Integration of Visual Information about the Speaker during Sentence Processing

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1   Introduction

Imagine you are having a conversation with a person you just met. During this conversation your counterpart tells you: "Recently, I bought a new dress to wear at my sister's wedding." A syntactically and semantically well-formed sentence, and probably also not surprising in its topic – if you are having a chat with a woman. If you were talking to a man you would probably be confused. Hearing this utterance from a man is quite odd if you relate the sex of the speaker to the content of the sentence. From the perspective of theory, the key question is at what point in time information from the extra-linguistic context, such as about a speaker's sex or age, is integrated during the process of sentence comprehension. According to traditional theories of language comprehension, the processing of a sentence takes place in two steps (Cutler & Clifton 1999; Fodor 1983; Perfetti 1999). First, the sentence is processed according to its syntax, and the semantic content gets established. Linguistic or extra-linguistic contextual factors are taken into account only in a second processing step. Thus, information which exceeds the lexical-semantic information of the actual sentence is integrated at a later point during comprehension. However, there is evidence pointing in the direction of one-step processing (Hagoort et al. 2004; Matsuki et al. 2011; Nieuwland & van Berkum 2006). According to this view, all information that is useful for interpreting the sentence in the actual context gets integrated instantly. This includes context variables like information from the previous discourse, visual environment, world knowledge and the characteristics of a speaker. Hagoort et al. (2004) showed that a violation of world knowledge ("The city of Venice has many roundabouts…") elicited a similar N400 component of the event-related potential (ERP) as a sentence containing a semantic violation ("The city of Venice has many thoughts…") when compared with correct sentences ("The city of Venice has many canals…"; see also Dudschig et al. 2016). Concerning the integration of information about a speaker, van Berkum et al. (2008) conducted an ERP study in which the characteristics of the speakers were conveyed via voice. The sentences were stereotypical for a certain gender, age or socio-economic background and spoken by a matching or non-matching voice. The socio-economic background was conveyed through an upper- or lower-class accent. Mismatches regarding these speaker variables elicited an N400 which was smaller but similar in nature to those elicited by semantic mismatches, indicating early integration of this extra-linguistic information.

Despite the evidence for early integration of contextual information, and hence for one-step models of sentence processing, alternative accounts remain viable. For instance, the N400 findings suggesting that the prior context immediately influences comprehension could also reflect the impact of low-level associations (e.g. Huang & Gordon 2011). This explanation holds especially for studies like Haagort et al.'s (2004), because "Venice" is highly associated with "canals", but not with "roundabouts" or "thoughts" (see Kutas & Federmeier 2000 for electrophysiological evidence for low-level lexical priming effects). Also a voice could activate associations and therefore prime for the matching words. Similarly, words, as well as the information about a speaker in voice or appearance most likely co-occur more often with certain words and less with others. Thus, maybe the word "dress" elicits a larger N400 in a sentence spoken by a male compared to a female voice, because males are not associated with dresses or do not mention this word as often as females do, resulting in associations between particular speaker appearances and particular words. Therefore, the results of these studies do not necessarily speak for the rapid integration of context information and sentence semantics and cannot rule out a two-step model of pragmatic processing. The aim of the current study was to address these objections by investigating the processing of negated sentences. Adding a negative particle to a sentence such as "I bought a new dress for my sister's wedding" allows changing the plausibility of the described situation in the mismatching case while keeping the content words stable. After all, there is nothing unusual to a man not buying a new dress for his sister's wedding. If such speaker-related congruency-effects reflect low-level association effects, then we would expect to see the exact same congruency effects for affirmative and negated sentences. If, however they reflect sentence-based integration processes, then we would expect to see differences between affirmative and negated sentences.

To test these predictions concerning the integration of contextual information about the speaker during comprehension, we conducted two self-paced reading studies. The aim of Experiment I was to examine if, and at what time point during comprehension, processing difficulties occur when the comprehender processes an utterance describing an event that is atypical for a particular speaker. Instead of presenting sentences auditory and manipulating the speaker's voice (van Berkum et al. 2008), here we employed a novel paradigm that allowed us to assess effects on reading time for written sentences. Sentences were presented phrase by phrase on screen and simultaneously the speaker's characteristics were made available by presenting a picture of the speaker (cf. Fig. 1). If it is possible to convey the speakers sex and age through pictures in such a self-paced reading paradigm, then differences in reading latencies should occur when comparing matching and mismatching picture-sentence pairings, resulting in longer reading times for mismatching pairings (i.e., a male picture with the sentence "Recently, I bought a new dress for my sister's wedding."). These differences should not emerge until the mismatch between the speaker characteristic and the stereotypical event appears. In fact, differences are only expected at or after the phrase which determines the typicality (i.e., the word "dress") and therefore contains a match or a mismatch with respect to the presented picture. According to a two-step model, we would expect reading time differences to emerge rather late, on the end of the sentence, but definitely not on the critical phrase. If the one-step model holds true, the characteristics of the speaker should get integrated early. In this case, reading time differences should appear at or directly after the critical phrase.

In Experiment II we then presented a new sample of participants with negated versions of the same sentences. The aim of this experiment was to determine whether the congruency effects observed in Experiment I reflect low-level association or rather sentence-based integration effects. Independent of the results speaking for a one-step or a two-step model – if the former is true, then we would expect to find the same congruency effects both for negated and for affirmative sentences, because the content words are the same in the two sentence types. If the latter is true, congruency effects should vanish for the negated sentences because the described situations and events are no longer implausible in the incongruent conditions.

2 Experiment I

2.1 Method

Participants

After signing informed consent, 62 participants took part in the experiment for course credit, compensation (5€), or voluntarily without payment. One participant's data was excluded directly after the experiment when it became clear in a questionnaire concluding the experiment, that she was aware of the purpose of the study. Forty-nine of the remaining 61 subjects were female (80%). Participants were 18 to 47 years old ($M = 23.23$, $SD = 4.53$). All were native speakers of German or had a native-like proficiency of German.

Materials

We designed sentence pairs with one version typical for a man and one version typical for a woman, or for a child and an adult, respectively. The typicality was determined by a critical phrase, apart from which the two versions of each sentence were identical. A rating study was conducted to verify the typicality with a sample of 19 female and 13 male participants ($n = 32$), aged from 19 to 44 years ($M = 24.69$, $SD = 5.78$), none of whom participated in the reading time study (see Table 1 for rating results). Forty-eight German sentences met the criterion of being typical for a certain speaker in the first version but atypical in the second version. Furthermore, 61 filler sentences were constructed. The fillers were similar to the experimental sentences, but neutral regarding gender and age. An additional nine neutral and one typically female sentence were used for practice trials. Yes/no comprehension questions were asked directly after about a quarter of the filler and practice sentences. Comprehension questions were included to keep the subjects focused and to ensure they read the sentences thoroughly. The portion of required "yes" and "no" answers was balanced. All experimental and filler sentences occurred in random order, as did the practice sentences within the practice block.

Table 1: Results of the typicality rating for the two versions of each sentence (mean and standard deviation)

Sentence version	male		female		child		adult	
Typicality	male	female	male	female	child	adult	child	adult
M ± SD	2.60 ± 0.77	5.64 ± 0.82	6.28 ± 0.78	2.26 ± 0.56	2.09 ± 0.74	6.49 ± 0.66	6.64 ± 0.58	2.11 ± 0.68

Note. Typicality was rated on a 7-point Likert-Scale ranging from 0 (very typical) to 7 (very untypical).

Fig. 1: Illustration of the self-paced reading paradigm. In the figure, the participant has reached the critical phrase of a sentence, *'ein schickes Cocktailkleid'* (*an elegant cocktail dress*). The picture on the left (taken from the Radboud Faces Database; Langner et al. 2010) stayed on the screen during the sentence presentation

Each sentence was presented phrase by phrase in a self-paced reading design employing a moving window paradigm. The sentences differed in length, so there were one to five subsequent phrases after the critical phrase. The ending phrases were pooled for calculation of reading times. In the example below, phrases are indicated by vertical bars. Asterisks separate the female and the male version of the critical phrase.

(1) *Letzte Woche | habe ich mir | ein schickes Cocktailkleid * einen schicken*
Last   week   have I myself an elegant cocktail dress * an   elegant

Smoking | für die Hochzeit | meiner Schwester | gekauft.
tuxedo   for the wedding of my sister   bought.

'Last week I bought an elegant cocktail dress*tuxedo for my sister's wedding.'

Additionally, a picture of a woman, a man, or a child – that is, a picture either matching or mismatching the critical phrase – was shown. At the beginning of each trial, participants saw the picture on the left of the screen, and placeholders for each word of the upcoming sentence on the right. By pressing the space bar, a phrase appeared instead of the placeholders (see Fig. 1). By pressing the space bar again, the previous phrase was replaced by placeholders and the next phrase appeared. Thus, participants could move at their own pace from the beginning of a sentence to its end. Response times were collected for each keypress. To answer the comprehension questions, participants had to click the left vs. right mouse key for "yes" vs. "no" answers.
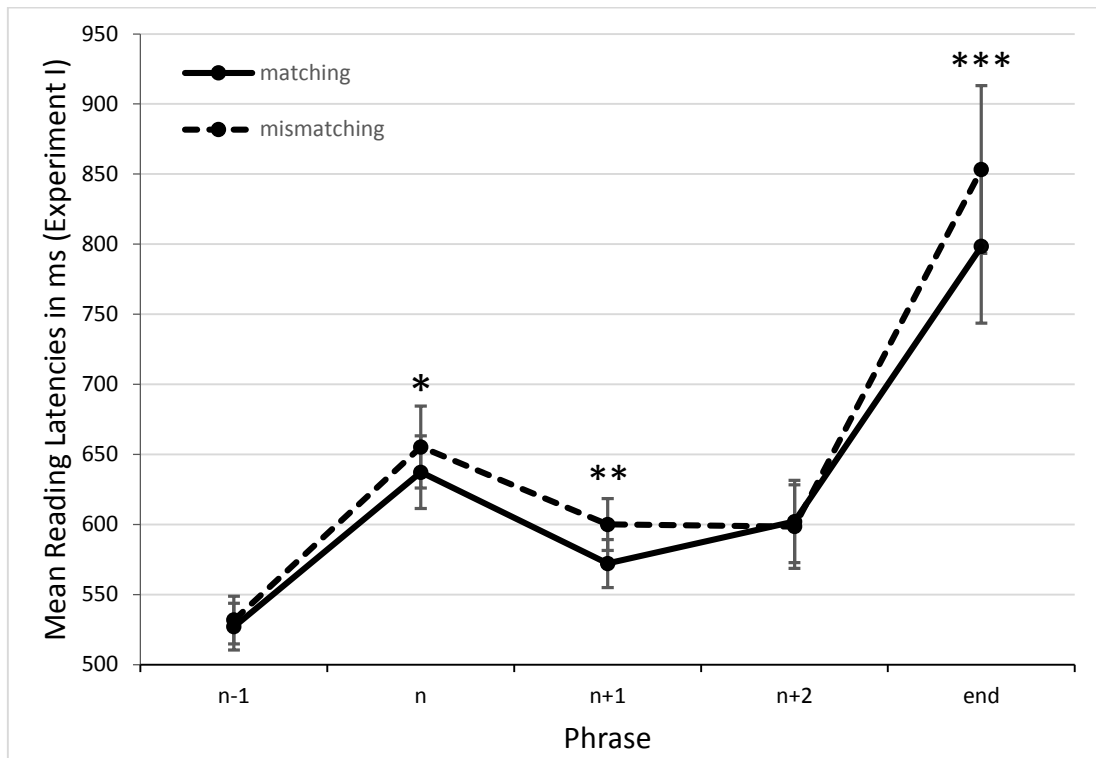
Fig. 2: Mean reading latencies in ms over the time course of affirmative sentences for matching and mismatching presentations. "n" represents the critical phrase. Error bars indicate the standard error of the mean.*p < .05, **p ≤ .01, ***p ≤ .001

2.2 Results and Discussion

We predicted longer reading times for mismatching speaker information in comparison to matching information. Moreover, on the basis of the findings of van Berkum et al. (2008), we expected this congruency effect to emerge quite early during processing on the critical phrase and/or the directly following phrase. On the basis of a two-step model of sentence processing, we expected no congruency effect on early phrases, but rather late on the sentence.

One-sided paired t-tests were conducted for the critical phrase (n), the phrase preceding (n-1) and the following two phrases (n+1, n+2) as well as for the ending phrase to test for a congruency effect. In each case, we conducted separate t-tests with either participants (index 1) or items (index 2) as random factor. As these were planned comparisons, we did not correct for multiple comparisons. However, for a Bonferroni correction with five comparisons the threshold for a significant p-value would be .01.

As expected, no significant differences occurred on the phrase preceding the critical phrase (t_1 < 1, t_2 < 1). On the critical phrase containing the stereotypical content, reading times were on average 18 ms longer when the sex or the age of the person in the picture mismatched the described events in comparison to matching sex or age (t_1(60) = 1.91, p = .03; t_2(47) = 2.10, p = .02). On the phrase directly following the critical phrase, reading times were prolonged as well (on average 28 ms; t_1(60) = 2.61, p = .006, t_2(47) = 3.42, p = .001). This congruency effect vanished on phrase n+2 (t_1

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< 1, t_2 < 1), but emerged again on the final phrase with a mean difference of 55 ms ($t_1(60) = 3.10$, $p = .001$; $t_2(47) = 3.51$, $p < .001$). See Fig. 2 for the time course of reading latencies.

The results suggest that readers implicitly take the picture as depicting the speaker and integrate his or her visible characteristics during language processing. More importantly, the congruency effect emerging on the critical phrase hints at early integration of these characteristics. This effect is still visible at the following phrase, which hints at persisting integration difficulties when encountering a mismatch. Of course it could also reflect a postponed effect which occurs when participants press the spacebar before they have fully processed the critical phrase. The integration difficulties of one phrase could therefore manifest itself in prolonged reading times on the following phrase. Considering this, the congruency effect on the critical and following phrase strongly suggest an early integration of visual speaker information, as predicted by a one-step model of language comprehension. Nevertheless, as noted above, the results may not originate from difficulties integrating the contextual information about the "speaker" in relation to the semantic meaning of the sentence, but may reflect priming effects from the face stimulus to words associated with the shown characteristics. Similarly, the results may be due to word-based associations with certain speaker characteristics. In this case, the prolonged reading times would reflect the unusual co-occurrence of certain speaker characteristics with a word not associated with his or her features, that is, word-based interference effects. In either case, the observed congruency effects could not be taken as positive evidence for one-step models of comprehension. To shed light on this explanation of the effects, we conducted Experiment II.

3   Experiment II

We conducted a second experiment employing negated item material to rule out the alternative, word-based explanation of the effects in Experiment I. Negation changes sentences in several ways. By negating a sentence, it is for instance possible to convert the content of a sentence into the opposite with only minor changes to the item material. In the current study, this turns the sentences in the mismatching speaker condition, describing events that are implausible with respect to the depicted speakers, into sentences that describe a more plausible situation in relation to the speaker information (further referred to as "mismatching[now plausible]"). The plausibility here refers to the action or circumstances talked about. It does not refer to the utterance itself. Returning to the introductory example, there is nothing implausible to a man not buying a dress for his sister's wedding. Usually, men are expected to buy suits and shirts for a wedding. With this change, the congruency effect observed in Experiment I should be diminished or even absent, due to the restored plausibility of the states of affairs described in formerly mismatching sentences. This outcome is expected if the plausibility of the described situation underlies the results in Experiment I. However, if the congruency effect found in Experiment I for affirmative sentences reflects priming or word-based interferences, exactly the same pattern should emerge for negated sentences in this experiment. Please note that we will continue to use the term "matching" as in Experiment I, because the now negated state of affairs is still plausible (there is nothing implausible to a woman not buying a dress).

3.1 Method

Participants

Sixty-seven undergraduates took part in Experiment II for course credit or monetary reward (5€). Forty-eight participants (72%) were female. The participants were between 18 and 33 years old ($M = 21.39$, $SD = 2.94$). None of them had taken part in Experiment I nor in the rating study for Experiment I. All were native speakers of German.

Materials & Procedure

The affirmative sentences used in the first experiment were negated, and if necessary, slightly adjusted to sound natural in the negated version. It was also made sure that the negation particle appeared before the critical phrase. The negated version of the female example looked as follows.

(2) *Letzte Woche | habe ich mir kein | schickes Cocktailkleid | für die Hochzeit |*
Last   week   have I myself no   elegant   cocktail dress   for   the wedding

meiner Schwester | gekauft.
of my   sister   bought.

'Last week I didn't buy an elegant cocktail dress for my sister's wedding.'

The fillers were the same as in Experiment I. The procedure for Experiment II was analogous to Experiment I.
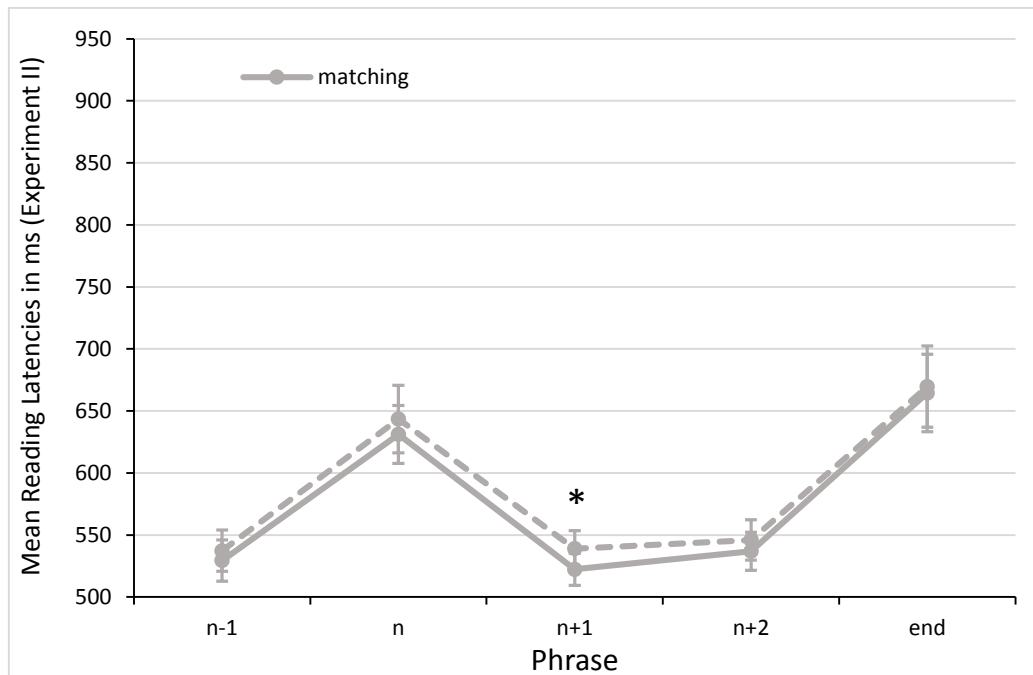

Fig. 3: Mean reading latencies in ms over the time course of negated sentences for matching and mismatching[now plausible] presentations. "n" represents the critical phrase. Error bars indicate the standard error of the mean. *$p < .05$

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3.2 Results and Discussion

Analogous to Experiment I we conducted separate one-sided paired t-tests with either participants (index 1) or items (index 2) as random factor. Again, as these comparisons were planned, we did not correct for multiple comparisons. As in the previous experiment, the Bonferroni corrected threshold for a significant p-value is .01.

T-tests revealed no effect of congruency on Phrase n-1 ($t_1(66) = 1.09$, $p = .14$; $t_2 < 1$). Critically, the reaction times in the matching and mismatching$^{\text{now plausible}}$ condition did not differ significantly on the critical phrase (12.38 ms, $t_1(66) = 1.01$, $p = .16$; $t_2 < 1$). Reading times were significantly prolonged on the following Phrase n+1 for a picture-word mismatch (16.64 ms, $t_1(66) = 2.14$, $p = .02$; $t_2(36) = 1.72$, $p = .05$). No such effect was found on n+2 (3.35 ms, $t_1 < 1$, $t_2 < 1$) or the ending phrase (5.04 ms $t_1 < 1$, $t_2 < 1$). See Fig. 3 for the time course of the reading latencies.

We conducted Experiment II to rule out the alternative explanation of a word-based congruency effect in Experiment I. Employing negations, no such effect should emerge if the reader rapidly takes into account not only the age and sex of a speaker, but also integrates this information with sentence meaning to arrive at an interpretation with respect to the plausibility of the described states of affairs in the negated version. The effect on the phrase following the critical phrase points in the direction of a word-based congruency effect and against the rapid integration with sentence meaning. However, compared to Experiment I, there was no effect on the final phrase.
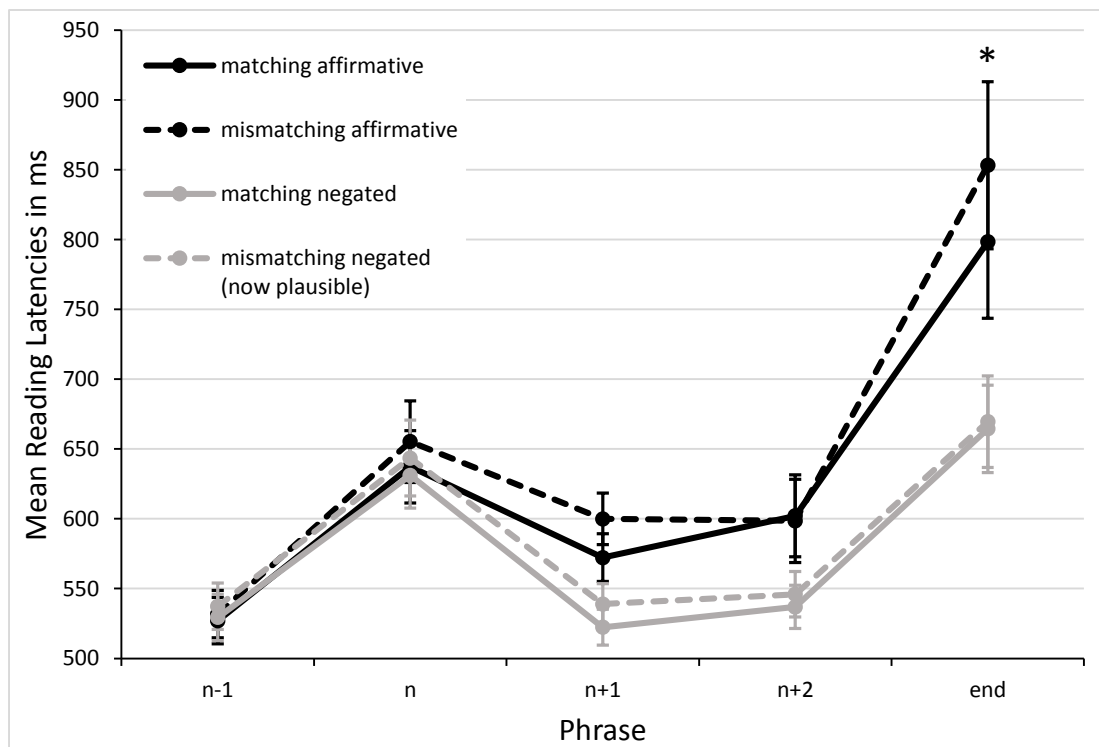

Fig. 4: Mean reading latencies in ms over the time course of affirmative and negated sentences for matching and mismatching presentations. "n" represents the critical phrase. Error bars indicate the standard error of the mean. *$p < .05$ marks the significant interaction between polarity and congruency

To get a clearer picture about how the negation influences the congruency effect, we conducted ANOVAs with repeated measurements for each phrase, with congruency as a within-participants factor and the variable polarity (affirmative vs. negated) as a between-participants factor. As expected, there were no significant effects on Phrase n-1 (congruency: $F_1(1, 126) = 1.69$, $p = .19$, $F_2 < 1$; polarity: both $Fs < 1$; congruency x polarity: both $Fs < 1$). On the critical phrase, there was only a marginally significant main effect of congruency (congruency: $F_1(1, 126) = 3.76$, $p = .055$, $F_2(1, 91) = 3.16$, $p = .08$; polarity: both $Fs < 1$; congruency x polarity: both $Fs < 1$). On Phrase n+1, the effect of congruency became fully significant and proved to be independent of the polarity of the sentence (congruency: $F_1(1, 126) = 11.63$, $p = .001$, $F_2(1, 72) = 11.40$, $p = .001$; polarity: $F_1(1, 126) = 6.74$, $p = .011$, $F_2(1, 72) = 5.73$, $p = .02$; congruency x polarity: both $Fs < 1$). On Phrase n+2, no main effect for congruency was observed (congruency: both $Fs < 1$; polarity: $F_1(1, 126) = 3.73$, $p = .056$; $F_2 < 1$; congruency x polarity: both $Fs < 1$). On the final phrase, there was a significant main effect for congruency and also a significant interaction (congruency: $F_1(1, 126) = 6.89$, $p = .01$, $F_2(1, 91) = 9.59$, $p = .003$; polarity: $F_1(1, 126) = 6.31$, $p = .013$, $F_2(1, 91) = 49.02$, $p = .000$; congruency x polarity: $F_1(1, 126) = 4.77$, $p = .03$, $F_2(1, 91) = 6.52$, $p = .012$), reflecting the fact that congruency influenced reading times for affirmative but not for negated sentences on their final phrase (see analyses above). See Fig. 4 for time course and interactions of reading latencies for affirmative and negated sentences.

Taken together these results show that early on in the sentence (Phrases n and n+1) the congruency effect is independent of the polarity of the sentence (affirmative vs. negated) pointing towards word-based congruency effects that probably reflect the fact that certain words occur less often together with certain speaker characteristics than others (e.g. the word "wine" with a child speaker, the word "dress" with a male speaker etc.) or are due to priming effects. At the end of the sentence, in contrast, comprehenders apparently distinguish between affirmative and negated sentences, and do seem to take into account plausibility differences between the described events in mismatching affirmative and mismatching[now plausible] negated conditions. Mismatching[now plausible] negated sentences describe plausible states of affairs and thus do not lead to prolonged reading times.

These results suggest that contextual information regarding speaker characteristics is taken into account at a very early time during the comprehension process. Mismatches between certain words and the speaker start to become evident at the critical phrase or at least at the phrase thereafter. However, at this point in time, speaker information does not seem to have been integrated with the meaning of the sentence as a whole. The congruency effects rather seem to reflect low-level association effects between speaker characteristics and certain words. At the end of the sentence, however, readers do distinguish between affirmative and negated sentences. At this point during the comprehension process they seem to have integrated the information about the speaker with the meaning of the sentence as a whole resulting in an interpretation of the sentence that takes into account the plausibility of the described states of affairs. All in all, these results seem to fit quite well with two-step models of comprehension, according to which a full-fledged interpretation of a sentence that takes into account the information in the sentence as well as the information from the linguistic and non-linguistic context takes some time to develop.

4 General Discussion

Considering different models of language comprehension, the integration of extra-linguistic information like speaker characteristics could take place at the same time as the processing of semantic content (Hagoort et al. 2004; Matsuki et al. 2011; Nieuwland & van Berkum 2006), or it could be delayed to a second step (Cutler & Clifton 1999; Fodor 1983; Perfetti 1999). In a first experiment, we employed a novel phrasal self-paced reading paradigm combined with photos to convey the speaker characteristics sex and age. Using affirmative sentences, we found a congruency effect at an early processing stage. When the sex or age of the person in the picture did not match the stereotypical content of the sentence, reading times were prolonged on the critical phrase. This effect persisted on the directly following phrase and strongly showed up again at the end of the sentences. These results replicate earlier electrophysiological experiments, and thus at first glance hint towards a one-step model of sentence processing, according to which all available cues are integrated instantly during comprehension (Hagoort et al. 2004; Matsuki et al. 2011; Nieuwland & van Berkum 2006). However, as argued in the introduction, the observed congruency effect could also reflect priming or low-level word-based effects reflecting associations between certain words and certain speaker characteristics. Certain words, such as "wine" and "dress" are more likely associated with and uttered by certain speakers (adults and women, respectively). If so, these effects would still show that speaker characteristics are taken into account early on during the comprehension process, but these effects would no longer show that this type of extra-linguistic context information gets integrated with sentential meaning early on. In this sense, the results then could not be taken as evidence for one-step models of comprehension.

To address this alternative explanation, we conducted a second experiment in which we used negated instead of affirmative sentences. Negating the sentences changes the plausibility of the described states of affairs in the formerly mismatching conditions. Consequently, the negated stereotype now fitted (better) for speakers for whom the sentence was odd before. On this basis we expected that if the results of Experiment I were solely based on low-level word based associations, we should find the same congruency effect in Experiment II as we did in Experiment I. However, if readers indeed rapidly integrated the cues provided by the speaker with the meaning of the developing sentence, no difference between matching and mismatching[now plausible] trials should emerge, due to restored plausibility of formerly implausible sentences. In a combined analysis of the two experiments, we found evidence for both predictions but at different points during the comprehension process. Early on during comprehension, namely during the processing of the critical phrase and Phrase n+1, we found congruency effects that were independent of the polarity of the sentence, thereby probably reflecting low-level word-based association effects. At the end of the sentence, in contrast, congruency effects were observed for affirmative but not for negated sentences, indicating that speaker information is being integrated with the meaning of the evolving sentence. Together, these results suggest that speaker information is taken into account immediately during comprehension but that integrating this information with the meaning of the sentence as a whole does take some time and probably is not accomplished until later during the comprehension process.

The processing of negated sentences entails certain characteristics. Using contradictory predicates (e.g. open/closed), Kaup et al. (2006) showed that comprehenders of negated sentences (e.g. "the door is not open") represent both, the negated state of affairs (an open door) and the actual state of affairs (a closed door), before focusing only on the actual state. At a first glance our results may suggest, that readers early have two representations available – the (negated) state of buying a dress and the (actual) state of not buying a dress. Further, that at the end of the sentence, the attention shift towards the actual state – not buying a dress – causes the absent congruency effect. However, this cannot solely explain the results. As both representations are available early, they should rule each other out and therefore cause no mismatch effect. The effect on the Phrase n+1 seems to be due to other mechanisms of sentence processing.

Up to now we have only looked at the effect that negation has on the plausibility of the described situations and events. We argued that negating a sentence such as "Last week I bought a dress for my sister's wedding" turns an action that is implausible for a male person into a plausible situation because males typically do not buy dresses. However, matters get more complicated if we also take into account pragmatic aspects of negation, meaning not only how plausible the described situation but the utterance itself is for the speaker. Negated sentences are typically uttered to indicate deviations from expectancies (for an overview see Moeschler 1992). Thus, if someone tells you "not p", you can assume that the speaker thought that you thought "p" would apply. Returning to the example in the introduction, a man telling you that he did not buy a dress for a special occasion describes a plausible situation. However, one could wonder why the person makes such a statement when no one expected him to buy a dress in the first place. Thus, out of context, negated statements are often pragmatically infelicitous. One could argue, that for our materials this is particularly true in conditions with non-matching speaker information, because in this case the action that is being negated (a man buying a dress for a wedding) is even less expected than in conditions with matching speaker information (i.e., a woman buying a dress for a wedding). In other words, if comprehenders take into account these pragmatic aspects of negation during comprehension then we might expect congruency effects for negated sentences as well, but for different reasons compared to the affirmative sentences. Negated sentences in incongruent conditions would lead to prolonged reading times compared to congruent conditions because the negated state of affairs was unexpected, resulting in pragmatically infelicitous utterances. In other words, strictly speaking, we cannot be sure that the early effects of congruency are indeed due to word-based associations or rather reflect the fact that comprehenders immediately take into account the pragmatics of negation. However, we do not consider the pragmatic explanation for our early effects to be very plausible considering the observed interaction between congruency and experiment (affirmative vs. negated) at the end of the sentences. It seems unlikely that comprehenders take into account the pragmatics of negation early on but later only focus on the plausibility of the described situation. However, interpreting the current results – namely the polarity-independent congruency effect on Phrase n+1 – in favor of a one-step model, where the pragmatics of a sentence are taken into account early on, demands for an explanation of the interaction between polarity and congruency on sentence end. Nevertheless, future studies are needed to find out more about these alternative explanations. Indeed, we are currently running an experiment in our lab in which we compare affirmative and negated sentences in one experiment. In a follow up study, we will

also include negated sentences with linguistic hedges and boosts ("It goes without saying, that I did not buy a dress …."). These sentences should provide the reader with the necessary information to make the negated utterances pragmatically feasible. Comparing sentences with and without boosts and hedges will provide further insight into the processing of pragmatic content during comprehension.

To sum up, in the current study we investigated predictions of one- vs. two-step models of comprehension with respect to the processing of sentences describing actions or events that are plausible or implausible with respect to the speaker of an utterance. We found similar congruency effects for affirmative and negated sentences early on in the comprehension process when the critical information was presented to the participants. These congruency effects most likely reflect word-based association processes that come about because certain words occur more often with certain speaker characteristics than with others. At a later point in time during the comprehension process, namely at the end of the sentences, we observed a congruency-by-polarity interaction, presumably reflecting sentence comprehension processes by which information about the speaker of an utterance is integrated with the meaning of the evolving sentence. These results seem to fit well with two-step models of comprehension, according to which comprehenders first create a semantic representation based on the information given in the sentence and only later on take into account contextual information as well. Future studies are necessary to determine the role that pragmatic aspects of negation play in speaker-based congruency effects during comprehension.

References

Van Berkum, J. J. A., D. van den Brink, C. M. J. Y. Tesink, M. Kos, & P. Hagoort (2008) The neural integration of speaker and message. *Journal of Cognitive Neuroscience*, 20(4): 580-591.

Cutler, A. & C. Clifton (1999) Comprehending spoken language: A blueprint of the listener. In C. M. Brown & P. Hagoort, eds., *The Neurocognition of Language*. Oxford University Press, Oxford: 125-166.

Dudschig, C., C. Maienborn, & B. Kaup (2016) Is there a difference between stripy journeys and stripy ladybirds? The N400 response to semantic and world-knowledge violations during sentence processing. *Brain and cognition*, 103: 38-49.

Fodor, J. A. (1983) *The modularity of mind.* MIT Press, Cambridge.

Hagoort, P., L. Hald, M. C. M. Bastiaansen, & K. M. Petersson (2004) Integration of word meaning and world knowledge in language comprehension. *Science (New York, N.Y.)*, 304: 438-441.

Huang, Y. T. & P. C. Gordon (2011) Distinguishing the time course of lexical and discourse processes through context, coreference, and quantified expressions. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 37(4): 966-978.

Kaup, B., J. Lüdtke, & R. A. Zwaan (2006) Processing negated sentences with contradictory predicates: Is a door that is not open mentally closed? *Journal of Pragmatics*, 38: 1033-1050.

Kutas, M. & K. D. Federmeier (2000) Electrophysiology reveals semantic memory use in language comprehension. *Trends in Cognitive Science*, 12(12): 463-470.

Langner, O., R. Dotsch, G. Bijlstra, D. H. J. Wigboldus, S. T. Hawk, & A. van Knippenberg (2010) Presentation and validation of the Radboud Faces Database. *Cognition & Emotion*, 24(8): 1377-1388.

Matsuki, K., T. Chow, M. Hare, J. L. Elman, C. Scheepers, & K. McRae (2011) Event-based plausibility immediately influences on-line language comprehension. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, 37(4): 913-934.

Moeschler, J. (1992) The pragmatic aspects of linguistic negation: Speech act, argumentation and pragmatic inference. *Argumentation*, 6: 51-76.

Nieuwland, M. S. & J. J. A. van Berkum (2006) When peanuts fall in love: N400 evidence for the power of discourse. *Journal of Cognitive Neuroscience*, 18: 1098-1111.

Perfetti, C. A. (1999) Comprehending written language: A blueprint of the reader. In C. M. Brown & P. Hagoort, eds., *The Neurocognition of Language.* Oxford University Press, Oxford: 167-240.