S words in Experiment 2, and ‘SW words in Experiment 3. Each target picture had distractor words of ‘SS, S’S, and ‘SW superimposed. As, target words of the same three suprasegmental patterns were used, a varying degree of suprasegmental relatedness between target and distractor was obtained. Fully related, partly related (either in stress pattern or vowel quality pattern), and fully unrelated conditions were compared. Target and distractor words were not related segmentally (neither phonologically, nor orthographically), nor semantically (neither categorically, nor associatively, as rated in a pilot study). Distractors words paired with a particular target were matched on word frequency, imageability, familiarity, age of acquisition, number of neighbours, and summated bigram frequency. Compound words were excluded as much as possible.

Procedure

Participants were tested individually, seated in a dimly illuminated room, at a 60 cm viewing distance in front of a computer screen. A series of practice trials was run in which six randomly presented practice drawings were named as quickly as possible. Next, the experimental drawings were shown in random order with their corresponding names written underneath to familiarize participants with the upcoming targets.

In the experimental trials, a fixation cross was presented during 600 ms in the middle of the screen, followed by the onset of a target picture. In one subject group the target onset coincided with the onset of the distractor word within the picture. In the other subject group the distractor onset was delayed for 100 ms (a +100-ms Stimulus Onset Asynchrony). The target remained on screen for 4000 ms or until the voice key was triggered by a response. The participants named each picture as quickly as possible while avoiding any mistakes. They were to mind the picture only, ignoring any word appearing within. The experimenter then pressed one of three keys on the computer keyboard to register the accuracy of the participant's response or a voice key malfunction. In case the participant failed to name the picture, the correct name was presented for 1500 ms, introduced by a short error sound. Otherwise a blank screen appeared instead, also for 1500 ms. The intertrial interval lasted 500 ms.

Results and Discussion of Experiments 1-2

Two separate analyses of variance were conducted on the reaction times, one by Subjects (F1 and p1) and one by Items (F2 and p2), with Relatedness (within-subjects and within-items) x SOA (between-subjects and within-items). In Experiment 1, the main effect of target-distractor relationship was significant, $F1(5, 330) = 188.58$, $MSE = 2192$, $p1 < .0001$ and $F2(5, 115) = 107.13$, $MSE = 2852$, $p2 < .0001$. SOA was also significant, $F1(1, 66) = 10.74$, $MSE = 36129$, $p1 < .002$ and $F2(1, 23) = 126.75$, $MSE = 2053$, $p2 < .0001$. SOA did not interact with Relatedness. Analysis of Experiment 2 led to similar effects of Relatedness [$F1(5, 325) = 103.79$, $MSE = 3010$, $p1 < .0001$ and $F2(5, 45) = 49.26$, $MSE = 1974$, $p2 < .0001$] and of SOA [$F1(1, 65) = 19.16$, $MSE = 31379$, $p1 < .0001$ and $F2(1, 9) = 258.23$, $MSE = 692$, $p2 < .0001$].

Post hoc comparisons of the Relatedness means indicated that each of the baseline means (nonword, label, or blank distractor) significantly differed from each of the experimental means ($p1 < .0001$; $p2 < .0001$). The picture-word interference effect was also obtained in Experiment 2 ($p1 < .0001$; $p2 < .0001$). Further, fully related distractors produced a significantly larger mean compared to partly unrelated distractors: $p1 < .0005$, $p2 < .05$ for 'SS versus S'S distractors, and $p1 < .0007$, $p2 < .05$ for 'SS versus 'SW distractors. And in Experiment 2, fully related distractors produced a larger mean compared to stress unrelated distractors ($p1 < .0009$, $p2 < .05$) and fully unrelated distractors ($p1 < .05$ but not significantly in the Item analysis). Summarizing, reaction times increased from unrelated to fully related conditions, contrary to the facilitatory effects provided by the picture-word paradigm in case of segmental overlap.

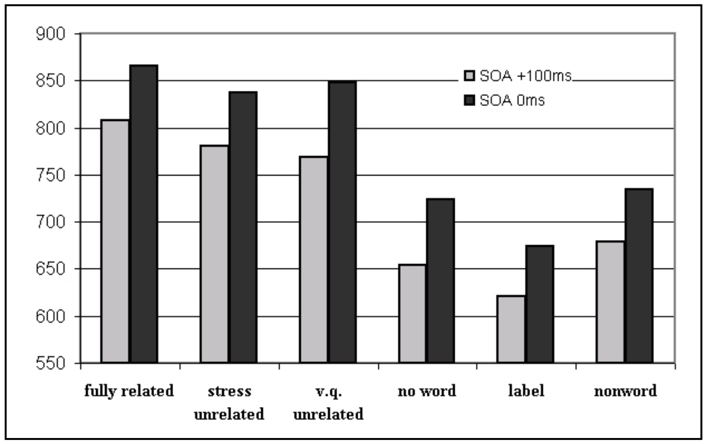

Figure 1. Mean vocal latencies for 'SS target pictures with suprasegmentally related distractors and their baseline conditions.

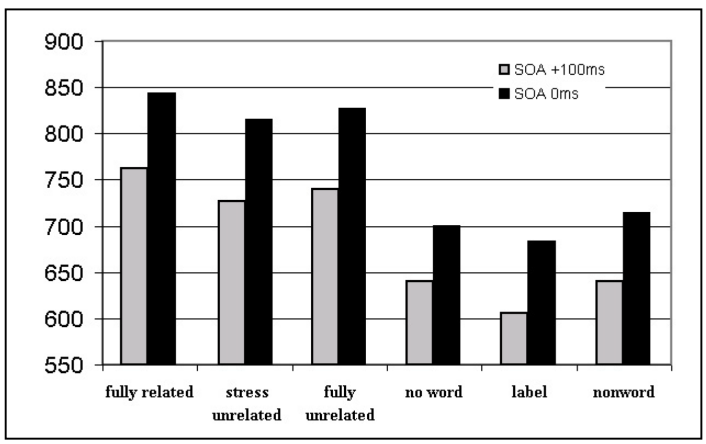

Figure 2. Mean vocal latencies for S'S target pictures with suprasegmentally related distractors and their baseline conditions.

In Experiment 1, the suprasegmental effect occurred only when both suprasegmental features overlapped, and comparison with a fully unrelated baseline in Experiment 2 confirmed combined overlap as necessary for suprasegmental form priming. Lacking control of vowel quality might therefore hinder the detection of a stress overlap effect. For instance, Meijer (1998, Experiments 1, 2, and 3) selected ‘SS as well as ‘SW words as stress-related distractors for both ‘SS and ‘SW targets (S’S words served as stress-unrelated distractors). No effect of suprasegmental overlap (in the absence of segmental overlap) was obtained.

Further, the combined manipulation of word stress and vowel quality in the picture-word task offered no evidence for mechanisms restricting the influence of suprasegmental overlap. The suprasegmental overlap effect is not confined to a particular suprasegmental word type, nor to segmental overlap.

The form overlap appeared to increase the weight of the distractor word, thus adding to its interference with the production of the target word. Inhibitory mechanisms have been suggested at various levels of phonological encoding: competition in phonetic encoding (Levelt et al., 1999, p64), competition in (sub)lexical selection (Dell, 1986, 1988), and lexical inhibition (Sternberger, 1985).

Inhibitory form priming (due to segmental overlap) has been observed before in the picture-word task (Jerger, Martin, & Damian, 2002; Jescheniak & Schriefers, 1998; Jescheniak, Schriefers, & Hantsch, 2003). Also, Experiment 2 replicated the inhibitory effect of overlap in non-initial (i.e. non-default) stress as found by the few studies manipulating non-default stress separatedly (unconfounded with default stress). Roelofs and Meyer (1998, Experiment 2) used targets bearing stress on the second or third of three strong syllables, and by Schiller et al. (2004, Experiments 1, 2, and 3) had targets with stress on the second of two strong syllables.

For Experiment 1 using ‘SS targets (stress on the first of two strong syllables), results turned out harder to compare. Experiment 9 of Meijer (1994) obtained facilitation for default stress, although targets were monosyllabic. Other studies yielding facilitatory or null effects of stress overlap (Meijer, 1994, Experiments 1, 2, and 3; Roelofs & Meyer, 1998, Experiment 5) were not analysed separately for default and non-default stress. Schiller et al. (2004, Experiments 1, 2, and 3) found facilitation for initially stressed (default) targets, although with ‘SS and ‘SW confounded. In addition to Experiment 1 with ‘SS targets, Experiment 3 aimed to clarify the effects of default stress, using ‘SW targets.

Results and Discussion of Experiment 3

The suprasegmental overlap effect was not obtained for ‘SW target words. The main effect of Relatedness was significant, $F1(5, 330) = 164.44$, $MSE = 2092$, $p1 < .0001$ and $F2(5, 75) = 122.49$, $MSE = 1359$, $p2 < .0001$. But no significant differences were found between the means of fully related, vowel quality unrelated, and fully unrelated distractors, neither at 0 ms nor at 100-ms SOA.

Stress effects might occur only in the presence of segmental overlap (Meijer, 1994). Or possibly, word stress is not encoded in case of default stress (stress placement at the first stressable syllable) and hence default stress priming cannot occur (Levelt et al., 1999). Earlier, such mechanisms were devised to account for similar null effects (Meijer, 1994, Roelofs & Meyer, 1998). Yet, a suprasegmental overlap effect was obtained for both default stress targets (‘SS in Experiment 1) and non-default stress targets (S’S in Experiment 2).

Moreover, in Experiment 3, segmental overlap was an artefact of the manipulation of suprasegmental overlap and could account for the absence of a suprasegmental overlap effect. The majority of ‘SW words ends in '-el' or '-er'. Consequently, in Experiment 3, segmental overlap inevitably arises in the suprasegmental overlap condition, where target and distractor are both ‘SW words. Facilitation due to such segmental overlap could neutralize interference due to suprasegmental overlap. In order to shed light on how the suprasegmental and segmental effects relate to each other, Experiment 4 included manipulation of segmental overlap.

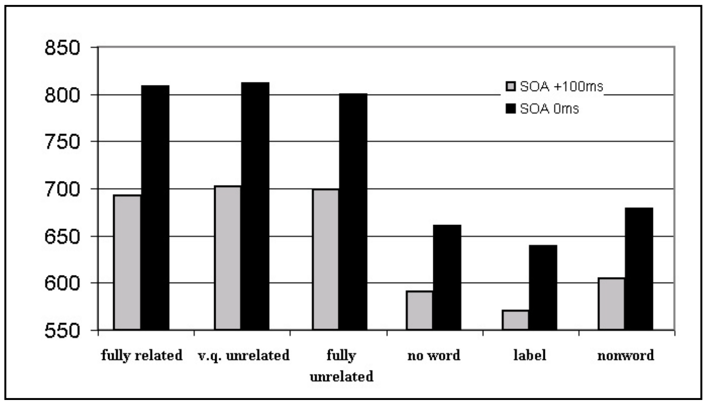

Figure 3. Mean vocal latencies for ‘SW target pictures with suprasegmentally related distractors and their baseline conditions.

Experiment 4

Method

Experiment 4 applied the method of the previous experiments, but segmental and suprasegmental overlap were factorially crossed (‘SS *or* S’S targets were combined with ‘SS *and* S’S distractors). For instance, the target 'walvis (‘ marking the stressed syllable) was paired with distractors pon’ton (no overlap), ‘bospad (suprasegmental overlap only), nar’cIS (segmental overlap only), and ‘thesIS (combined suprasegmental and segmental overlap).

Results of Experiment 4

A main effect of segmental overlap was observed, $F1(1, 37) = 124.93$, $MSE = 6575$, $p1 < .0001$ and $F2(1, 12) = 10.19$, $MSE = 2877$, $p2 < .01$. It also interacted with suprasegmental overlap, $F1(1, 37) = 7.55$, $MSE = 6917$, $p1 < .01$ and $F2(1, 12) = 9.17$, $MSE = 427$, $p2 < .02$. The suprasegmental effect arose only in the absence of segmental overlap. The suprasegmental effect dissipated when suprasegmental features are manipulated in the presence of segmental overlap.

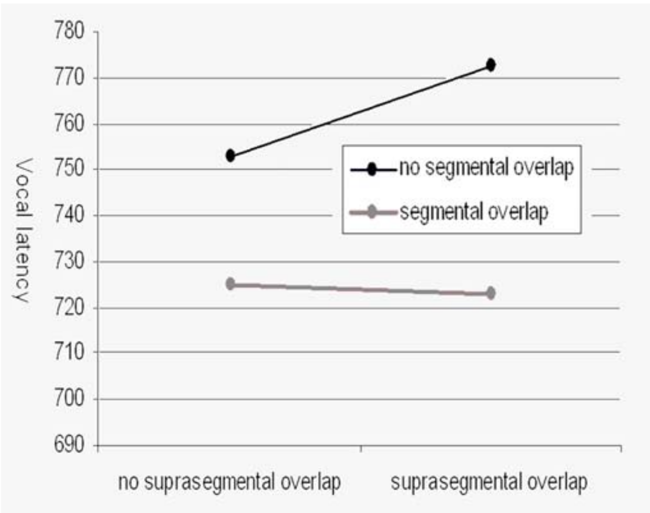

Figure 4. Mean vocal latencies in function of segmental and suprasegmental overlap.

Implications for Experiment 3

The null effect in Experiment 3 was hypothesized to arise from a confound between suprasegmental and segmental overlap in ‘SW distractors. But Experiment 4 found a main effect of segmental overlap, dismissing the neutralization account: combined segmental and suprasegmental overlap led to significantly lower latencies than the suprasegmentally and segmentally unrelated condition.

However, the absence of a suprasegmental main effect offers an alternative explanation for the missing suprasegmental effect in Experiment 3. The segmental overlap arising in Experiment 3 had been controlled for, whenever possible. Therefore, five out of 16 target words in Experiment 3 shared a penultimate -e- with the ‘SW distractor word only. But a majority of 11 out of 16 target words shared a penultimate -e- with all three distractors words. Consequently, the majority of trials compared segmentally and suprasegmentally related distractors with segmentally related but suprasegmentally unrelated distractors, where Experiment 4 did not obtain a suprasegmental overlap effect.

Experiment 4 also pointed out that the segmentally and suprasegmentally related ‘SW distractors should facilitate picture naming, compared to the segmentally and suprasegmentally unrelated ‘SS and B distractors. Thus, when analyzing a subset of Experiment 3 containing the five items that share the penultimate character with the ‘SW distractor only, an effect should arise that is exactly the opposite of the originally expected effect. This was confirmed at 100-ms SOA, using planned comparisons. Reaction times decreased from vowel quality unrelated to fully related condition (12-ms advantage). And reaction times decreased from stress and vowel quality unrelated to fully related (39-ms advantage)

Implications for Experiment 1

Schiller et al. (2004) is the only other study using disyllabic targets and distinguishing between initial and non-initial stress. The results for non-initial stress correspond with the results of Experiment 2, but the inhibition in Experiment 1 and the null effect in Experiment 3 contrast with the facilitation for initial stress overlap in Schiller et al. (2004).

However, Schiller et al. included both ‘SS and ‘SW targets in the initial stress condition. Eight of 12 ‘SS targets were matched with ‘SW words as stress-related distractors. Yet, Experiments 1 and 2 indicated suprasegmental form priming requires the overlap to include the pattern of vowel quality. Further, 11 of 12 ‘SW targets were matched with ‘SW distractors sharing a penultimate -e-, of which six shared the full word ending (-el or -er). Experiment 4 and the subset of Experiment 3 showed a facilitatory effect by the combination of segmental and suprasegmental compared to a fully unrelated baseline (i.e. word-final stress targets in Schiller et al.).

Discussion of Experiment 4

The suprasegmental inhibitory effect has been replicated and again offers no evidence for mechanisms restricting the influence of suprasegmental overlap. A suprasegmental effect arose in the absence of segmental overlap whereas segmental overlap would be a prerequisite for stress effects according to the parallel independence hypothesis. Quite the opposite was found: a suprasegmental effect occuring only without segmental overlap. Also, the suprasegmental overlap effect is not modified by the suprasegmental word type.

However, there is no immediate explanation available for how segmental overlap could foil an inhibitory effect of stress overlap. Such explanation should not only account for the suprasegmental null effect, but also for facilitatory effects of stress overlap in the presence of segmental overlap, as well as the inhibition found for pure stress overlap (without any segmental overlap). An extension of the competition approach by Dell (1986, 1988) might provide the most suitable account.

The corresponding suprasegmental representations of target and distractor additionally activate the distractor phonemes. But when target and distractor phonemes do not correspond segmentally (only suprasegmentally), the activated (segmentally) mismatching phonemes hamper the generation of the target phonemes. When target and distractor phonemes do correspond segmentally (and suprasegmentally), the additionally activated phonemes match the target phonemes segmentally as well, and do not hamper but facilitate the generation of the target phonemes. Similar findings were obtained in manipulations of orthographic (cfr. suprasegmental) overlap and phonological (cfr. segmental) overlap (O'Seaghdha, Dell, Peterson, &

Juliano, 1992; Peterson, Dell, & O'Seaghdha, 1989; Sevald & Dell, 1994)

Depending on the ratio of matching and mismatching segments, the observed effect of suprasegmental overlap could range from facilitation to inhibition. Further research is required to identify which factors determine the ratio. But for instance, overlap in the pattern of vowel quality was necessary for the inhibitory effect of pure suprasegmental overlap, and it might be equally important in the presence of segmental overlap. If stress position and the pattern of vowel quality compose one stress-related suprasegmental template, the combined overlap might enhance the miscuing mechanism. Otherwise the matching phonemes could be prevalent, replacing an inhibitory or null effect by facilitation as observed in experiments lacking matching of vowel quality (Meijer, 1994; Roelofs & Meyer, 1998).

Acknowledgements

Preparation of this manuscript was supported by grants from the Fund for Scientific Research-Flanders (FWO).

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