Spatial distance modulates reading times for sentences about social relations: evidence from eye tracking

Ernesto Guerra[1,2] (ernesto.guerra@mpi.nl)
Pia Knoeferle[1] (knoeferl@cit-ec.uni-bielefeld.de)

[1]Cognitive Interaction Technology Excellence Cluster and Department of Linguistics,
Bielefeld University, Inspiration I, 33615, Bielefeld, Germany

[2]Max Planck Institute for Psycholinguistics, Wundtlaan 1,
Nijmegen, 6525 XD, The Netherlands

Abstract

Recent evidence from eye tracking during reading showed that non-referential spatial distance presented in a visual context can modulate semantic interpretation of similarity relations rapidly and incrementally. In two eye-tracking reading experiments we extended these findings in two important ways; first, we examined whether other semantic domains (social relations) could also be rapidly influenced by spatial distance during sentence comprehension. Second, we aimed to further specify how abstract language is co-indexed with spatial information by varying the syntactic structure of sentences between experiments. Spatial distance rapidly modulated reading times as a function of the social relation expressed by a sentence. Moreover, our findings suggest that abstract language can be co-indexed as soon as critical information becomes available for the reader.

Keywords: spatial distance, social distance, semantic interpretation, eye tracking.

Introduction

Recent eye-tracking evidence showed that spatial distance between depicted objects can distinctively modulate reading times for sentences expressing semantic similarity (Guerra & Knoeferle, 2012). Participants inspected objects (playing cards) and then read a sentence about abstract ideas (e.g., 'Peace and war are certainly different…'). Reading times were shorter for sentences expressing similarity between two abstract 'and'-coordinated nouns when the cards were presented close together, compared to farther apart. For sentences expressing dissimilarity the opposite pattern was observed, namely reading times were shorter when cards were presented far apart (vs. close together).

These results represent important advances in the understanding of the relation between visual context effects and sentence interpretation. For instance, they suggest visual information can influence abstract-language interpretation – an effect previously shown for concrete language (see, e.g., Tanenhaus et al., 1995). Moreover, they suggest that linguistic and non-linguistic information can interact in the absence of an overt referential link, or lexical association (cf. Altmann & Kamide, 2007; Knoeferle & Crocker, 2007).

However, several open questions remain concerning the extent to which spatial distance affects abstract language processing and the mechanisms underlying such effects. The investigation of non-referential visual context effects in Guerra and Knoeferle (2012) was motivated by a linking hypothesis from Conceptual Metaphor Theory (CMT, Lakoff & Johnson 1999). To accommodate the rapid and incremental effects of spatial distance on semantic interpretation, the authors relied on a mechanism that relates corresponding elements in the sentence and in the visual context by co-indexing them (see the Coordinated Interplay Account, CIA, Knoeferle & Crocker, 2006, 2007). Yet, it is unclear whether spatial distance can rapidly influence processing of other semantic relations besides similarity (see Lakoff & Johnson, 1999).

In addition, it remains to be seen how precisely abstract language is co-indexed with spatial distance depicted in the visual context during comprehension. The present study examined spatial distance effects on another abstract domain (social relations), and additionally, assesses the co-indexing between visual cues and abstract language comprehension.

Spatial distance and social relations

In everyday language, people commonly use spatial concepts to communicate aspect of social relations in expressions such as "he's a close friend". The CMT suggests that such expressions arise because abstract representations such as social intimacy are grounded in physical experience such as spatial distance through metaphorical mapping (Lakoff & Johnson 1999).

Recent behavioral studies have investigated the link between social and spatial distance. For instance, in a study, Williams and Bargh (2008) found that participants reported weaker bonds to their families and hometowns after they had been primed with far (vs. close) distance (by marking off two points on a Cartesian plane, either far apart or close together). More recently, Matthews and Matlock (2011) found that in a path-drawing task participants drew paths closer to figures described to them as *friends* (vs. *strangers*). Another study reported how perceived distance (in a picture with depth perspective, e.g., scenery of alleys with trees) interacted with the content of written words (i.e., *friend* vs. *enemy*), modulating response latencies in a distance-estimation and a word-classification task (Bar-Anan et al., 2007). In both of these tasks longer response times emerged when the word *friend* was presented far away in the picture (compared to close), and the opposite pattern for the word *enemy*.

These results showed that spatial information can modulate participants' reports on their social bonds in a way that is coherent with the conceptual metaphor hypothesis. In addition, such findings show that a verbal description of friendliness (vs. unfriendliness) can modulate the way participants use space in an otherwise unrelated task (path drawing). Finally, the implicit relation between perceived distance and different social relations also modulated response times in a distance-estimation and word-classification task.

However, these data cannot tell us whether the relation between spatial and social distance is relevant for the incremental interpretation of sentences. They also leave open the question of how precisely spatial distance is related to words during sentence processing. Re-consider the above-mentioned paradigm from Guerra and Knoeferle in which participants inspected two cards moving either farther apart or closer together. Next they read a sentence. Each card showed a noun, and these nouns appeared again in the sentence (e.g., 'Peace and war…'). These two sentence-initial nouns could be co-indexed with the two playing cards, which in turn allows participant to integrate spatial distance with semantic representations. This is particularly plausible when coordinated objects in the visual context can be directly related to coordinated nouns in the sentence (see Guerra & Knoeferle, 2012, Experiment 1). Alternatively, spatial distance could be directly co-indexed with the abstract concept of similarity even when there is no one-to-one mapping between coordinated objects and coordinated nouns. The results presented by Guerra and Knoeferle (2012), could not confirm or rule out this second possibility.

To address these open issues, we aimed to extend findings of spatial distance effects on abstract sentence interpretation in two ways: First, we examined a different abstract semantic domain, namely intimacy in social relations, which according to the CMT is also associated with spatial distance. Second, we asked whether spatial distance effects could be observed in the absence of an 'and'-coordination of nouns. In Experiment 2, we tested whether the predicted effects could emerge even before both sentential nouns can be co-indexed with the objects in the visual context. If so, then interaction effects should appear as soon as the manner of the social relation becomes available in the sentence (e.g., at the ADV region 'cheerfully' vs. grumpily') even when only one of the two nouns has been encountered (and could thus be co-indexed with the cards).

Experiment 1

In an eye-tracking reading experiment we examined whether spatial distance (close vs. far) depicted in a visual context could modulate real-time semantic interpretation of German sentences about social relations (friendly vs. unfriendly interactions). Based on existing evidence, we predict that if spatial cues modulate social distance interpretation rapidly and incrementally, then reliable interactions between spatial distance and social relations should emerge in relatively early measures (i.e., first-pass reading times, regression path
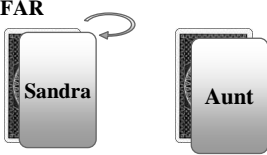
duration). Moreover, these effects should emerge time-locked to the sentence region conveying information about the social relation, or at the ensuing region (see Guerra & Knoeferle, 2012, see also Mitchell, 1984).

Method

Participants Thirty-two native speakers of German with normal or corrected-to-normal vision participated in the experiment for a compensation of 6 Euro. None of them had learned a second language before age six, and all gave informed consent.

Materials and Design A 2x2 within-subject Latin square design crossed two levels of spatial distance (close vs. far) and two levels of social relation (friendly vs. unfriendly) as factors. Distance was depicted using two playing cards presented in a visual context before each sentence. Social relations were conveyed through 48 sentences expressing either a friendly or an unfriendly relation between two characters (96 further filler sentences were included). Except for the adverb expressing the manner of the relation, the sentence materials were identical in all conditions. Sentences in previous research had included nouns coordinated by a conjunction ('and') that could have been mapped one-to-one onto the two cards in the visual context (which were coordinated in their motion). In Experiment 1, sentences did not include an 'and'-coordination of nouns. Instead, the sentence structure was NP – VP – NP – ADV – PP – NP. Table 1 presents an example sentence illustrating the combination of the two manipulated factors.

Table 1: Visual context and sentence examples for one item (translated from the German originals). Both levels of spatial distance (close / far) were crossed with both sentence levels (friendly / unfriendly) yielding 4 conditions.

Visual Context	Sentence	Condition
FAR (Sandra, Aunt)	**FRIENDLY** 'Sandra$_{NP1}$ met$_{VP}$ her aunt$_{NP2}$ **cheerfully$_{ADV}$ in$_{PP}$** the elevator$_{NP3}$.'	**Far-Friendly** / **Close-Friendly**
CLOSE (Sandra, Aunt)	**UNFRIENDLY** 'Sandra$_{NP1}$ met$_{VP}$ her aunt$_{NP2}$ **grumpily$_{ADV}$ in$_{PP}$** the elevator$_{NP3}$.'	**Far-Unfriendly** / **Close-Unfriendly**

Procedure On critical trials, participants inspected a visual context with two playing cards that moved either apart or closer together, and then turned around (as indicated by the arrow in Table 1) showing two nouns. These two nouns were the first two sentential nouns (e.g., 'Sandra', 'Aunt'). Next, participants read a sentence and judged its veracity contrasted to their world-knowledge. Finally, they saw a picture of two playing cards and verified whether these

cards were identical to the two playing cards presented before the sentence. Figure 1 shows the order and the timing of presentation of the stimuli.
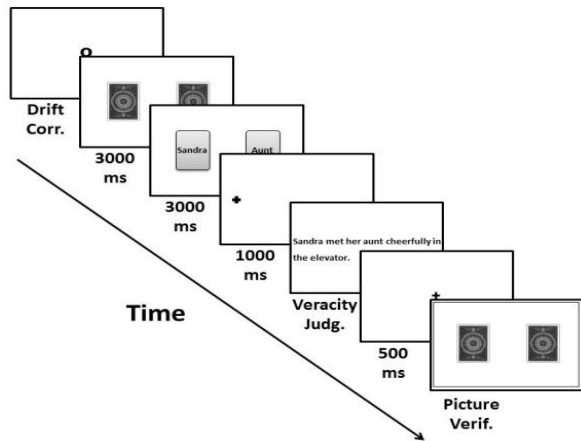

Figure 1: Schematic representation of an experimental trial.

Data Analysis We removed fixations < 80 ms and > 1200 ms before computing reading measures (see, e.g., Sturt, Keller, & Dubey, 2010). We report three reading measures for critical sentence regions. First-pass reading times (the duration of all fixations from first entering an interest area and prior to moving to another interest area); regression path duration (the time from first entering a region until moving past that region to the right, including reading time after regressions out of the region); and total reading times (the duration of all fixations in a given region, see, e.g., Rayner, 2009). We report analyses of the data from two critical regions, namely the ADV region, where the manner of the social relation is made explicit (friendly vs. unfriendly) and the immediately ensuing region (i.e., PP, see Table 1).

We analyzed log-transformed reading measures using a linear mixed effect regression (LMER, lmerTest Package in R). Our models[1] included random intercepts both for participants and items and fixed effects random slopes for both random intercepts as well as for their interaction (see Barr et al., 2013 on the use of full models in LMER).

Results

At the critical ADV region, a main effect of distance in regression path duration was observed (close: 475 ms, far: 385 ms; p=.007). Moreover, while first-pass times for sentences expressing similarity were virtually the same when preceded by cards close together vs. apart (296 ms vs. 298 ms, resp.), for sentences expressing dissimilarity shorter first-pass times were observed when preceding cards were close vs. far (278 ms vs. 298 ms, resp.). Data analysis

---

[1] Model example: lmer (first-pass ~ distance * social relation + (1 | participant) + (1 | item) + (0 + distance | participant) + (0 + social relation | participant) + (0 + distance : social relation | participant) + (0 + distance | item) + (0 + social relation | item) + (0 + distance : social relation | item), data)

showed this interaction to be only marginally significant (p=.095). No other significant effects emerged in this region. At the immediately subsequent region (PP), we observed marginally significant main effects of distance in first-pass, and of distance and social relation in regression path duration (all p-values <.1). More importantly, reading times at the PP region were faster when a sentence expressing a friendly interaction was preceded by cards close together compared to far apart, while reading times for sentences expressing an unfriendly interaction were faster when preceding cards moved far apart compared to close together. This interaction between spatial distance and social relations was reliable in first-pass (p=.035) and regression path (p=.009). Figure 2 shows the pattern of interaction in Experiment 1.
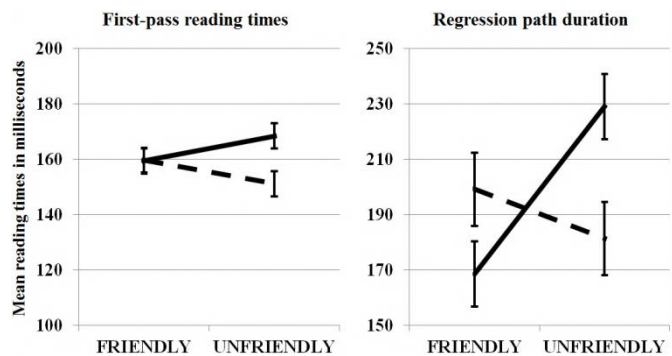

Figure 2: Mean first-pass reading time (on the left) and regression path duration (on the right) in milliseconds for the PP region as a function of spatial distance (solid and dashed lines represent close and far distance, resp.) and sentence type (friendly vs. unfriendly) in Experiment 1. Error bars represent standard errors of the mean (*SE*).

Discussion

In Experiment 1, we asked whether recently reported effects of spatial distance on incremental interpretation of sentences about similarity would extend to sentences about social relations. Furthermore, we examined whether these effect could emerge in the absence of an 'and'-coordination of nouns. The results from Experiment 1 showed that spatial distance distinctively affected reading times (at the PP) as a function of whether they expressed a friendly or an unfriendly social relation.

In coherence with previous findings, reliable interaction effects emerged in first-pass and regression path duration, immediately after the nature of the social relation was mentioned in the sentence (see Guerra & Knoeferle, 2012). This suggests that the effect of spatial information on the interpretation of social relation occurs rapidly and incrementally, and it did so in the absence of an 'and'-coordination of nouns. Yet, it is unclear whether comprehenders co-indexed the first two nouns in the sentence with the two playing cards, or whether spatial distance was directly co-indexed with the friendliness

expressed by the adverb, since both nouns were processed before the adverb. Experiment 2 addresses this open issue.

Experiment 2

Our second experiment was identical to Experiment 1 but we changed the structure of the sentence by moving the adverb before the second noun phrase (see (1)). With that sentence structure, the manner of the social relation (friendly vs. unfriendly) becomes available before the second noun is processed. If spatial distance effects on sentence processing require the co-indexing between nouns and cards (from the visual context), the <u>earliest</u> interaction effect should appear at the second noun region. However, if spatial distance can co-index directly with the manner of the social relation we should observe interaction effects in first-pass reading times (or regression path duration) at the ADV region. Even late effects (e.g., total reading times) at the ADV would favor a noun-to-object co-indexing account.

Method

Participants A further group of thirty-two native German speakers with normal or corrected-to-normal vision received 6 Euro for participating in the study. None of them had acquired a second language before age six, and all gave informed consent.

Materials, design, procedure and data analyses In Experiment 2 we varied the structure of the sentence by moving the adverb before the second noun as in (1). Otherwise, the materials were identical to Experiment 1.

(1) Sandra$_{NP1}$ met$_{VP}$ **cheerfully**$_{ADV}$ her$_{PRON}$ **aunt**$_{NP2}$ in$_{PP}$ the elevator$_{NP3}$.

The design and procedure were identical to Experiment 1. Data analysis was identical except for the analyzed sentence regions (the ADV region and the NP2 region were analyzed to see whether interaction effects emerge only after the second NP2 has been encountered or earlier, at the ADV).

Results

At the ADV region, first-pass reading times were faster for sentences that expressed a friendly social relation when preceded by cards far apart (299 ms) compared to close together (278 ms). By contrast, reading times for sentences expressing an unfriendly social interaction were faster when cards in the visual context moved close together (266 ms) compared to far apart (289 ms). The LMER analysis confirmed this interaction as reliable (p=.042). A similar interaction pattern was marginally significant in total times (p=.097). No other effects emerged in this region.

At the NP2 the main effect of social relation was marginal in first-pass (friendly: 227 ms, unfriendly: 243 ms, p=.062) and statistically significant in total reading times (friendly: 375 ms, unfriendly: 415 ms, p=.035). No other effects emerged in this region. Figure 3 presents the pattern of

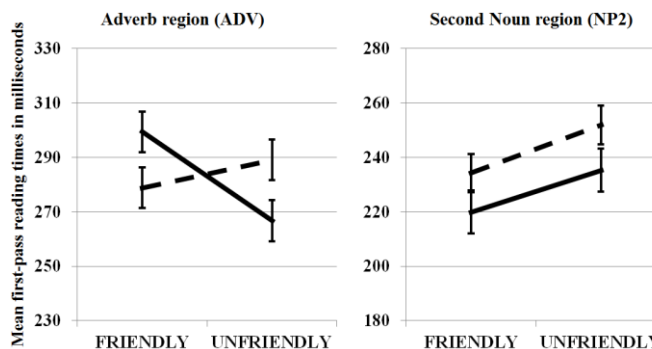results for the two regions of interest in first-pass reading times with error bars marking the *SE*s.

Figure 3: Mean first-pass reading time for the ADV region (on the left) and the NP2 region (on the right) in milliseconds as a function of spatial distance (solid and dashed lines represent close and far distance, resp.) and sentence type (friendly vs. unfriendly) in Experiment 2. Error bars represent *SE*.

Discussion

Experiment 2 examined whether spatial distance effects on reading times for sentences about social relations could emerge even before participants encountered the second noun in the sentence. It's possible that co-indexing of the cards and the nouns is necessary for spatial distance effects to emerge. Alternatively, co-indexing is not tied to individual words in the sentence but could be also "conceptual" (between the concepts of spatial distance and social relations) Spatial distance between objects in the previous visual context modulated semantic interpretation before the second noun had been encountered, as reflected by the reliable interaction effect in first-pass reading times at the ADV region (i.e., as soon as the manner of the social relation became clear).

When comparing Figures 2 and 3, it is noteworthy that the interaction pattern observed in Experiment 2 is the opposite of that found in Experiment 1. Such <u>interference patterns</u> have been previously reported (see Kaschak et al. 2005; Richardson et al., 2003). Some have argued that differences in the experimental tasks produce interference (e.g., Richardson et al., 2003). Others have argued that interference effects emerged when related spatial and semantic information are difficult to integrate (see Kaschak et al., 2005 for a discussion on the notion of integrability). For our experiments, however, the task and materials were identical, making our results less compatible with task-based or integratibility-based accounts of interference effects. More recently, accounts that appealed to the role of attentional modulation (see Connell & Lynott, 2012) and the level of activation of semantic and perceptual representations (Chen & Mirman, 2012) have been proposed to accommodate interference and facilitation effects. According to Chen and Mirman (2012), for instance, weakly active similar representations facilitate semantic processing

while strongly activate similar representations interfere with it. Such accounts seem to be more compatible with the kind of interaction effects observed in Experiment 2.

General Discussion

In a recent study (Guerra & Knoeferle, 2012), participants read sentences that expressed similarity (or dissimilarity) between two abstract nouns immediately after they had inspected a visual context with two playing cards that moved far apart (or close together). Overall, the results from this study showed that (a) visual context can influence sentence interpretation in the absence of a referential or a lexical-semantic link and (b) that abstract language can also interact with perceptual information derived from the visual context. However, we do not yet have a good understanding of the mechanisms behind such effects. In the CIA account (see Knoeferle & Crocker, 2007), co-indexing is predicted for nouns and their visual referents and for verbs and depicted actions. Nevertheless, this account has been extended to include co-indexing based on subtler associations, such as spatial information and abstract adjectives/adverbs (Guerra & Knoeferle, 2012). The authors argued that the observed rapid and incremental effects can be accommodated by co-indexing between spatial distance and abstract semantic information.

Against this background, we tested whether visual information could modulate real-time interpretation of other abstract semantic domains, namely social relations. We examined these effects in real time and asked whether they occur even in the absence of an 'and'-coordination of nouns corresponding to cards in motion as in Guerra and Knoeferle (2012). If the effects of spatial distance on reading times require the co-indexing between the two objects in the visual context and the two first sentential nouns, they should disappear when these two nouns are not coordinated. Alternatively these effects could emerge independent of noun coordination, as soon as other relevant semantic information becomes available in the sentence.

In our first experiment, we replicated and extended previous findings on the effects of spatial distance during abstract sentence interpretation (to another semantic domain and syntactic structure). First-pass times at the PP region for sentences expressing friendly social relations were faster when preceding cards were close together (compared to far apart). In turn, sentences expressing unfriendly social interactions were read faster when preceded by cards far apart (vs. close together). The results from our second experiment further extended and specified the co-indexing mechanism, showing that rapid and incremental effects of spatial distance do not depend on relating individual cards to individual nouns but can appear as soon as the critical semantic content is accessible otherwise (i.e., when encountering an adverb expressing social relations). Therefore the influence of non-referential visual context does not demand the co-indexing between objects (in the visual context) and abstract nouns in the sentence.

Undoubtedly, the contrasting patterns of interaction between Experiments 1 and 2 deserve further discussion. As mentioned earlier, both facilitation and interference results have been reported and discussed in the literature (see Chen & Mirman, 2012; Connell & Lynott, 2012; Kaschak et al. 2005; Richardson et al., 2003). We argue that the present findings are compatible with an account that considers activation and attention as moderators in the interaction between spatial distance and semantic similarity, rather than with accounts focusing on task or integration (see Kaschak et al., 2005). This is because the task and materials were the same in Experiment 1 (facilitation effect) and in Experiment 2 (interference).

Consider the following potential sequence of processes in Experiment 1: Participants inspected a visual context with two playing cards. After three seconds, the cards turned around, revealing two nouns. Participants were instructed to remember the cards. After six seconds, the visual context disappeared and a sentence was presented. As participant begin to read the sentence, their working memory probably includes an active representation of the location of the cards in the visual context, the distance between them and the words on them. Upon encountering the first noun of the sentence, participants' internal attention is directed to the visual representation of that noun and its card in the preceding context (see Altmann, 2004; Knoeferle & Crocker, 2007) possibly boosting its activation level. Participants continue to read and encounter the second noun of the sentence previously presented on the other card.

As participants continue reading, they encounter the critical adverb, which expresses the manner of the social relation. Arguably at this point, participants' internal attention is focused on the visual context, maintaining its representation highly active. Accounts that rely on attentional modulation and level of activation would predict that since attention is maintained on the perceptual aspect of the visual context (e.g., card distance), related semantic representations will be more difficult to process, producing interference effects. In fact, the trend of interaction in first-pass reading times at the adverb region in Experiment 1, matches qualitatively an interference effect. Yet, unlike the nouns, the adverb does not refer to the depicted objects (the nouns but not the adverbs were printed on the cards). Moreover, in Experiment 1, the cards could have been co-indexed to nouns in the sentence once participants read the adverb. Thus, the highly active visual context representation may have decayed as the adverb was processed, producing the observed facilitation (in first-pass times at the adverb).

For Experiment 2, the processes should be identical up to the adverb. After the first sentential noun, participants' attention is directed to the representation of the visual context in working memory. Presumably, the card and distance representations are active as participants encounter the adverb. In contrast to Experiment 1, however, we moved the adverb before the second noun, and the latter has thus not yet been integrated with the other card. Under that condition, it is possible that the visual context representation

does not decay quickly enough to produce facilitation. Instead, remains active in working memory, producing interference on the assumption that highly active distance representations interfere with processing social relations.

This view of the interaction between perceptual representation and semantic interpretation can potentially accommodate both the observed facilitation and interference effects. However, it is important to be cautious with conclusions regarding the mechanisms that we attribute to these facilitation and interference effects. For instance, a recent study aimed to replicate previous findings on the role of visual features during sentence comprehension and found the exact opposite pattern of effects (see Zwaan & Pecher, 2012, Experiment 3a and 3b; cf. Connell, 2007). Thus, although an attentional account appears compatible with our results and the co-indexing mechanism, further research should confirm these initial results.

Conclusion

In two eye-tracking reading studies we examined the effects of non-referential visual context on real-time interpretation of social relations. We showed that spatial distance between objects distinctively modulated reading times for sentences expressing friendly or unfriendly social interactions. Just as for semantic similarity, these effects occurred rapidly and incrementally. Moreover, spatial distance affected semantic interpretation even when coordinated elements in the visual context did not directly map onto a coordination of nouns in the sentence. Instead, spatial distance affected interpretation of social relations as soon as other critical semantic information became available. These results appear as further evidence for effects of non-referential visual information on abstract semantic interpretation and they also contribute to the refinement of the co-indexing mechanism.

Acknowledgments

References

Altmann, G. T. M. (2004). Language-mediated eye movements in the absence of a visual world: The 'blank screen paradigm'. *Cognition, 93*, B79–B87.

Altmann, G. T. M., & Kamide, Y. (2007). The real-time mediation of visual attention by language and world knowledge: Linking anticipatory (and other) eye movements to linguistic processing. *JML, 57*, 502–518.

Bar-Anan, Y., Liberman, N., Trope, Y., & Algom, D. (2007). Automatic processing of psychological distance: evidence from a stroop task. *JEP: General, 136*, 610–622.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random-effects structure for confirmatory hypothesis testing: Keep it maximal. *JML, 68*, 255–278.

Chen, Q., & Mirman, D. (2012). Competition and cooperation among similar representations: Toward a unified account of facilitative and inhibitory effects of lexical neighbors. *Psychological Review, 119*, 417-430.

Connell, L. (2007) Representing object colour in language comprehension. *Cognition, 102*, 476–485.

Connell, L., & Lynott, D. (2012). When does perception facilitate or interfere with conceptual processing? The effect of attentional modulation. *Frontiers in Psychology, 3*, 1-4.

Guerra, E., & Knoeferle, P. (2012). Abstract language comprehension is incrementally modulated by non-referential spatial information: evidence from eye-tracking. *Proceedings of the 34th Annual Meeting of the Cognitive Science Society* (pp. 1620–1625). Austin, TX: Cognitive Science Society.

Kaschak, M. P., Madden, C. J., Therriault, D. J., Yaxley, R. H., Aveyard, M., Blanchard, A. A., & Zwaan, R. A. (2005). Perception of motion affects language processing. *Cognition, 94*, B79-B89.

Knoeferle, P., & Crocker, M. W. (2007). The influence of recent scene events on spoken comprehension: Evidence from eye movements. *JML, 57*, 519–543.

Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought.* New York, NY: Basic Books.

Matthews, J. L., & Matlock, T. (2011). Understanding the link between spatial distance and social distance. *Social Psychology, 42*, 185–192.

Mitchell, D. C. (1984). An evaluation of subject-paced reading tasks and other methods for investigating immediate processes in reading. In D. E. Kieras & M. A. Just (Eds.) *New methods in reading comprehension research* (pp. 69–90). Hillsdale, NJ: Erlbaum

Rayner, K. (2009). Eye movements and attention in reading, scene perception, and visual search. *The Quarterly Journal of Experimental Psychology, 62*, 1457–1506.

Richardson, D. C., Spivey, M. J., Barsalou, L. W., & McRae, K. (2003). Spatial representations activated during real-time comprehension of verbs. *Cognitive Science, 27*, 767-780.

Sturt, P., Keller, F., & Dubey, A. (2010). Syntactic priming in comprehension: Parallelism effects with and without coordination. *JML, 62*, 333–351.

Tanenhaus, M. K., Spivey-Knowlton, M., Eberhard, K., & Sedivy, J. (1995). Integration of visual and linguistic information during spoken language comprehension. *Science, 268*, 1632–1634.

Williams, L. E., & Bargh, J. A. (2008). Keeping one's distance : The influence of spatial distance cues on affect and evaluation. *Psychological Science, 19*, 302–308.

Zwaan, R. A., & Pecher, D. (2012). Revisiting mental simulation in language comprehension: Six replication attempts. *PloS ONE, 7*, 1–10.