REGISTER
Aspects of
Language
in Situation

Register and standard language knowledge in interaction

The influence of social factors

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The semantic relation between a verb and its argument rapidly impacts language comprehension much like world knowledge and the linguistic context (Altmann & Kamide 1999, Golden & Rumelhart 1993, Kutas & Hillyard 1984). Considering this, the social information that becomes available within a communicative situation could also be considered to belong to the contextual information that language users draw on during comprehension. In the present study, social information is established via matching and mismatching relations between the formality of a context and the use of formal or informal register. In two self-paced reading experiments with an additional picture-selection task we examined how the semantic relation between a verb and its argument may interact with congruence relations between formality contexts and register. We assessed whether comprehenders benefit from habituation enabled by presentation of the stimuli in formality blocks (Exp 1, N = 66) and whether they can rapidly adapt to changes in situation formality (Exp 2, N = 64). We successfully replicated incremental verb-argument (mis)match effects. No significant register-congruence effect was found, but the observed picture-selection accuracy patterns could be taken to suggest that the processing of social contextual information might impact late sentence processing. To gain an understanding of the variability found across all dependent measures and experiments we discuss these effects in the context of social background factors such as a participant's educational background and currently-used language variants.

Keywords: register, verb-argument congruence, self-paced reading, social background and context, written sentence processing

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1 Introduction

The modulation of language comprehension via context has been the center of many previous research efforts. For instance, parallel-interactive, constraint-based accounts (MacDonald et al. 1994, McRae et al. 1998, Seidenberg & McClelland 1989) accommodated the idea of multiple information types (e. g. of semantic, syntactic, phonological nature) to be available and processed simultaneously. Moreover, it was proposed that the interaction of the various information types as well as their relative importance in the given context, impact the outcome of the language comprehension process. On these accounts, comprehension is viewed as determined by probabilistic knowledge about language, which comprehenders accumulate during their lifetime. Thus, linguistic information such as thematic fit (Trueswell et al. 1994) or verb-specific subcategorization information (Trueswell et al. 1993)[1] or contextual information expressed via linguistic or non-linguistic cues can rapidly impact language comprehension. Along with the broader linguistic context, extant research has shown that world knowledge and language experience exercise a rapid influence on the comprehension (Altmann & Kamide 1999, Kutas & Hillyard 1984) of both shorter and longer stretches of linguistic input (see Golden & Rumelhart 1993 for a parallel-distributed model on story comprehension). Together with visual contextual information, these factors were hypothesized to be operated in a probabilistic manner, to obtain the most likely interpretation of the linguistic input. This was based on evidence stemming from the various information types, (e. g. structural, lexical, pragmatic, discourse, see Levy 2008), that become available incrementally,[2] resulting in a highly constraining context. The contribution of numerous constraints from the context was thus hypothesized to influence the comprehension process but also to aid in building expectations about the upcoming linguistic input.

This prior research and research on situation models (Zwaan & Radvansky 1998), paved the way for accounts of real-time, situated language comprehension (Altmann & Kamide 2007, Kukona & Tabor 2011, Münster & Knoeferle 2018a).

[1]Thematic fit and verb-specific subcategorization information refer to the semantic contribution of a word and the elements it should be combined with to create complex meanings. For instance, the subcategorization scheme of a verb informs about which (semantic) arguments a verb requires. For example, the verb 'eat' requires or subcategorizes for a subject and an object.

[2]"Incremental" refers to gradual comprehension effects, as a participant processes a sentence. For instance, when investigating incremental effects of verb-argument relations on written sentence comprehension, we ask how matching or mismatching semantic information between a verb and its argument impacts reading patterns as participants gradually advance through a sentence.

While the situation models underline the multidimensionality of communication situations, accounts of situated comprehension focus on accommodating how visual perception of objects and scenes, along with attention coordinate with spoken or written language to achieve an incremental interpretation of linguistic input. Specifically, the CIA (Coordinated Interplay Account) (Knoeferle & Crocker 2006, 2007, Knoeferle et al. 2014) and sCIA (socially Coordinated Interplay Account) (Münster & Knoeferle 2018a) describe the incremental process of language comprehension (spoken or written), in the presence or absence of a concurrent visual scene in three steps that are specified to either occur in parallel or overlap during comprehension. In this sense, the incoming linguistic input is interpreted step-by-step. As comprehenders read or listen to a sentence, the interpretation of incoming words is updated based on the existing interpretation of previous words in the sentence as well as linguistic constraints. In addition to this, the interpretation of a current sentence fragment or word is complemented by already-existing linguistic and world knowledge, yielding expectations about the upcoming linguistic input. Next, if a visual scene is present, then the result of the sentence interpretation step would guide the comprehender's attention in a visual scene and if the visual scene has been inspected previously, then the information from the latest scene inspection will be merged with earlier scene-based representations stored in the working memory. In a following or – as previously stated – possibly in a parallel step, the information gathered from the visual scene is reconciled with both the interpretation of the linguistic input and the expectations that were formed, accounting for both matching or mismatching outcomes. In addition to that, the interpretation of the sentence can be further informed by the co-present visual scene. As such, as a comprehender advances through the linguistic input and hears or reads the next word(s), the sentence interpretation is constantly updated based on previous interpretations and expectations formed up until that point in comprehension. The multifaceted character of the aforementioned theoretical frameworks of language processing constitutes a way to accommodate the processing of several types of information that come into play during language comprehension.

Such types of information, could for instance be of visual nature, including a speaker's gaze (Knoeferle & Kreysa 2012) or emotional face (Carminati & Knoeferle 2013, 2016, Maquate & Knoeferle 2021a,b). Moreover, the auditory information about a speaker's voice can be used to determine their gender (Johnson et al. 1999) or (social) identity (Van Berkum et al. 2008), much like information about a speaker's moral stance ('t Hart et al. 2021) or their (social) group membership (Weirich et al. 2020) has been shown to impact language processing. More specifically, Van Berkum et al. (2008) observed increases in mean N400 amplitudes

to mismatching compared with matching social information that was similar in timing and topography to an N400 effect that is typically observed in lexical-semantic mismatches (cf. Kutas & Hillyard 1980).

The existence of such evidence stemming from language comprehension research indicates that among all facets that constitute the manifold contextual information that language users operate with, the social factors need to be acknowledged when studying the interactions between linguistic and non-linguistic contextual elements.

The pervasiveness of social information is also supported by findings in the field of language production, which reinforces its impact on multiple facets of language processing (Lev-Ari 2015, Pickering & Garrod 2004, Raviv et al. 2020). In this sense, as regards language production, it has been shown that social factors influence the extent to which language users learn from different speakers. Based on two experiments, Lev-Ari (2015) has shown that the degree to which a listener liked a speaker impacted the degree of convergence in the use of certain grammatical structures. By contrast, dislike of a speaker led to less convergent usage of grammatical structures, compared to when the speaker was liked by the comprehender. This shows that learning from the incoming linguistic input is not necessarily an effortless process (Pickering & Garrod 2004), since it may be subject to the influence of social factors.

Furthermore, Raviv et al. (2020) hypothesized that different types of social structures and behaviors could influence the emergence of artificial languages. Three simulated social groups with varying levels of population density and connections between individuals were created. The study compared linguistic productions from small-world social networks (scarcely populated, whereby individuals have fewer connections between each other), socially fully connected groups (densely populated, with fully connected individuals) and scale-free groups (scarcely populated, with individuals that can be highly connected or isolated). The results of the study, as informed by artificial languages created by these different social groups, yielded no significant differences that could be traced back to the social structures within each group. However, they found that small-world groups (with scarce population and social contact), were characterized by more within-group variability in linguistic production and convergence, while fully connected social network groups were defined by more stability and convergence among their members in their language behavior. In summary, social factors can modulate language production and use.

The present research adds a comprehension focus and asks how the influence of social factors could be accounted for when it comes to real-time language comprehension. Recent work such as the social Coordinated Interplay Ac-

count (Münster & Knoeferle 2018a) takes into consideration a comprehender's biological (e. g. age, gender) and experiential (e. g. world knowledge, educational background, stereotypes) characteristics and their impact on language comprehension. In addition, the processing of social contextual information extends beyond the characteristics of the comprehender (Münster & Knoeferle 2018a) and the speaker (Van Berkum et al. 2008) and can for instance extend to the social situation that linguistic input occurs in. To accommodate the processing of social information, it is essential to also tap into the time course that describes how individuals comprehend sentences in a social context. In this sense, the present study assesses the interplay during sentence comprehension between situation-formality register congruence (see Sections 1.1 and 1.2 for a more in-depth motivation) and standard language knowledge, (i. e. fundamental grammatical knowledge about a language, here Standard German), in form of verb-argument relations.

1.1 Social information as context

Though for a long time research has not been focused on the importance of socially situated linguistic study (cf. Firth 1950), the linguistically encoded social behavior was not left unnoticed. Mills (1939: 672) underlined the importance of a social theory of mind. According to him, making sense of "a given thinker's production" (Mills 1939: 672), which could also be understood as an individual's social expression or attitude, was only possible in the presence of clear hypotheses about the influence of social and cultural factors on an individual's psychological or mental domain. A similar idea was also brought into discussion by Sapir, who considered that social factors shape language and thought (Sapir 1912: 227), and that the structural aspect of a language should not be the only aspect of interest to a linguist but also the adaptation to structures that stem from the social culture (Sapir 1942: 150). Furthermore, Labov (1966, 1972) was among the first researchers to pinpoint the fact that speakers conveyed their attitudes via their heterogeneous, socially-modulated linguistic production and that they did so in a conscious fashion.

More recent research suggests for example that, in line with these earlier theoretical views, listeners interrelate their knowledge about speaker ethnicity with their linguistic knowledge about phoneme deletion (Staum Casasanto 2008). Other findings have shown that comprehenders use social information about a speaker's gender to make judgments about the grammaticality of a sentence. For instance, Hanulíková & Carreiras (2015) investigated the effects of social information in the form of a speaker's gender on the processing of subject-verb

(dis)agreement in Slovak, where the gender of the speaker is attached to the verb as a morpheme, resulting in a mismatch if the attached morpheme is signaling male gender and the speaker's voice signals female gender (e. g. 'I *stole$_{MASC}$ plums' spoken by a female speaker). They found that ERP responses to verbs disagreeing with the speaker's gender (e. g. words including masculine verbal inflection spoken by a female person) elicited a larger early posterior negativity than correct sentences. In a similar vein, Van Berkum et al. (2008) have indicated that factors such as speaker gender, voice, age and thus identity play a crucial role during the early stages of comprehension. For example, when male speakers uttered *If only I looked like Britney Spears* or when speakers used an upper-class accent to say *I have a large tattoo on my back* event-related brain responses indicated difficulty in semantic processing when the expectations of the hearer with respect to the speaker identity were not met, providing additional evidence that the interpretation of incoming speech is impacted by social contextual information. Social information is thus an essential modulator of linguistic behavior because based on the social reality and on the speaker's values and communicative intentions, expressions of social information can be adjusted to the communication situation (Fishman 1972: 170f).

The fact that language is influenced by the social context seems to be based on previously learned connections between the different types of social information and how they are expressed linguistically. For instance, the array of phonetic information about a speaker serves as a basis for attribution of certain social characteristics and vice versa (Drager 2010). These types of "learned" characteristics, acquired as a result of observation and direct interaction, enable language users to act in line with the social codes and practices of a given linguistic community, based on the knowledge that they have (Gumperz & Hymes 1972: 17f.).

One element belonging to the multifaceted spectrum of social information that is likely to impact how people understand language is register. Defined as "a range of situational variation within a given language" (Biber 2009: 27) as well as "intra-individual variation in linguistic behavior influenced by situational and functional settings" (Lüdeling et al. 2022: 2), register was also described as a "continuous rather than concrete construct" Biber (2009: 31). Furthermore, everyday observations leave space for the hypothesis that language users seem to be generally register-sensitive – once common social-contextual situations are established, register use in native language users might be viewed as effortless.

In their communicative function model of variation, Finegan & Biber (2001) highlighted that the situations which determine varying use of register go beyond the notion of formality. Instead, they hypothesized that register use depends on a number of social dimensions such as social status, the topic and the

purpose of their communication as well as formality degree. According to Hudson (2012), people often take notice of the rules imposed by certain social groups; and by using certain registers, language users not only position themselves in social space, but they also show that they are aware of their environment and its implications.

One of the extant findings investigated how speaking style[3] influences responses to grammatical violations. In an ERP study, Viebahn et al. (2017) have shown that the measured brain responses were more pronounced for incorrectly inflected Dutch adjectives produced within careful versus more casual speech. Similarly, Brouwer et al. (2012) have found that listeners were less sensitive to speech reductions when these were produced within casual, rather than careful speech. Furthermore, comprehenders' awareness about the change in the register context in which linguistic input appeared, influenced how they integrated noun phrases missing their determiner (Schumacher & Avrutin 2011). For instance, article omissions were tolerated when they were presented to the participants in the context of newspaper register, child and aphasic speech, showing that comprehenders' awareness of a certain register context impacts processing. Note that when participants expected to read sentences in standard German compared with special registers (e. g. newspaper register), omissions of articles within noun phrases led to left-lateral negative deflections in event-related brain potentials, indicative of extra processing costs.

Importantly, a recent ERP study investigated the effects of register switching on language comprehension (Yurchenko et al. 2023). The authors provided evidence that alternating between standard and slang vocabulary in a given sentential context, which has been referred to as register switching, has impacted the lexical-semantic integration of target words in a similar way as observed for semantic incongruencies. The processing of sentences containing register-context mismatches led to significantly larger N400 amplitudes compared to register-congruent sentences. According to the authors, this suggests that integrating register words in mismatching sentence contexts leads to additional lexical-semantic processing costs. However, many aspects of register and socially-situated language use are yet to be explored; it is unclear what mental representations and processes are involved in dealing with this kind of information and how they would interact with other processes and stimuli involved in language comprehension.

[3]We would like to point out that the definitions of register and speaking style are not always clear cut. For instance the casual vs. careful speech could be associated with the informal and respectively the formal register.

1.2 The semantic relation between a verb and its argument

Accommodating register variation and its processing within psycholinguistic accounts is only one aspect that should be further investigated. The interaction of language register with other types of linguistic information also needs to be understood. For instance, the semantic relationship between a verb and its argument belongs to the array of standard linguistic knowledge that has been shown to exercise a substantial influence on language users' production and comprehension (Andreu et al. 2012, Sanz-Torrent et al. 2017, Trueswell & Kim 1998).

Concerning real-time processing, the semantic relations between a verb and its arguments have been shown to impact spoken and written language comprehension (Altmann & Kamide 1999, McRae et al. 1998). Correspondingly, evidence from electrophysiological studies revealed that comprehenders quickly react to and thus display sensitivity to the (in)congruent semantic information conveyed by a verb and its argument. This has been shown to hold for healthy (Friederici & Frisch 2000, Kielar et al. 2012) and, to a lesser degree, aphasic patients (Grodzinsky & Finkel 1998, Kielar et al. 2012), thus supporting the fundamental status of this information for language comprehension.

Furthermore, previous research has shown that the semantic relation between a verb and its argument,[4] is rapidly integrated with the linguistic context and with comprehenders' world knowledge and language experience (Altmann & Kamide 2007, Hagoort et al. 2004, Pyykkönen et al. 2010, Willits et al. 2015), contributing to the shaping of expectations during comprehension.

Based on their world knowledge, language users seem to easily and naturally adapt to various social settings by adjusting their linguistic behavior and production in accordance with the social scenarios they encounter. For this reason, one could hypothesize that speakers may use register appropriately in a situation and seemingly effortlessly. Likewise, knowledge about a verb's semantic fit with its arguments seems to rapidly affect language processing. Thus, social and verb-argument semantic information could be expected to interact during language comprehension. While verb-argument relations have already been proven to impact comprehension, the influence of situation formality on register processing is yet to be further examined. The present self-paced reading studies investigated to what extent these two kinds of information might influence each other and how similarly they impact comprehension, positing their similar nature.

[4]To illustrate what we mean by "semantic relation of a verb to its argument" consider the following example: The verb *eat* is in a congruent semantic relation with the object *food* but in an incongruent semantic relation with an object such as *luggage*.

2 The present study

Via two internet-based, self-paced reading experiments and a secondary picture-selection task, this study examined to what extent there exists an interplay between two different types of information and if there are commonalities in the way they impact sentence comprehension.

The first factor levels were represented by the match or mismatch between a situation-formality context and register use. The situation-formality context was established by way of context sentences that informed participants about a given speaker and their social attributes (e. g. *Elegant angezogen spricht Peter*, lit. transl. 'Elegantly dressed says Peter' conveys a formal social context via the information that the described speaker's identity is that of an elegantly dressed male person). The aforementioned social information would set expectations for the upcoming target sentence – that is, after reading a sentence describing a formal social situation, the use of a formal register would be expected. The target sentence contained either a formal or informal register, thus leading to either matches or mismatches between the situational formality in the context sentence and the register used in the target sentence. The high and low registers were operationalized using informal vs. formal or standard nouns, e. g. *Schuhe* 'shoes' (standard/formal) compared to *Latschen* 'worn-out shoes' (informal), *Kleider* (standard/formal) 'clothing' vs. *Klamotten* 'worn-out clothes' (informal). The second type of information that was manipulated within the target sentence represented the matching or mismatching semantic relation between a verb and its argument, e. g. *Ich binde gleich meine Kleidung*, lit. transl. 'I tie right now my clothes' conveys a semantic mismatch between the verb and its argument..

Firstly, we asked whether situation-register (mis)matches would trigger similar effects as verb-argument mismatches. This would be suggested by similar response patterns to both kinds of mismatches (mismatches in register and context congruence and verb-argument structure). Note that the semantic mismatches in verb-argument structure were expected to trigger behavioral effects as captured by response times due to mismatches between a verb and an object, e. g. *Ich befülle gleich meine Flasche* vs. **Haare*, lit. transl. 'I fill right now my bottle (stand.) / *hair (stand.)'. By contrast, differences in response latencies to the two mismatch types could suggest that register mismatches are not processed similarly to those triggered by violations of standard-language knowledge.

Secondly, we explored the dynamics of the possible interaction between (mis)-matches associated with register and verb-argument relations. If the mismatches between register use and the social-contextual setting do trigger difficulties in processing, then it is also possible that the processing of verb-argument semantic

relations would be impacted. Following this scenario, the presence of mismatches between the social context and the register use could lead to overall increased processing difficulty resulting in increased response latencies over all congruency levels of verb-argument relations. Conversely, semantic information stemming from (mis)matching verb-argument relations could impact the processing of social contextual information. In this sense, semantic mismatches between a verb and its argument might impact the processing of situation formality congruence. This is expected to manifest in the form of longer picture-selection latencies in the presence of mismatching verb-argument relations, over all levels of congruence between register and its social context.

Thirdly, we assessed whether comprehenders adjust quickly to the information provided by the social formality context. For this purpose, two experiments were employed: For the purpose of the first experiment, the experimental stimuli were presented in formality blocks, such that for example, the first half of the items were introduced by informal contexts and the second half by formal contexts. However, the second experiment employed a fully pseudo-randomized stimulus presentation mode, such that the formality of the context sentences would shift pseudo-randomly from one item to the other. By including stimuli presentation mode in an additional analysis, we assessed whether participants could quickly adjust to the situational context. In that case, similar response patterns were expected to be observed in both experiments, regardless of the presentation type. By contrast, different response patterns were assumed to point towards different types of adjustment to the situational context and will offer insights into the way participants make use of the social contextual information.

2.1 Participants' social background

In addition to the previously outlined research questions, we also explored how the social identity of our participants might reflect on their patterns of written language comprehension via post-hoc analyses. Having conducted the present series of experiments via the internet, we had the opportunity to anonymously recruit participants whose social identities extended beyond the usual sample comprised of young university students (see Henrich et al. 2010). By asking the participants to fill in a social background questionnaire, we collected information regarding their educational background as well as linguistic varieties used during their upbringing and on a daily basis. Furthermore, we collected scores of self-perceived standard and dialect language competence.

Because the majority of the extant research addressed the impact of social fac-

tors on language comprehension only partly and mostly via offline[5] methods, our aim was to capture the influence of these factors in interaction with other linguistic types of information during on-line sentence comprehension. For instance, past research has primarily looked into the differences in text comprehension and language production between young speakers of dialect and standard language (Eberwein 1982, Edwards et al. 2014, Goodman & Buck 1997). Importantly, most of these studies were, however, set to explore as well as debunk the preconception of weaker linguistic abilities associated with speakers of low-status dialects, rather than understand if and how a situational-functional context influences the processing of (in)congruent linguistic variants.

In a similar vein, Larsen & Hermann (1974) explored the influence of socioeconomic status on language comprehension while addressing previous claims of differences in linguistic performance between the working and the middle classes (Bernstein 1971). Bernstein claimed that middle-class persons make use of a more elaborate and formal set of "codes", while the working class disposes of a rather reduced public "code" (Bernstein 1971: 106)[6]. Albeit, the evidence provided by Larsen & Hermann (1974: 166) suggests that participants' output was similar across tasks and that social class does not seem to modulate their performance. Importantly, these conclusions were based on data stemming from offline methods such as text summarising and underlining.

By contrast, a person's educational background is one type of social factor that leads to major differences between low and high literates for instance. More recent research has provided evidence that a person's level of literacy impacts spoken language comprehension (Mishra et al. 2012). When provided with spoken sentences, high literates engaged in predictive language processing and shifted their eye gaze towards a target object before its mention, while low literates only did so upon the mention of the object, likely indicating reduced or delayed predictive language processing. Considering the work of Mishra et al. (2012), where the high literates had an education that spanned on average over 15 years, while the low literates on 2 years, we asked how varying levels of education might impact language comprehension. Would there be any difference between comprehenders with non-academic versus academic educational backgrounds?

[5] *Offline* is used here to refer to experiments using measures that do not study real-time language processing or comprehension. By contrast, we use the term *on-line* to refer to studies that employ measures concerning real-time language processing or comprehension

[6] Interestingly enough, Bernstein 1962 defines a "code" as being either elaborated or restricted and connects them to social situations and associated verbal planning as well as different social behaviors. He also relates each of the two codes to social classes.

In other words, we aim to understand how the situation-formality register congruence and verb-argument relation congruence impact written sentence comprehension in a gradual manner, as participants read through the experimental sentences. Would the time course of sentence comprehension differ across members of a certain social subgroup? Would patterns of differences be comparable across experiments that used different participant samples?

3 Experiments

3.1 Participants

64 monolingual German participants aged between 18 and 31 years were planned to be tested for each of the two experiments using the crowd-sourcing platform Clickworker (Clickworker GmbH 2023). However, the recruitment resulted in a total of 66 participants for Experiment 1 (female participants = 22, male participants = 43, diverse participants = 1, M_{age} = 26.3, SD_{age} = 3.6) and 64 participants for Experiment 2 (female participants = 38, male participants = 26, M_{age}= 25.3, SD_{age}= 3.9). All participants were tested online, using a self-programmed, ca. 45-minute-long experiment in PennController for Ibex, which was hosted on the servers of Humboldt-Universität zu Berlin. Each participant was rewarded with 4,40 € for their participation based on the lab-wide payment rate of 11 € / hour and in accordance with the recruitment fees processed by the recruitment platform. Ethics approval was given by the Ethics Committee of the German Linguistic Society (DGfS, #2019-07A-200424).

3.2 Materials and Design

3.2.1 Materials

The linguistic stimuli,[7] used for both experiments amounted to a total of 120 German sentence pairs comprised of a context and a target sentence, whereof 40 items were critical, and 80 were fillers. The critical items, which had been previously pre-tested using rating studies, were comprised of a context and a target sentence. The context sentence provided a social setting, whereby the social characteristics of the speaker of the following target sentence would be described. As such, a formality situation would be created based on their social attitudes expressed via pairings of verbs and adverbs, and their social appearance conveyed by way of adjectives (see Figure 1). The target sentence consisted of a

[7] All experimental stimuli are available at: https://osf.io/83xy6/

pre-critical region: [NP1] [VP] [ADVP], a critical region containing a post-verbal object [NP2] and a spillover region in the form of a [PP] which matched the situation formality introduced via the context sentence (see Figure 1). The pre-critical (NP1 + VP + ADVP) and critical (NP2) regions were matched in gender and length, while the spillover region (PP) was matched in gender and frequency but not in length. The 80 filler items comprised a context and one target sentence. 40 were taken over from a project studying the interplay between register-situation congruence and inflectional congruence, while the other 40 items were taken over from a study exploring the impact of social status information about a speaker and morphosyntactic violations on language comprehension. In contrast to the critical items, the filler items introduced inflectional violations. What is more, the filler types differed in terms of the number of conditions they appeared in. While fillers from the first mentioned category appeared in 4 conditions resulting from a 2x2 design (register congruence and subject-verb congruence), the latter category of fillers only appeared in two conditions, depending on the grammaticality (correct or incorrect verb inflection) of the target filler sentence.

In addition to the context and target sentences, participants were presented with visual sets of pre-tested stimuli, consisting of 4 pictures each. The set of pictures consisted of 1 target, 1 competitor and 2 distractor pictures for each condition, as illustrated in Figure 1. The visual stimuli depicted the post-verbal nominal object that was manipulated experimentally both in terms of situation-formality register congruence and verb-argument congruence. While the distractor pictures were semantically unrelated to the word named in the post-verbal critical region, the target and competitor pictures were semantically related to it. Importantly, the target picture represented an accurate depiction of the register encoded at the post-verbal critical region of the target sentence, while the distractor picture mismatched the conveyed register.

3.2.2 Design

Both experiments employed a 2x2 Latin square design (register-context congruence was fully crossed with verb-argument relation congruence), resulting in 4 base conditions described in Figure 1: a) full match, b) verb-argument mismatch, c) register mismatch and d) full mismatch. The register-context factor was realized via a sentence introducing a situation-formality context that (mis)matched the register of the target sentence. The verb-argument relation manipulation was embedded in the target sentence (match: *tie shoes* vs. mismatch: *tie clothes*). While in Exp. 1 the items were presented in formality blocks (e. g. one half of the stimuli was introduced by formal contexts, while the second half was introduced by

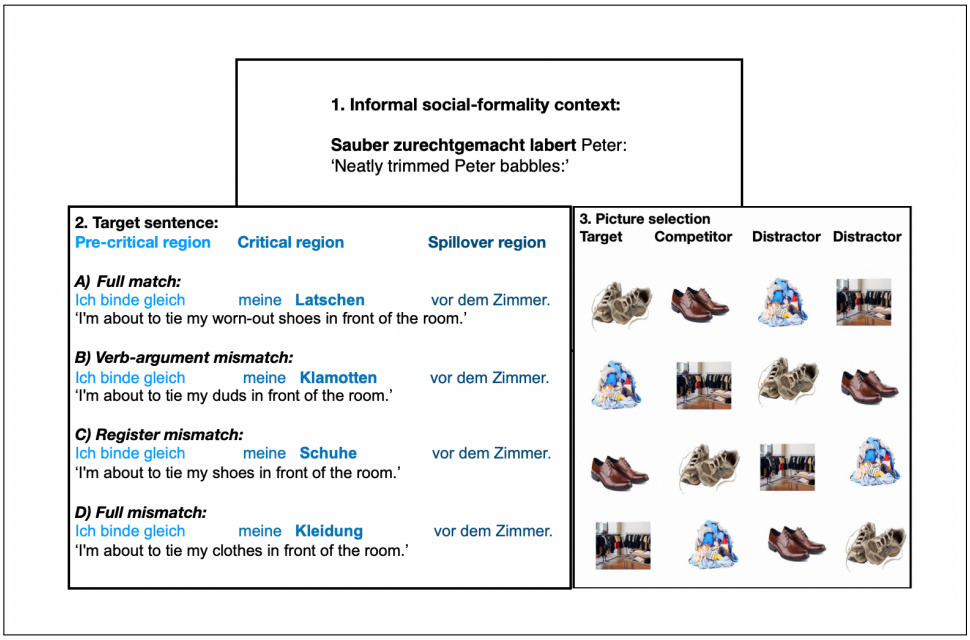

Figure 1: Overview of example experimental items and conditions introduced by informal social-formality contexts; 1. Example of an informal social context; 2. Overview of the experimental items in the informal block; 3. Example distribution of visual stimuli across conditions.

informal contexts), in Exp. 2 they were fully pseudo-randomized.

The linguistic stimuli were distributed into 8 lists and counterbalanced by ways of a script that allowed unique item entries and an equal number of conditions and item types (i. e. critical and filler items) as well as a maximum of 3 consecutive instances of conditions and item types. The positions of the visual stimuli in the post-experiment selection task were randomly rotated with each experiment trial to avoid selection biases due to picture placement.

3.3 Hypotheses

The primary task of the participants was to complete a phrase-by-phrase self-paced reading time task, the result of which was the primary dependent measure in form of reading times measured in milliseconds at space-bar presses. Based on this, the measures of interest were total reading times as well as reading times measured within the critical region (see Figure 1 and the NP2 region in Figure 3) and in the spillover region (see Figure 1 and the PP region in Figure 3).

The secondary task was a picture-selection task. Extant positron emission tomography (PET) evidence has indicated that semantic information is processed via a system that presents commonalities for pictures and words (Vandenberghe et al. 1996), suggesting that semantic information is processed similarly for pictures and words. In a similar vein, an electrophysiological study investigating the comprehension of pictures and words during reading found evidence for functionally similar brain responses, similar to N400 effects, elicited after encountering semantically (in)congruous combinations of sentences and words and sentences and pictures (Ganis et al. 1996). If participants display sensitivity to linguistically encoded register context (in)congruencies, it might be possible for them to react in a comparable manner to visual stimuli representative of the register-context (in)congruencies. Additionally, we expected the offline picture-selection data to complement the results from the on-line measure (i. e. reading times). We also expected the offline data to offer complementary information about participants' ability to differentiate between the different register variants and the potential effects that the context-target sentence congruence has had on language comprehension.

As a result of this task, we were able to measure the picture-selection latency from the display of pictures until the moment of picture selection as well as use picture-selection accuracy as an exploratory measure of participants' hypothesized capacity to discriminate between depicted register variants (e. g. depictions of elegant versus worn-out shoes). An accurate selection was that of the picture that matched the register and semantic content of the post-verbal noun phrase from the target sentence.

We expected a main effect of verb-argument (in)congruence, with increased reading times for mismatching (vs. matching) verb-argument relations in the critical or spillover regions or for the entire sentence as well as longer picture-selection latencies and decreased accuracy for picture selections. Additionally, a main effect of register-context (in)congruence was expected (increased reading and picture-selection latencies as well as decreased picture-selection accuracy for register-context mismatches than matches).

3.4 Procedure

All participants were provided with an information sheet and a consent form for data collection. After having received written instructions, participants saw 3 practice trials, followed by the actual experimental session. Each experimental trial was completed following the procedure outlined in Figure 2.

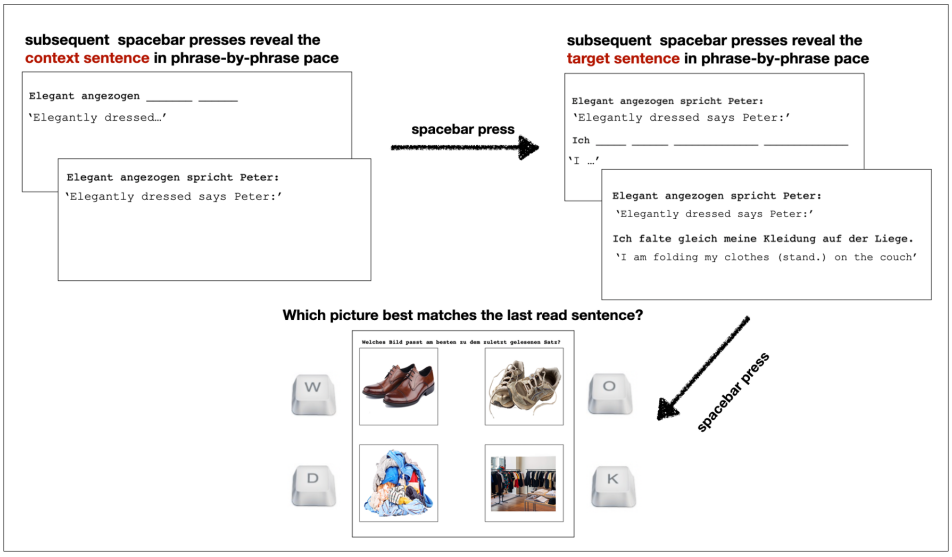

Figure 2: Schematic overview of the experimental procedure. Note that the English translation of the sentences was not visible to participants

Experimental trials were introduced by a fixation point, which guided participants' gaze toward the first-word segment of the masked context sentence. Next, they were presented with one sequence of masked segments of the context sentence. By pressing the space bar after each phrase, participants could advance until they read the entire sentence. When they finished reading the last sentence region, an additional space-bar-press served as a delimitation between the context and the target sentence. The target sentence was then presented and read in an identical fashion as described above. Immediately afterward they read a question asking them which of the presented pictures best matched the last read (target) sentence. Their answer was recorded after they pressed any of the following keys: W, for the picture in the upper left corner, D corresponding to the picture in the upper right corner, O for the picture in the lower left corner and finally K for the picture in the lower right corner. For the sake of uniformity, the picture-selection task followed all experimental items. The experiment took approximately 45 minutes to complete.

3.5 Analysis

Some participants had to be excluded (Exp. 1, N = 13; Exp. 2, N = 12), such that the final data set contained data from 53 participants for Experiment 1 and 52

participants for Experiment 2. The reasons for the exclusion were linked to recruitment errors (bilingual participants were recruited, even though only monolingual speakers of German were invited to take part in the experiment) or unsatisfactory performance in the post-sentence comprehension task (scoring an accuracy score below 70 % for critical items). Reading times shorter than 200 ms and longer than 3000 ms per word within each sentence region were filtered out (Jegerski 2014, Roberts & Felser 2011). This resulted in a loss of 3.7 % of the data for Experiment 1 and 4.5 % for Experiment 2, besides the participants that have already been excluded.

Picture-selection latencies were computed by subtracting the time when the picture set appeared on the participants' screen and until they chose a picture by pressing one of the four designated keys. Picture-selection latencies shorter than 200 ms (Welford & Brebner 1980) were excluded from analysis, such that 0.27 % of the picture-selection latency data was lost for Experiment 1 and 2.17 % for Experiment 2. For the accuracy measure, we computed a strict score, where only selections of the target picture would count as accurate since they matched the target sentence both in the expressed register and in the verb-argument semantic relation.

Total reading times as well as reading times measured in the critical and in the spillover region (see Figure 3) were analyzed using linear mixed-effects models implemented using the *lmer* function from the *lme4* package (Bates et al. 2015a) in R (R Core Team 2021). The linear mixed-effects models included log-transformed reading times (for the critical regions) or residualized log-transformed reading times (for the spillover region and total reading times)[8] as a dependent variable. The most complex model structure justified by the experimental design was reduced backward in line with Bates et al. (2015b).

The reaction times elicited after the picture-selection task were analyzed by way of linear mixed-effects models, following the structure applied for reading times. Finally, accuracy data were coded with 1 for an accurate selection and 0 for incorrect answers and used as a dependent variable for generalized linear mixed models of binomial family, following the same structure and procedure as previously described. It holds for all models that register-context congruence and verb-argument congruence were used as the categorical fixed effects of interest, which were sum-coded prior to model fitting (matching levels of both factors were assigned a weight of 1, while mismatching levels of both factors were assigned the weight -1). Participant and item were included as random effects in the

[8] Spillover regions have been residualized in two steps according to Jaeger (2008) and Enochson & Culbertson (2015). This was necessary since the nouns used within the spillover regions were only matched in gender and frequency category but not in word and syllable length.

mixed-effects models and maximal models were fit with correlated varying intercepts and slopes for register-context and verb-argument relation congruence.[9]

Additional analyses of each of the aforementioned dependent variables were conducted to explore how each social factor impacted written sentence comprehension. For this purpose education and currently used language variety were selected and separately introduced in the models as fixed effects but also within the by-item varying random effects structure. While the experimental factors were sum-coded (-1 for mismatch levels, 1 for match levels), the social factor had categorical levels and were contrast-coded such that there was a separate contrast between a baseline level and the other associated levels.[10] Education was comprised of the following subgroups for both experiments: academic studies (Exp. 1: 22; Exp. 2: 22), upper secondary education (Exp. 1: 24; Exp. 2: 19), vocational education (Exp. 3: 2; Exp. 2: 7) and lower secondary education (Exp. 1: 4; Exp. 2: 4)

Currently and primarily used language varieties were represented by the following subgroups: colloquial German (Exp. 1: 18; Exp. 2: 10), dialectal German (Exp. 1: 2; Exp. 2: 3), standard German (Exp. 1: 29; Exp. 2: 32), standard and colloquial German (Exp. 1: 3; Exp. 2: 3) and standard and dialectal German (Exp. 1: 1; Exp. 2: 1). Experiment 2 also included the subgroup of people speaking standard, colloquial and dialectal German (N = 3) on a current and majority basis.

3.6 Results

3.6.1 Main results

Analyses of the reading times for the entire sentence revealed significant main effects of verb-argument relation congruence at the level of **total reading times**[11]

[9]The structure of maximal models was expressed as such using R: *lmer(log(RT) ~ Verb-argument-relation * Register-context + (1+Verb-argument-relation * Register-context | participant) + (1+Verb-argument-relation * Register-context | item)*

For model specifications including uncorrelated random slopes we use here the || notation, but in all analyses, the uncorrelated slopes were specified using the extended notation for categorical factors.

[10]The social factor levels were coded differently due to varying number of levels of each social factor. Note that across experiments the number of the levels would change since new participants were tested.

[11]The most parsimonious models for total reading times were expressed in R as follows:

Exp. 1: *lmer(log(residualRT) ~ Verb-argument-relation * Register-context + (Verb-argument-relation + Register-Context || item) + (1|participant)*

Exp. 2: *lmer(log(residualRT) ~ Verb-argument-relation * Register-context + (Register-Context: Verb-argument-relation + Verb-argument-relation || item) (1|participant)*

both in Exp 1: $\beta = -0.020$, $SE = 0.005$, $df = 50.53$, $t = -4.006$, $p < 0.001$ (see Figure 3) and Exp 2: $\beta = -0.018$, $SE = 0.006$, $df = 45.77$, $t = -2.79$, $p < 0.01$ (see Figure 4).

Further significant effects of verb-argument relation congruence were detected at the **spillover region**,[12] both in Exp. 1: $\beta = -0.066$, $SE = 0.013$, $df = 61.81$, $t = -5.030$, $p < 0.001$ and in Exp. 2: $\beta = -0.08$, $SE = 0.014$, $df = 66.68$, $t = -5.685$, $p < 0.001$.

Moreover, the verb-argument effect was significant for **picture selection latencies**[13] (Exp. 1: $\beta = -0.076$, $SE = 0.011$, $df = 45.53$, $t = -6.647$, $p < 0.001$, Exp. 2: $\beta = -0.081$, $SE = 0.012$, $df = 45.43$, $t = -6.814$, $p < 0.001$) and **accuracy**[14] (Exp. 1: $\beta = 0.209$, $SE = 0.072$, $z = 2.893$, $p < 0.01$; Exp. 2: $\beta = 0.25$, $SE = 0.076$, $z = 3.303$, $p < 0.001$) in both Exp. 1 and Exp. 2. The predicted probability of choosing the correct picture in verb-argument relation match conditions was thus significantly higher than in verb-argument relation mismatch conditions (Exp 1: 62 % vs. 51 %, $\beta_{Match} = 0.209$, $\beta_{Mismatch} = -0.209$, SE = 0.072, $z = 2.893$, $p < 0.01$; Exp 2: 59 % vs. 47 %, $\beta_{Match} = 0.25$, $\beta_{Mismatch} = -0.25$, SE = 0.076, $z = 3.303$, $p < 0.001$). However, the differences in picture-selection accuracy in situation-formality register match vs. mismatch conditions were not significant (Exp 1: 55 % vs. 52 %, $\beta_{Match} = 0.064$, $\beta_{Mismatch} = -0.064$, SE = 0.07, $z = 1.44$, $p = 0.14$; Exp 2: 55 % vs. 53 %, $\beta_{Match} = 0.05$, $\beta_{Mismatch} = -0.05$, SE = 0.04, $z = 1.18$, $p = 0.2$). No significant

[12]The most parsimonious models for the spillover region reading times were expressed in R as follows:

Exp. 1: *lmer(log(residualRT) ~ Verb-argument-relation * Register-context + (Verb-argument-relation + Register-Context || item) + (1|participant)*

Exp. 2: *lmer(log(residualRT) ~ Verb-argument-relation * Register-context + (Verb-argument-relation || item) + (1|participant)*

[13]The most parsimonious models for the picture selection latencies were expressed in R as follows:

Exp. 1: *lmer(log(RT) ~ Verb-argument-relation * Register-context + (Verb-argument-relation | item) + (1|participant)*

Exp. 2: *lmer(log(RT) ~ Verb-argument-relation * Register-context + (Verb-argument-relation || item) + (1|participant)*

[14]The most parsimonious models for the picture selection accuracy were expressed in R as follows:

Exp. 1: *glmer(log(PictureScore) ~ Verb-argument-relation * Register-context + (Verb-argument-relation | item) + (Verb-argument-relation | participant)*

Exp. 2: *glmer(log(PictureScore) ~ Verb-argument-relation * Register-context + (Verb-argument-relation | item) + (Verb-argument-relation | participant)*

main effects of register emerged in the reading times and picture-selection latencies and accuracy. In addition to that, there were no reliable effects found for the reading times measured within the critical region.

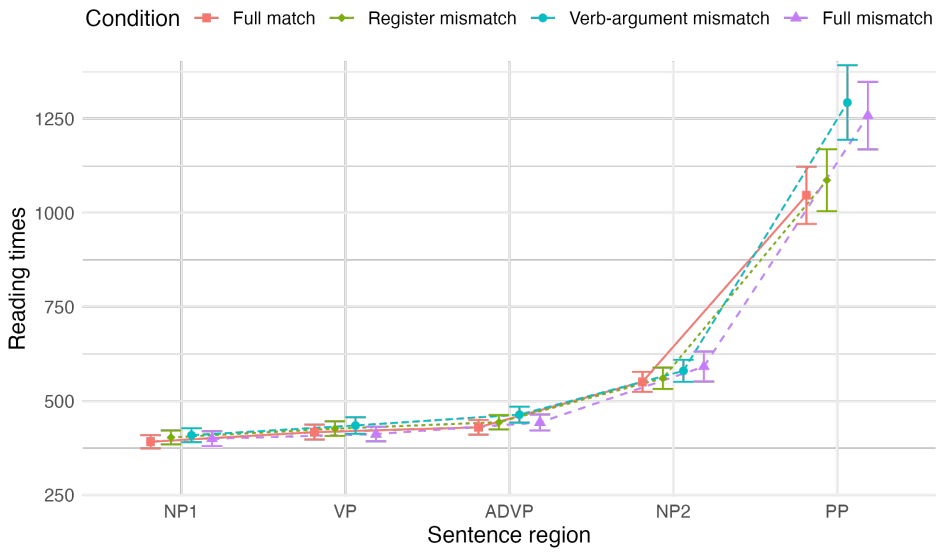

Figure 3: Experiment 1 (presentation of experimental stimuli in informal, respectively formal blocks): Average raw reading times across regions and conditions. Error bars = 95 % CIs.

Analyses of the **total reading times** further revealed the sole significant two-way interaction between register-context congruence and verb-argument relation congruence (verb-argument mismatches elicited longer reading times than matches but only for register-context matches, not mismatches) but only in the blocked experiment (β = -0.013, SE = 0.004, z = -3.028, $p < 0.01$, see Figure 5). The result was followed up with Bonferroni-corrected post-hoc pairwise comparisons which revealed significant contrasts between the full match condition and the verb-mismatch conditions (β = 0.067, SE = 0.013, z = 5.011, $p < 0.001$), full match and register-mismatch conditions (β = 0.041, SE = 0.015, z = 2.648, $p = 0.048$). There was an additional contrast that did not reach significance, yet indicated that the register-mismatch and verb-argument mismatch conditions differed from each other (β = 0.040, SE = 0.015, z = 2.615, $p = 0.053$).[15] The analyses did not reveal any additional interactions between the factors of interest for

[15] All aforementioned results hold up when trials with incorrect responses within the picture-selection task were excluded.

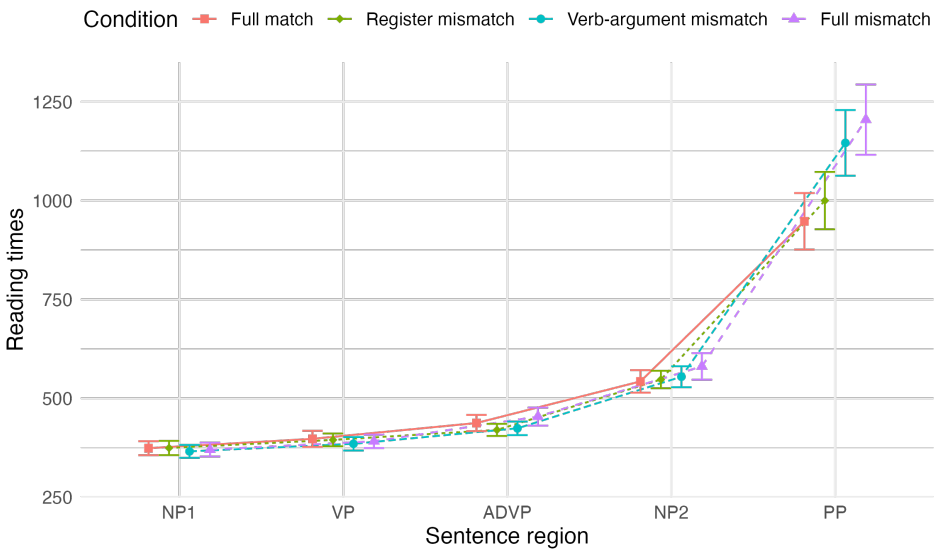

Figure 4: Experiment 2 (fully pseudo-randomized presentation): Average raw reading times across regions and conditions. Error bars = 95 % CIs.

any other measure within the two experiments. The joint analysis of the two experiments, where stimuli presentation mode was included as an additional factor yielded no additional significant results.

3.6.2 Additional results: Taking into account the social factors

The analysis of the total reading times observed following Experiment 1 yielded a significant main effect of currently used language variety. Users of both standard and colloquial German were significantly slower to read the entire sentence compared to speakers of primarily only colloquial German (β = 0.39, SE = 0.19, df = 52.93, t = 2.07, p = 0.043).

The analysis of the spillover region furthermore revealed a significant interaction between register and education. More specifically, we observed that register match conditions triggered longer reading times compared to mismatch conditions for participants with vocational training: β = 0.11, SE = 0.05, df = 1983.22, t = 2.20, p = 0.027, (Figure 6, Panel a). Similarly, an interaction was detected between verb-argument relation congruence and education, where only the vocational training subgroup was found to read verb-argument mismatch conditions

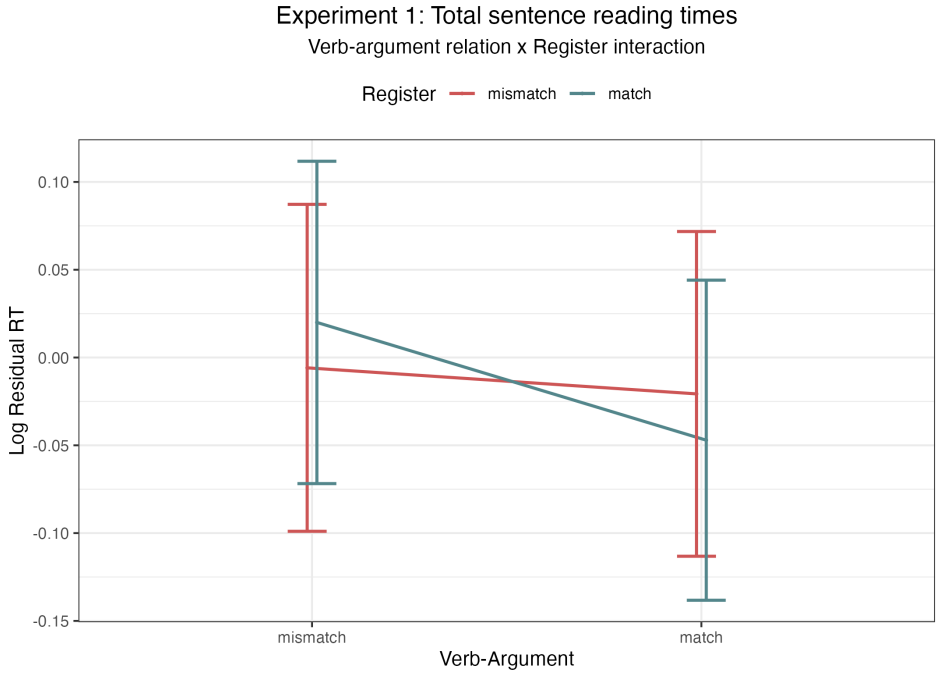

Figure 5: Experiment 1: 2-way interaction between register and verb-argument relations found at the total reading times. Error bars = 95 % CIs.

faster than verb-argument match conditions: β = 0.10, SE = 0.05, df = 1996.32, t = 2.01, p = 0.043 (Figure 6, Panel b). Considering the exploratory nature of the present analysis and the uneven distribution of data points within each level of education, the results have to be interpreted with caution (cf. the large confidence intervals associated with lower secondary education and vocational education compared to the academic and upper secondary education.).

The spillover reading times analyzed as a function of currently and primarily used language variety (Figure 7) revealed a further significant 3-way interaction between register, verb-argument relation and language variety: β = 0.127, SE = 0.06, df = 2024, t = 1.98, p = 0.048. The interaction revealed that speakers of dialectal German took significantly longer to read sentences containing register mismatches vs. matches when the verb matched its argument. By contrast, when a verb-argument mismatch condition was co-present with a register mismatch condition, participants exhibited faster reading times compared to register-matching conditions, as displayed in Figure 7.

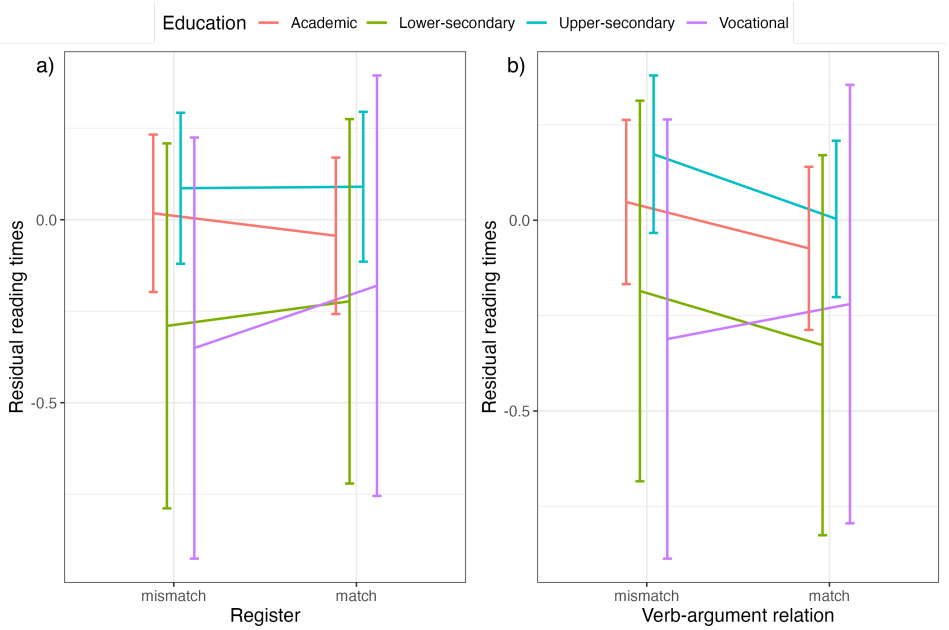

Figure 6: Spillover region in Experiment 1 (blocked presentation). Panel a): Register x education interaction. Panel b): Verb-argument relation x education interaction. Error bars = 95 % CIs. The levels of the register, resp. verb-argument factors are plotted on the x-axis. On the y-axis, the log-transformed residual reading times are plotted as a function of color-coded education level and register condition.

The sole finding related to social factors for the data from Experiment 2, was a significant difference in participants' picture reaction latency for the academic versus upper secondary education groups (β = 0.17, SE = 0.08, df = 53, t = 2.10, $p < .05$). Participants with an upper secondary educational background were overall slower in their reading times compared to the academic education group.

4 Discussion

The reading times, picture-selection latency as well as accuracy measures, corroborated that the verb-argument relation factor had a consistent and significant effect on sentence comprehension as well as on participants' speed and accuracy of picture selections. The verb-argument relation mismatch effect was significant for target sentence reading times as well as for reading times in the so-called "spillover" region (see Figure 1). Additionally, it also led to increased response latencies and decreased accuracy during the post-sentence task. This supports the

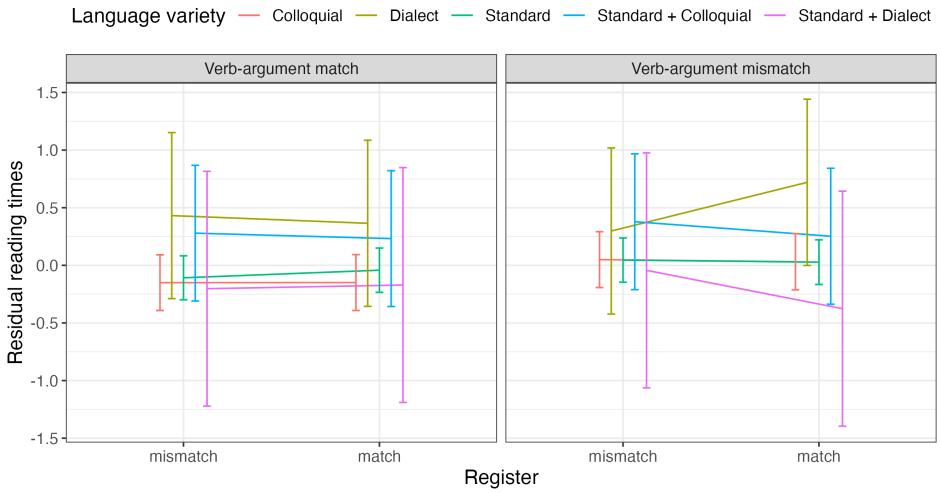

Figure 7: Spillover region in Experiment 1 (blocked presentation): Register x verb-argument relation x currently-used language variety interaction. Error bars = 95 % CIs. Along the x-axis are the levels of the register factor. On the y-axis the log-transformed residual reading times are plotted as a function of color-coded language varieties and register condition.

claim that semantic relations, as captured by the semantic relation between verb and its argument, have pervasive effects on language comprehension and its subsequent verification with visual stimuli. In this sense, the experiments represent successful replications of already well-established effects of verb-argument relation congruence, respectively thematic fit (Trueswell & Kim 1998, McRae et al. 1998, Friederici & Frisch 2000, Kielar et al. 2012) even by way of internet-based experiments. Moreover, the present results speak for the efficacy of the cumulative self-paced-reading method in internet-based experiments, so long as the investigated effects are robust and have previously been proven to impact comprehension across different measures (e. g. the verb-argument congruence effect).

The lack of any significant main effect of register congruence in either one of the three outcome variables (total sentence reading times, critical-region reading times and spillover-region reading times) is surprising because one of the assumptions was that the presentation of the stimuli in formality blocks (Exp. 1) of the experimental stimuli would strengthen participants' representations of the social formality situation. Via repeated exposure to context sentences of the same formality, we assumed that participants would build associations about the register that would most likely be used in a given social formality context and

thus be sensitive to any mismatch present in the target sentence. The assumption underlying this expectation was that register represents language variation as a function of a social situation.

The first research question asked to what extent the two semantic phenomena resemble each other in how they impact language comprehension. The hypothesis was that if similar reading times, picture-selection latencies or accuracy patterns were observed for register-context and verb-argument relation (mis)matches, then this would point towards similarity in the associated mental representations and processes. Since the present study has found evidence supporting a reliable main effect of verb-argument relation and null effects of register-context congruence in the very same settings (blocked vs. fully pseudo-randomized), one could conclude that the two effects differ from each other. Firstly, the results from both experiments showed that participants took longer to read sentences containing a semantic mismatch between a verb and its argument than reading sentences containing a verb-argument match. This effect was detected both at the level of total sentence reading times and at the spillover region. In a similar vein, participants took longer to react to the picture-selection task and they were also less accurate in choosing the correct picture. By way of contrast, register mismatches neither slowed down participants' reading speed nor significantly impacted their behavior and performance during the picture-selection task. Even though we did not observe any main effect of register in the present experiments, this does not mean that register could not affect language comprehension. One could argue that the present experiment set-up and design have favored the detection of strong, rather than possibly subtle effects. In this sense, the salience of the verb-argument relation congruence effect might have overshadowed any main effect of register congruence. In addition to that, the formality and the register of the items might have been perceived differently by the participants, possibly due to varying formality and register associations that they might have had. This claim is further backed up by the fact that the variability in the random effects structure of all models could be traced back to the by-participant varying intercepts, which suggests that the between-participant variability was high. To compensate for this possible variability in perception, a larger participant sample size would be needed for future studies, as well as participants' ratings of formality for the experimental items they would encounter.

A second research question targeted how the two studied factors might impact each other during comprehension. A significant interaction between verb-argument relation congruence and situation-formality register congruence was detected only in Experiment 1. A post-hoc analysis revealed significant contrasts

between full match conditions and verb-argument mismatch and register mismatch conditions for Experiment 1, where the stimuli were introduced by formality contexts in formal and informal blocks. The pattern of the interaction shows, as depicted in Figure 5, that as long as a verb-argument mismatch was present, register mismatches were read faster than matches, displaying the opposite of the expected pattern, whereby register mismatches compared to matches, would also lead to longer reading times. By contrast, when the verb-argument relation was semantically correct, register mismatches were, as expected, read slightly slower than matches. This is an indication that the processing of the verb-argument relation (in)congruence dominates the sentence comprehension and likely overshadows the processing of register if any verb-argument semantic incongruence is present. In that sense, the matching semantic relationship between a verb and its argument may have served as a "filter" for further processing of the social information represented by the situation-formality register congruence.

Interestingly enough, the only significant effects of either education or currently and primarily used language variety have been observed for the first experiment, in which participants were accommodated to the social context. By contrast, only one effect of educational background appeared in Experiment 2, when formality changed from one trial to another. This result, along with the significant interaction detected in Experiment 1 between verb-argument relation congruence and situation-formality register congruence suggests that the more consistent the exposure to a certain formality context, the greater the readiness to consider social information during comprehension.

One intriguing finding is that the participants with a higher level of education were less variable in their reading times compared to participants with a lower level of education (cf. Chmykhova et al. 2014). As illustrated in Figure 6, the error bars depicting confidence intervals illustrate a larger amount of variability in the measured reading times for participants with lower compared to higher educational backgrounds.

A further surprising post-hoc observation was that participants with vocational educational backgrounds displayed a counter-intuitive reading pattern. As illustrated in Figure 6, it took participants who belonged to the vocational training subgroup longer to read sentences displayed in both verb-argument and register matching vs. mismatching conditions. This finding is pending replication, considering that the opposite reading pattern was expected. Moreover, studies on vocational training have shown that people with this training have a high literacy proficiency, especially if their vocational training is more academically oriented (Rasmusson et al. 2019).

In terms of education, it appears that further comparisons can be made even within the higher educational group since participants' latencies differ significantly between participants with academic and upper secondary education. Additionally, what concerns the most frequently used language varieties, speakers of dialects were significantly slower to read spillover regions containing register mismatch vs. match conditions, so long as the verb matched its argument semantically. On the other hand, when both types of mismatches were present, dialect speakers were observed to speed up their reading, suggesting that they might have employed this strategy when dealing with stimuli they might have deemed to be obviously faulty. This result is particularly thought-provoking, considering that regional differences in lexical semantics might have resulted in a greater sensibility to register violations. One such example from our stimuli set could be the word *Latschen*, which in standard language could be taken to mean 'worn-out shoes', while in some dialects it most commonly refers to 'slippers'.

Though the empirical findings concerning the influence of an individual's social background on written sentence comprehension seem promising, they should be treated with caution. They represent only two population samples collected under rather low experimental control. Furthermore, the categories associated with each subgroup resulting from the social background questionnaire were unbalanced and larger numbers for each social subcategory are needed to make more confident claims and eventually discover consistent patterns across social (sub)groups.

Nevertheless, the present results could be taken as an impulse to integrate aspects of a person's social background into accounts of (written) language comprehension and thus account for differences between social groups or individuals. One account that could accommodate this is the previously mentioned sCIA (Münster & Knoeferle 2018b) since it already is specified to take into account a speaker's experiential attributes. In this sense, education and currently used language variety for instance could very well be accommodated as experiential factors, which could take graded values. These values could represent certain social subcategories hypothesized to impact comprehension differently, yet consistently. Based on this, not only could one make predictions about the time course of comprehension as a function of a speaker's social characteristics but also potentially uncover if and how comprehenders might operate with linguistic and non-linguistic types of information distinctly, depending on their experiential characteristics (e. g. education or language experience as reflected by the currently used language varieties).

Although no significant main effects of register were found, the present experiment represents an impulse for further research that explores the interplay

between register and verb-argument effects. Perhaps the nature of the register effect is more subtle than that of the verb-argument semantic relation and thus should be studied along with aspects of standard language knowledge that lead to violations that are less dominant during the comprehension process (e. g. comparative illusions, which are ungrammatical but often perceived to be acceptable: '*More people have visited Berlin than I', see Wellwood et al. 2018). Together with richer social contexts that could be reinforced by additional linguistic input or via visual information, register ought to be researched by employing a more time-sensitive measure that informs about the ongoing cognitive processes that unfold during comprehension.

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Authors' contributions

Ana-Maria Pleșca, Katja Maquate, and Pia Knoeferle created the stimuli and designed the experiment. Ana-Maria Pleșca conducted the study, performed data analysis, and wrote the manuscript (original draft). Pia Knoeferle and Katja Maquate contributed feedback on drafts of the article and all authors approved the submitted version.

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