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Effects of linguistic context and world knowledge on the processing of tense and aspect: evidence from eye-tracking

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Abstract

The present eye-tracking reading study investigated the real-time processing of the so-called *Lifetime Effect*, which involves the integration of temporal verb morphology and knowledge of a referent's lifetime (alive vs. dead). Critical stimuli contained famous referents, meaning that their lifetime status is widely known. In addition, context sentences mentioned their lifetime status and occupation. Tense/aspect was manipulated in a following target sentence to contain either the present perfect or the simple future (e.g., *She* ***has performed / will perform***...). For dead referents, the target sentence was infelicitous given the tense/aspectual marking; for living referents, the marking was felicitous. This design permitted us to examine effects of lifetime status conveyed via world knowledge and linguistic context on the processing of tense/aspect morphology. Eye-tracking reading times revealed longer total reading times at the critical (verb) and post-critical regions for the present perfect when following a deceased context, while the *dead-simple future* condition had shorter overall reading times than any other condition. Naturalness ratings revealed the *dead-simple future* to be quickly and reliably rejected, while the *dead-present perfect* was deemed acceptable. However, the latter was rated significantly lower than the *living/present perfect* condition. Taken together, the results imply that world knowledge and an immediate context defining a real-world referent as being dead or alive can jointly modulate the processing of subsequent verb tense/aspect, but with striking differences between the present perfect and simple future.

Keywords: eye-tracking reading; language processing; tense and aspect; context effects; world knowledge

Introduction

Language comprehension involves the integration of both linguistic and non-linguistic information. Of relevance to the current study, the integration of *word* and *world* knowledge has been demonstrated for verb tense and aspect (e.g., Carreiras, Carriedo, Alonso, & Fernández, 1997; Madden & Zwaan, 2003), real-world knowledge (e.g., Filik & Leuthold, 2013; Troyer & Kutas, 2018), as well as their integration (Altmann & Kamide, 2007). The present study investigates the interaction between temporal verb morphology (tense and aspect) and knowledge about a specific real-world referent's lifetime status (dead or alive) during language processing, through the so-called *Lifetime Effect* in English. Of interest is how this 'lifetime' knowledge, established through world knowledge and context, modulates the processing of the present perfect and the simple future.

Temporal verb morphology

Temporal verb morphology carries information about an event, often divided into tense and aspect. Tense relates the time of an action to the time of utterance, (past, present, or future; ex.1a), while aspect describes the relationship between the internal structure of the action and the topic time (*ongoing*: imperfective aspect, or *complete*: perfective aspect; ex. 1b) (Comrie, 1976).

(1) a. Lynn *lived/lives/will live* in the Beaches.
b. Lynn *was sitting/sat* in the wing chair.

While languages vary in whether and to which degree they grammatically mark tense and aspect, English, the focus of the current study, grammatically marks both. However, time reference may also be lexically defined (e.g., *yesterday, right now, tomorrow*). When time reference is lexically defined, verb morphology must agree with it (Comrie, 1976). Violations of this agreement are arguably relatively overt, as the distinction between the past, present, and future is quite stark. However, violations of aspect are arguably more subtle (Madden & Zwaan, 2003).

Processing Tense and Aspect Although aspect has received ample attention in theoretical linguistics (e.g., Comrie, 1976; Kiparsky, 2002; Klein, 1992), empirical studies investigating aspect are scarce, and have focussed on inferences about event structure and information foregrounding (e.g., Ferretti, Kutas, & McRae, 2007; Madden & Zwaan, 2003), or the asymmetry and interaction of tense/aspect impairment in agrammatism (e.g., Dragoy & Bastiaanse, 2013).

By contrast, the processing of tense has been extensively studied using various psycho- and neurolinguistic techniques. For instance, the Visual World Paradigm (eye-tracking of visual attention during auditory language processing) has shown visual attention to be modulated by tense marking (past vs. future). In Altmann and Kamide (2007), for example, participants inspected a scene containing an empty wine glass and a full beer stein. More looks were directed at the empty wine glass when participants heard *The man* <u>*will drink*</u>..., than *The man* <u>*has drunk*</u>, and vice versa. Thus, verb tense can modulate anticipation during comprehension.

Additionally, electroencephalography (EEG) studies have shown tense violations (ex.2b) evoke a larger biphasic (left anterior negativity 'LAN' - late positivity, 'P600') event-related brain potential (ERP) than non-violations (2a), a pattern often elicited by violations of morphosyntax (Baggio, 2008; Steinhauer & Ullman, 2002).

(2) a. Yesterday, I *sailed* Diane's boat to Boston.
b. *Yesterday, I *sail* Diane's boat to Boston.

While extant empirical research has compared the present simple (*does*) with the past simple (*did*) or present progressive (*is doing*), few studies have investigated the English Present Perfect (*has done*), the focus of the current study.

The English Present Perfect The English Present Perfect can be used to describe on-going (ex. 3a) or completed events (ex. 3b) when these bear some current relevance or future possibility (Klein, 1992). It is infelicitous with completed past time reference, as it requires the topic time to include the present. The use of the present perfect in conjunction with a completed past temporal adverbial is therefore infelicitous (ex. 3c). In other words, it connects past events to the present.

(3) a. *Since 1996*, Gino has lived in Italy.
b. *Since 1996*, Gino has been/*went to Italy twice.
c. *In 1996*, Gino *has been/went to Italy twice.

Roberts and Liszka (2013) investigated the processing of tense/aspect violations in English in sentences like 3b and 3c. In an acceptability rating task, sentences containing a time reference violation were rated lower than their congruent counterparts by English native speakers for both the present perfect and past simple. Interestingly, while both violations received low ratings (reflecting explicit awareness), only present perfect violations (ex. 3c) elicited longer self-paced reading times in native speakers. The authors interpreted this asymmetry in reading times as reflecting higher severity of violations in which the present perfect is used in a completed past time frame, compared to the past simple in an incomplete time frame.

World Knowledge and Context Effects

In addition to linguistic knowledge, such as temporal verb morphology, real-world semantic knowledge has been shown to be rapidly integrated during language processing (e.g., Altmann, 1999; Altmann & Kamide, 1999), while violations of such real-world knowledge have been shown to elicit processing costs (ex. 4a). However, prior contexts which establish situations in which these violations become felicitious (ex. 4b) have been shown to facilitate processing in comparison to when real-world violations are presented in isolation (e.g., *EEG*: Ferguson & Cane, 2015; Nieuwland & van Berkum, 2006; *eye-tracking in the visual world*: Ferguson, Scheepers, & Sanford, 2010; *eye-tracking during reading*: Ferguson & Sanford, 2008; Ferguson, 2012).

(4) a. The peanut was salted / *in love.
b. A woman saw a dancing peanut with a big smile on his face.

These studies exemplified that prior contexts *(i)* are rapidly integrated during on-line comprehension, and *(ii)* can create a mental representation in which 'real-world violations' are no longer processed as violations.

Specific long-term knowledge about well-known fictional characters has also been shown to be integrated during language processing, facilitating integration of otherwise anomalous linguistic input (e.g., *EEG*: Filik & Leuthold, 2013; Troyer & Kutas, 2018; *eye-tracking during reading:* Filik, 2008; Filik & Leuthold, 2013). In an eye-tracking experiment, Filik and Leuthold (2013) presented sentences such as ex. 5a, describing a scenario involving a well-known fictional character (e.g., *The Incredible Hulk* or *Shaggy* from *Scooby Doo*) or an unknown real-world character (e.g, *Terry*), followed by a target sentence (ex. 6a) which was plausible for one fictional character (*The Incredible Hulk*), but not the other two characters (*Shaggy* or *Terry*)[1], or a sentence which was plausible for the real-world character (ex. 6b).

(5) a. *The Incredible Hulk/Shaggy/Terry* was annoyed at the traffic in front of him.

(6) a. The angry man picked up the lorry and continued on his way.
b. The angry man *picked up/glared at the lorry* and continued on his way.

The authors reported early processing costs for both well-known and real-world characters for whom an action is implausible at the critical word (*lorry*; first-pass regressions out, regression path duration), but later processing costs for the real-world implausible condition only (total reading times). This was consistent with a similar ERP experiment from the same study, in which a larger N400 was reported for implausible conditions, suggesting participants were able to incorporate their long-term knowledge about famous fictional characters during early language processing in a similar way to new real-world characters, but the differences in later reading measures implies this implausibility was more easily accomodated for fictional than real-world characters.

Lastly, specific factual real-world knowledge has also been implicated as rapidly available during language processing (e.g., Hagoort, Hald, Bastiaansen, & Petersson, 2004), and highly constrained hypothetical contexts have been shown to override biographical real-world knowledge in on-line processing, similar to ex. 4 above (e.g., 7a; Nieuwland & Martin, 2012).

(7) a. If NASA hadn't developed its Apollo Project, the first country to land on the moon would have been Russia/??America.[2]

[1] *The Incredible Hulk* is a superhero from Marvel Comics with super strength, whereas Shaggy is a fictional human for whom lifting a lorry is not plausible.

[2] America was in fact the first country to land on the moon.

The Lifetime Effect: Tense, Aspect, and World Knowledge

Similar to the integration of real-world knowledge during language processing evidenced above, the Lifetime Effect refers to congruence between world knowledge (about the lifetime status of a referent: dead vs. alive) and temporal/aspectual marking (e.g., Mittwoch, 2008; Musan, 1997). As in ex.1, in which the temporal verb morphology allows the reader to infer the time of the event, the Lifetime Effect allows inferences to be made about a referent's lifetime (ex. 8). However, lifetime status may already be known through world knowledge and/or context. Verb tense/aspect can therefore be congruous or incongruous with respect to prior knowledge about a referent's lifetime, as in ex. 9.[3]

(8) a. My grandmother *is* from Prince Edward Island. (*inferred: living*)
 b. My grandfather *was* from Prince Edward Island. (*inferred: dead*)

(9) a. Will Smith *is*/**was* from West Philadelphia. (*common knowledge: living*)
 b. Amy Winehouse **is*/*was* from Camden Town. (*common knowledge: dead*)

The Lifetime Effect also applies to the English present perfect (*has done*), which is infelicitious with completed past time and events in a dead referent's lifetime (ex. 10; Chomsky, 1969; Katz, 2003; Klein, 1992)[4]. Note that, unlike the violations in ex. 2 and 3, violations in examples 9 and 10 are unproblematic if we don't know the lifetime status of Will Smith and Amy Winehouse.

(10) a. Will Smith *has won*/*??won* 4 Grammys. *common knowledge: living*
 b. Amy Winehouse **has won*/*won* 7 Grammys. *common knowledge: dead*

In the first-known investigation into the processing of the Lifetime Effect, Chen and Husband (2018) presented participants with short narrative contexts establishing the lifetimes of two fictional characters (ex. 11). Participants were then presented with a sentence containing the present simple, which is incongruent with a deceased referent (ex. 12).

(11) a. *living*: John...is a real estate agent...,
 living: Bill...lives in Europe.
 b. *living*: John...is a real estate agent...,
 dead: Bill...lived in Europe his whole life.
 c. *dead*: John...passed away last year...,
 dead: Bill...lived in Europe his whole life.

[3]Amy Winehouse died in 2011. As of the time of writing,Will Smith is alive.

[4]The past simple is also used to describe actions of living individuals, but this is often done in a pre-determined topic time. A statement such as *Will Smith won 4 Grammys* on its own leaves the listener 'hanging in the air' in the absence of an established past topic time (Klein, 1992, pp.18; Werner, 2013).

(12) a. *Critical*: They *are* both very handsome.

Lower acceptability ratings and longer reading times in a self-paced reading study were elicited when *are* was preceded by a context introducing two dead referents (ex. 11c), or one dead and one living referent (ex. 11b) compared to a context introducing two living referents (ex. 11a).

Self-paced reading results revealed later processing costs for the dead-dead context (at spillover sentence end) than the living-dead context (post-verb region), suggesting late or cumulative costs for the former and immediate costs for the latter violation. This provided the first evidence that information about the lifetime status of a referent(s) is integrated during processing, albeit with differing patterns depending on the severity and salience of the violation.

Experiment

The current eye-tracking reading study investigated how knowledge of a referent's lifetime status can modulate the processing of temporal verb morphology through the present perfect Lifetime Effect. A secondary aim was to investigate how the processing of subtle present perfect lifetime violations differs from more overt lifetime violations presented by the simple future. Critical sentences included the English present perfect or simple future, and were preceded by congruent or incongruent lifetime contexts (i.e., dead or living) describing famous cultural figures. Naturalness ratings were combined with eye-tracking in order to tap into both explicit language awareness (ratings) and implicit language processing (reading measures). Names of famous cultural figures were used to tap into world knowledge, with short context biographies ensuring participants actually knew who the referents were. The reported experiment followed three pilot studies with similar format and stimuli, but different judgement tasks.

Methods

Participants Twenty-four native English speakers (aged 18-31, 21 female) participated in the study and were compensated 16 Euros for their time. Participants were all right-handed and had learned no other language before the age of six.

Materials and Design The experimental stimuli contained two two-level factors (*lifetime*: living or dead, *verb tense*: present perfect or simple future), resulting in four conditions (Table 1; *PP*: present perfect, *SF*: simple future). The materials consisted of 80 items which contained biographies of two cultural figures with the same occupation and nationality, but differing in lifetime status (ex. 13), and two critical sentences describing an accomplishment which each of the cultural figures achieved in either the present perfect or simple future (ex. 14). Each item therefore contained four possible sentence combinations. There were 320 (80 items x 4 conditions) sentence combinations in total, distributed across 4 lists (80 items each appearing once in a given base list) in a Latin square design. A total of eight verbs were used (*appear,*

Table 1: Example item

Condition	Context (lifetime)	Critical (tense)
(1) living/PP	*Beyoncé...*	*...has performed...*
(2) dead/PP	*Whitney Houston...*	*...has performed...*
(3) living/SF	*Beyoncé...*	*...will perform...*
(4) dead/SF	*Whitney Houston...*	*...will perform...*

perform, play in, receive, release, sell, star in, win, work with, write), balanced within each list to be presented evenly across conditions (twice per condition per list).

(13) a. Beyoncé is an American performer.
She lives in California. (*context - living*)
b. Whitney Houston was an American performer.
She died in California. (*context - dead*)

(14) a. She has performed in many arenas in the past, apparently. (*critical - present perfect*)
b. She will perform in many arenas in the future, apparently. (*critical - simple future*)

Importantly, neither congruent nor incongruent stimuli contained overt mention of time reference to which the subsequent verb tense (present perfect or simple future) should agree. Rather, the time reference was *implied* to be the lifetime of the cultural figure. Additionally, the two possible critical sentences (ex. 14a and 14b) were identical for the dead and living conditions (ex. 13a and 13b). Therefore, reading time differences (reflecting processing costs) are assumed to reflect the difficulties integrating verb tense/aspect with time reference implicitly determined through world knowledge and/or immediate context.

Filler items (n = 124) consisted of sentences describing fake cultural figures with similar structure to the critical items. The exclusion criterion from subsequent analyses was pre-determined as a median acceptability rating of $\leq$3 for unambiguously incorrect filler items (e.g., context: *Sarah Jones was a Canadian sculptor. She lived in Saskatoon*, critical: *He is a father of five, according to Wikipedia*).

Predictions Longer reading times reflecting processing costs were predicted at the verb region in the *dead/present perfect* condition, compared to the *living/present perfect* condition (Table 1). We also predicted lower ratings on a 7-point naturalness Likert scale for the *dead* compared to *living* in both the *present perfect* and *simple future* conditions, reflecting explicit awareness of the violations. Furthermore, these ratings were expected to be lower for the *dead/simple future* than *dead/present perfect*. No processing costs were expected for the *dead/simple future* condition compared to the *living/simple future*, due to the expectation of a quick detection of the violation which would then lead to less time spent viewing the sentence.

Procedure Eye-movements were recorded using an EyeLink 1000 desktop tracker with head-stabilizer (SR Research, Mississauga, Ontario, Canada). Context biographies were presented on a computer display, followed by the critical sentence in isolation. Participants then rated the naturalness of the critical sentence in relation to the preceding context on a scale of 1 (*definitely wrong*) to 7 (*perfectly fine*).

Data Analyses Sequential fixations shorter than 80ms in duration were merged prior to analysis. Fixations shorter than 80ms or longer than 800ms were excluded. Critical sentences contained six interest areas (shown in 15). The critical region of interest contained the auxiliary and main verb. First-pass time, regression path duration, and total reading time were computed using Data Viewer (SR Research). First-pass time and regression path duration are considered early measures, reflecting early processing of the region (*first-pass*: sum of all fixation durations in the critical region before exiting the region; *regression path*: sum of all fixations in the critical region before exiting to the right of the region). Total reading time is considered a later measure, and is the sum of all fixation durations in a region, reflecting late or cumulative processing (Rayner, 1998).

(15) $She_{pronoun}$ | $\underline{has\ performed}\ /\ \underline{will perform}_{verb}$ | $in\ many\ arenas_{NP/PP}$ | $in\ the\ past\ /\ future,_{time}$ | $apparently_{spillover}$

One participant was excluded from analysis, as their median rating for unambiguously incorrect filler items (median = 4) was above the pre-determined threshold (median = 3).

Given the residuals of the data were not normally distributed (Box-Cox test), the data were log transformed (Box & Cox, 1964). Subsequent analyses were run on the log transformed data. Linear mixed-effects regression models were fitted to the log-transformed reading times and reaction times (*lme4* package in R), and ordinal logistic regression models to rating data (*ordinal* package in R). Fixed effects were lifetime status, verb tense, and their interaction. Participant and item were included as random effects, with main and interaction effects as random slopes. The models most parsimonious given the data and research questions were used (Bates, Kliegl, Vasishth, & Baayen, 2015).

Results

As described above, longer reading times reflecting processing costs were expected for the *dead/present perfect*. Low ratings and shorter reaction times were expected for the *dead/simple future*, reflecting explicit awareness of the violations. Ratings for the *dead/present perfect* were expected to be relatively high, but lower than the *living/present perfect*.

Reading measures Main effects of tense (t = 3.68, $p < .01$, *Cohen's* d = 0.2) and lifetime (t = 4, $p < .001$, *Cohen's* d = 0.18), as well an as interaction effect (t = 3.8, $p < .001$, *Cohen's* d = 0.35) were found in total reading times at the verb region, but not in early measures (first-pass duration, regression path duration). Visual inspection of the data and subset analyses indicated that the interaction effect was driven by longer reading times at the verb in the *dead/present perfect* compared to all other conditions (Figure 1, all ps $< .001$,

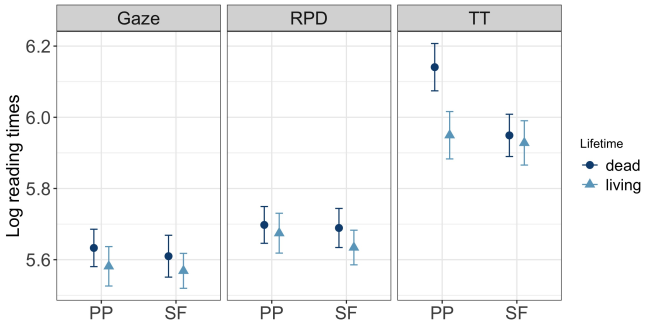

Figure 1: *Log mean reading times at the verb region with 95% confidence intervals (Gaze: first-pass duration, RPD: regression path duration, TT: total reading times; PP: present perfect, SF: simple future.*

Bonferroni corrected). There were no differences in reading times between the *dead/simple future* and *living/simple future* conditions, which was also observed in previous pilot studies.

Exploratory analyses into other sentence regions yielded significant differences in total reading times at the *NP/PP* region between the *dead/* and *living/simple future* conditions ($p < .05$, *Cohen's d* = 0.29, Bonferroni corrected), as well as the *dead/simple future* and *dead/present perfect* conditions ($p < .05$, *Cohen's d* = .4). There were also differences between the two *dead* conditions in regression path duration in the *time* and *spillover* regions (*time*: $p < .05$, *Cohen's d* = .24; *spillover*: $p < .05$, *Cohen's d* = .32; Bonferroni corrected). The reading times differences involving the *dead/simple future* were driven by significantly shorter reading times for this condition.

These results indicate processing costs for the present perfect, but not simple future, when preceded by a context establishing the referent as deceased. The lack of any significant effects in the first-pass duration and regression path duration measures implies the violation elicited late effects (or cumulative, as late measures such as total reading times may also include early processing effects; see Vasishth, von der Malsburg, and Engelmann (2013)).

Naturalness ratings The *dead/simple future* condition was rated significantly lower (M = 1.3, *sd* = 0.96) than all other conditions (all *ps* $<$ .001; Figure 2a). The *dead/present perfect* was rated as relatively natural (M = 6.1, *sd* = 1.34), but significantly less so than the *living/present perfect* condition (M = 6.4, *sd* = 0.94; t = -3.78, p = .001).

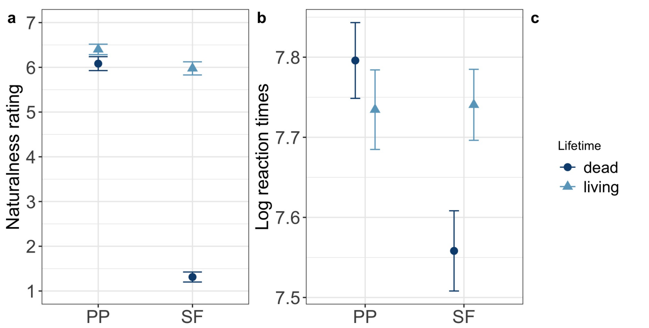

Figure 2: *Error bar plots with 95% confidence intervals of (**a**) mean ratings across conditions, and (**b**) mean log reaction times. PP: present perfect, SF: simple future.*

Reaction times The reaction times to the critical screen were significantly shorter for the *dead/simple future* condition than all other conditions (all $p < .001$; Figure 2b). There were no other significant differences between conditions.

Discussion

Results from eye-tracking measures, reaction times, and naturalness ratings revealed that the *dead/present perfect* condition elicited (late/cumulative) processing costs than any other condition, and significantly lower naturalness ratings than the *living/present perfect* condition. However, the *dead/present perfect* received an overall high mean rating, indicating that the violation either was not overt enough to be explicitly detected, or was detected and deemed to not be severe. In contrast, the *dead/simple future* elicited shorter reading measures from its *living/simple future* and *dead/present perfect* counterparts in late regions and measures, as well as shorter reaction times (representing total time viewing the critical sentence), and extremely low ratings.

Three issues remain: (i) what are the implications of the asymmetry between the violation ratings (low for *dead/simple future*, implying explicit detection and reading measures, and longer for *dead/present perfect*, implying implicit detection); (ii) how can we account for the shorter reading times for the *dead/simple future*, and (iii) what are the implications of the overall absence of an effect in early reading measures at the verb region?

Turning first to the asymmetry between the violation rating scores and the reading measures, we raise a question: how does the *overtness* of a violation modulate on-line processing? Roberts & Lizska (2013) reported that the present perfect elicited longer reading times and lower ratings when preceded by an infelicitous temporal phrase (e.g., *last week*) than when preceded by a felicitous temporal phrase (e.g., *since last week*), whereas violations elicited by the past simple likewise elicited low ratings, but no differences in reading times. The authors concluded that although in both cases the violations were rated similarly low (indicating explicit awareness and high violation *overtness*), violations elicited by the past simple were less *severe*, eliciting no processing costs, as reflected in the absence of reading time differences.

In a design more comparable to the present study, Madden and Zwaan (2003) presented participants with subtle (i.e., less overt) aspect violations: sentences in either the past simple (*made*) or past progressive (*was making*) were followed by a picture showing the named action as either completed (match: past simple) or in-progress (match: past progressive). In a forced binary choice task, participants reliaby accepted all items (both match and mismatch), but reaction times were significantly slower for mismatches. Thus, the authors concluded that the aspectual mismatches were "sufficiently subtle", and participants were not explicitly aware of the aspectual mismatches (pp. 667).

The results from the current study are somewhat similar in that violations containing the present perfect elicted processing costs, indicating the detection of something not quite right, but still received high acceptability ratings. In addition, the simple future constitutes the more severe and obvious violation, but elicited no processing costs during reading. The *overtness* of the violation (i.e., how *obvious* the violation is), as well as its severity, could explain the rating asymmetries between the present perfect and simple future. If a violation is both overt and severe, it stands to reason explicit ratings of the violation would be low because participants know there is a violation (severe) and what the violation is (overt), as in Roberts and Liszka (2013). However, if a violation were less obvious and less severe, it is likely it would be found more acceptable but could lead to parsing delays, as in Madden and Zwaan (2003). To reiterate this point, ex.16 replaces the context biography with a referent's name (examples adapted from Chomsky (1969)).

(16) a. Albert Einstein *<u>*has visited*</u> Princeton. (*dead - present perfect*)
b. Albert Einstein *<u>*will visit*</u> Princeton. (*dead - simple future*)

When comparing the two violations, we argue the violation in ex. 16b is both more *severe* and more *overt* than in ex.16a. This could be attributed to the fact that the present perfect refers to past events, and since Albert Einstein did visit Princeton in the past, sentence 16a is *true*, but the tense/aspect distinction, though subtle, is wrong (similar to the mismatch conditions in Madden and Zwaan (2003)). The event described in ex. 16b on the other hand is impossible. This distinction may have well contributed to an imbalance in *overtness* of the violation, as well as *severity*. Considering the extreme rejection rate in the naturalness ratings of the (severe and overt) *dead/simple future* violations, along with the longer reading times for the (more subtle and less severe) *dead/present perfect* violations, this is not far fetched.

Turning to the second issue of the longer reading times for the *dead* compared to the *living/simple future* condition, the high overtness of the *dead/simple future* condition may again provide an explanation. Assuming participants immediately detected violations such as ex.16b, we suggest they continued to the rating upon detection of the violation, also accounting for the shorter reaction times and low ratings. Whereas Roberts & Liszka (2013) concluded the lack of processing costs elicited by past simple violations was due to lower severity of the violation compared to the present perfect, the shorter reading times for the *dead/simple future* violations in the current study are more likely to be due to a combination of the high overtness and severity of the violations with the task which immediately followed each item. However, naturalness ratings are not enough to tap into the distinction between the *severity* and *overtness* of the violations.

Lastly, the lack of reading time differences in the early measures (first-pass reading time and regression path duration) is not dissimilar from the findings in Chen & Husband (2018), who found longer reading times at the sentence end when the Lifetime Effect had been violated by preceding a *dead-dead* context (ex. 11c). Similar to the present study, critical sentences alone did not constitute violations. Rather, a violation could only be detected once considering the immediately preceding context. Insofar as self-paced reading times can be compared to reading measures, the delayed effect reported in Chen & Husband (2018) for the dead-dead violation is not dissimilar to the processing costs found in the total reading time in the current study.

The aim of the study was to investigate whether the lifetime status of a referent modulates the processing of temporal verb morphology deemed incongruent by the *Lifetime Effect*, and how this modulation differs between subtle and overt violations presented by the present perfect and simple future, respectively. The results revealed that a preceding dead context lead to an increase in total reading times at the verb region, and to lower ratings. However, each of these measures seems to have been led by the present perfect and simple future, respectively: the *dead/present perfect* had significantly longer total reading times and lower naturalness ratings (albeit relatively high ratings) than the *living/present perfect*, whereas the *dead/simple future* condition led to significantly lower ratings and *shorter* regression path duration and total reading times than its *living* counterpart in later sentence regions. The *present perfect* results are taken to suggest that the violations were implicitly but not explicitly detected, whereas the *simple future* findings suggest that the violation was quickly and easily detected and rejected. These findings taken together imply that the lifetime status of a referent does indeed modulate the processing of temporal verb morphology, but that the subtlety of the violation plays a crucial role in this modulation.

Conclusion

The current study contributes to the growing evidence of the integration of non-linguistic information during language processing. The processing of temporal verb morphology was shown to be modulated by the immediately preceding context defining the lifetime of a referent as living or dead. However, asymmetries in the rating and reading measures imply that violations presented by the *dead/simple future* condition were highly overt, and yet they elicited no processing effects in comparison to the *living/simple future*. Meanwhile, *dead/present perfect* violations were rated much higher (although still lower than the *living/present perfect*) but did elicit processing effects. This imbalance may be attributed to the overtness of the violations and/or metalinguistic awareness of the violations presented by the simple future, but not the present perfect.

On-going experiments are investigating the separate effects of context and world knowledge on processing of the Lifetime Effect, which the current study design cannot tease apart.

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