ORIGINAL RESEARCH REPORT

What's Done is Done: Verb Aspect and Verbatim Memory

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Grammatical verb aspect uses morphosyntactic cues ('-ed', '-ing') to convey whether an action is, for example, complete ("walked") or on-going ("was walking") and has shown notable comprehension ramifications for a reader's event model. Additionally, research suggests that the reader quickly forgets verbatim surface-form information, such as morphosyntactic cues, while the event model remains intact. The current study used three different memory tests to probe readers' event models of the texts, testing readers' event model at retrieval. More importantly, we explored whether participants could have biased memory for the perfective aspect consistent with events unfolding in the narrative world. We show that verbs in the perfective aspect were remembered more accurately than those in the imperfective aspect. Moreover, imperfective verbs had a stronger tendency to be misremembered as being in the perfective aspect. That is, readers' memory seems to be affected by the passage of narrative time, rather than maintaining fidelity to the temporal status of the verb at original presentation.

Many components of language convey subtle aspects of meaning to the listener or reader. One such component is grammatical verb aspect. Grammatical verb aspect is represented via morphosyntactic cues. One function of grammatical aspect is to indicate whether an action is finished (complete) or on-going (incomplete). For example, "walked" (perfective) is considered complete, whereas "was walking" (imperfective) is considered on-going, as the protagonist is still engaged in the action. Grammatical verb aspect, and how it influences cognition, has been of theoretical interest for some time (e.g., Miller & Johnson-Laird, 1976; Rohde, Kehler, & Elman, 2006; Salomon, Magliano, & Radvansky, 2013).

Grammatical aspect is a marker of time, but maintains uniqueness from other markers of temporal status of an event. In describing grammatical aspect, we do not intend to overlap with other markers, namely lexical aspect or tense. Lexical aspect describes the temporal status of the verb's event, oftentimes categorized as an activity or accomplishment. Activities have no certain endpoint ("skating on the lake"), while accomplishments ("skating for an hour") are marked by completion (Comrie, 1976; Dowty, 1977). Tense is also different from grammatical aspect. Tense does use markers, but the purpose of these markers is to act as a temporal

referent in indicating when an event occurred (Moens & Steedman, 1988; Reichenbach, 1947), rather than indicating the current ongoing-ness or completion of an event. The current study examines effects of neither lexical aspect nor tense.

Besides notifying readers of the completeness of the described action, grammatical verb aspect generally has also been considered to be an element of language that could affect comprehension on a more fine-grained level (Comrie, 1985; Dowty, 1977; Vendler, 1967). In fact, studies have investigated the salience and cognitive availability of temporal verb status during reading (Altmann & Kamide, 1999, 2007; Carreiras, Carriedo, Alonso, & Fernández, 1997; Ferretti & Katz, 2010; Ferretti, Kutas, & McRae, 2007; Madden & Ferretti, 2009; Madden & Zwaan, 2003; Salomon et al., 2013) and have shown that using one grammatical verb aspect can differentially direct attention within the sentence via a reader's event model. Imperfective aspect ("was walking") has been shown to activate knowledge pertaining to the action in the sentence. Because the protagonist is attempting to achieve a goal via their action, a reader is most focused on whether the goal, in this case the action, will reach completion (Matlock, Fausey, Cargill, & Spivey, 2007). Imperfective aspect directs attention to descriptive information within the sentence, like the setting of the sentence (Ferretti, Kutas, & McRae, 2007). In the perfective, the action of the sentence has already been completed, so there is little need to recruit attention to monitoring the temporal status of that action. Perfective aspect has been shown to direct attention to other objects of the sentence, such as tools or characters, if mentioned (Salomon et al., 2013).

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Not only has aspect been found to direct attention within a sentence, but readers use the temporal information of grammatical verb aspect in other demonstrations of online comprehension. Previous research by Morrow and colleagues (Morrow, 1985, 1990; Morrow, Greenspan, & Bower, 1987) showed that the aspect used in a sentence could affect event model construction by tapping into a reader's semantic and schematic understanding of the world. They found that household items were more or less salient based on the status of a protagonist's location. For example, when a protagonist "was walking" (imperfective aspect) from the bathroom to a kitchen, the word "toothbrush" is more salient than "knife" to a reader; an imperfective aspect illuminates the path, not the destination. Thus, bathroom schema is active. However, if a protagonist "walked" (perfective aspect) from the bathroom to the kitchen, the kitchen schema is active. The action is complete, so the reader understands the protagonist is at his destination in the kitchen. As such, participants respond faster to the word "knife" (kitchen schematic words) than "toothbrush" (bathroom schematic words). These findings show that readers use semantic and schematic knowledge to foreground salient information, depending on the aspect used in the sentence (Anderson, Matlock, & Spivey, 2013; Anderson, Matlock, Fausey, & Spivey, 2008; Anderson, Matlock, & Spivey, 2010).

Overall, this work suggests that readers' event models are richly colored by verb aspect, which directs attention and activates knowledge representation of certain elements of the sentence. However, no research has evaluated retrieved event models vis a vis memory for grammatical aspect. This would reveal differentiating features of how the information conveyed by aspect is remembered, by bringing to light the state of a participant's retrieved event model. The question here is not whether verbatim memory is well preserved (we know it is not)[1] nor that event models are unaffected by aspect (we know they are). Instead, we use memory for aspect as a proxy to assess the state of the remembered event model. We suggest that accounts for long-term memory of verb aspect derive from event cognition. According to this view, readers perceive goals and goal achievement as separate events (Kurby & Zacks, 2012). Event cognition theory suggests that each event in a narrative is parceled and committed to memory separately, and additionally, that these events capture a temporal flow through the narrative (Zwaan & Radvansky, 1998). This finding lends itself to a possible phenomenon: readers may parcel events in violation of verbatim exposure, and later remember the events as having been completed (perfective). In this case, these events tend to run to completion in memory (via the narrative timeline), causing memory to be remembered better for complete (perfective) rather than ongoing (imperfective) events.

Event models are referential mental representations that capture events as they are described by language. One way to think of language is as a set of instructions for how to build an event model (Zwaan, 1999). As such, readers should construct event models that correspond directly to the text that was read. Yet, work in text memory indicates

that remembered text may be affected by other external forces: namely, the passage of time. Anderson and Conway (1993) found that participants' recall of events were more detailed when the event was retrieved in a forward order, suggesting that there is a cognitive bias to move forward in time rather than backward (Anderson & Conway, 1993; Bekerian & Conway, 1988). Thus, if there is a bias in event model memory, it would be to play events forward in time toward completed events. The texts in our study had temporal markers, via grammatical verb aspect, which may not be faithfully captured by the retrieved event models. This forward order bias suggests that readers should be more accurate at retrieving event models consistent with a perfective aspect, because readers would be more likely to retrieve event models with completed events, which is progress forward in time. But readers would be less likely to retrieve events as on-going, especially if the original event was described as completed, because this would involve progress backward in time, and would mean that the readers were playing their event models backwards. Thus, it is unlikely that a person will misremember a completed action as being incomplete (a perfective verb aspect as being an imperfective verb aspect).

We predict less accurate memory for the imperfective aspect. It seems more plausible that readers may play this event forward in narrative time and later retrieve this event as completed. That is, the temporal flow of event models would bias memory towards the end state of that event and, by playing the event forward, cause readers to remember an on-going event as completed. As such, event model theory makes the prediction that it is more likely that people will be biased to remember presented verbs in the perfective verb aspect, relative to the imperfective aspect.

All of the following experiments met the approval of the IRB of the University of Notre Dame. All subjects were consented, and told they could leave the study at any time, while still receiving pay. After each study, participants were debriefed and paid.

Experiment 1

The aim of Experiment 1 was to assess whether the perfective and imperfective verb aspects are differentially remembered. This was done using a yes/no recognition paradigm. We predict that participants will be biased to remember the event as completed, and thus in perfective aspect.

Method

Participants. A total of 150 adults (90 female) were recruited using Amazon's Mechanical Turk system and were reimbursed with $.15 for their participation. Ages ranged from 18 to 74 years old ($M = 35.27$, $SD = 13.53$). Fourteen participants were eliminated from analysis because they completed the task faster than 3 standard deviations of completion time, indicating they were not paying attention. All were native English speakers.

Materials and Procedure. A series of 24 single sentence items were tested, and participants randomly received one of 4 lists of sentences, counterbalanced by

presented aspect. Each sentence was of the form "The *person VERB direct object.*" such as "The mother laughed at the joke." There were two versions of each sentence, one in the perfective and the other in the imperfective, such as "The mother laughed at the joke." and "The mother was laughing at the joke."

Experiment 1 was created and presented using Qualtrics and distributed through Mechanical Turk. Participants were first shown each sentence, one at a time, in a random order, and were asked to rate the pleasantness of each sentence using a 1 to 7 Likert scale, with 1 indicating most unpleasant and 7 indicating most pleasant. These rating data were neither scored nor analyzed.

After reading and rating these sentences, participants were given a yes/no recognition task for those sentences. Test stimuli were counterbalanced so that participants would see either imperfective or perfective sentences at test. Half of the sentences were identical to the sentences they had previously read. The other half were presented in the aspect participants had not read. Additionally, 10 completely incorrect sentences were added as fillers at test only. Each recognition probe sentence was presented one at a time. Participants responded 'yes' or 'no' as to whether they had read each sentence before. Responses were made by clicking on 'yes' or 'no' radio buttons on the screen. Responses were then scored for accuracy.

Results and Discussion

Because there were both hit and false alarm rates, A' signal detection measures were calculated for each participant. These data were submitted to a one-way repeated measures ANOVA. This analysis was significant, $F(1,149) = 4.52$, $MSE = .02$, $p = .04$, $\eta^2 = .03$, with participants being more accurate for perfective ($M = .87$; $SE = .01$) than imperfective aspect ($M = .83$; $SE = .01$). Although this effect is quite small, it is still present. We suspect that the small size is due in part to the nature of the paradigm.

We find two points about these data to be relevant. First, although accuracy for imperfective sentences was smaller than that of perfective sentences, overall accuracy was still high (>80%). We take these findings to indicate that participants are not complying with a blanket preference for perfective, rather than imperfective. Instead, at test, they proved sharp in correctly remembering verbatim cues, such as presented grammatical aspect.

Additionally, when presented with one version of a sentence, participants show the ability to match what they read at test to what they saw at study, although this is stronger for perfective, rather than imperfective verbs. What does this mean for the retrieved event models? Specifically, this seems to indicate that participants are using an event model that has been played forward in time.

To more thoroughly investigate whether these effects were attributable to a demand characteristic or whether this finding could be replicated, and possibly more easily detected with other methodologies, we used other memory tasks in Experiments 2 and 3.

Experiment 2

Experiment 2 used a forced choice recognition paradigm rather than yes–no recognition. If memory retrieval involves selecting the option that most closely resembles the circumstances captured by an event model, then there should be a difference between the conditions with there being a greater bias to remember actions having been completed than on-going. This would mean that the reader remembers the completedness of the event, rather than its verbatim presentation.

Method

Participants. A total of 36 adults (25 female) were recruited using the Mechanical Turk system and were reimbursed $.15 for their participation. Ages ranged from 18 to 63 years old ($M = 31.62$, $SD = 11.68$). One participant needed to be eliminated because they completed the task faster than 3 standard deviations of completion time, indicating they were not paying attention. All were native English speakers. The sample size used in Experiment 2 was smaller than that for Experiment 1 because pilot data revealed that forced choice recognition produced a much larger effect, obviating the need for such a large sample size.

Materials and Procedure. The initial presentation and ratings of the sentences were the same as Experiment 1. However, after all of the sentences had been rated, a two-alternative forced choice task was used to test memory for each sentence. For this task, both versions (perfective and imperfective) of each sentence were presented pairwise, and the participant was asked to select which of the two had been read earlier. This was done by selecting the radio button next to the preferred option. Again, filler sentences were added to the test stimuli only. Responses were scored for accuracy.

Results and Discussion

The accuracy data was submitted to a one-way repeated measures ANOVA. There was a significant effect, $F(1,34) = 40.83$, $MSE = .04$, $p < .01$, $\eta^2 = .55$, with, like Experiment 1, participants being more accurate at choosing for the perfective aspect condition ($M = .82$; $SE = .03$) than the imperfective aspect condition ($M = .53$; $SE = .03$). Note that here, the effect size is much larger. So, there was a greater probability of misremembering the imperfective verbs as being perfective, consistent with the idea that participants are playing their event models forward.

Experiment 2 replicated the basic findings of Experiment 1 using a different type of memory task. These results indicate that readers did not necessarily remember the events as they were conveyed by the original sentence itself. Instead, there was a consistent bias to recognize the completed version of the sentence given. Moreover, there was a bias to misremember this event as complete rather than on-going, consistent with the idea that the event model is moving forward in time.

This evidence is especially convincing. Participants were presented with two versions of a sentence at test. Yet, one of these sentences was one that they had never seen before. In

allowing participants to compare the correct and incorrect options at test, they were provided the opportunity to directly compare the aspects to memory, holding all other discourse level features constant. In both the correct and incorrect options, the actions (laughed/was laughing) were identical, but the difference lay in the event model that was retrieved for that sentence. Thus, the operational task was not about the action within the sentence, but rather the reader's retrieved event model. If this event model captured the event as it was described in the text, then accuracy scores should be similar for the perfective and imperfective aspect stimuli. However, if participants are mentally playing event models forward, then they should rely on the memory of the completed event and be more likely to choose the option consistent with it. The results show that participants were poorer at identifying the imperfective aspect sentence they had previously read. Because of this, it is not only obvious that participants were using event models to make recognition decisions (Garnham, 1981), but that this event model reflected a completed event. This indicates that participants were making erroneous memory distinctions (perfective, rather than imperfective) to reflect their erroneous event model depictions in memory (completed events).

Experiment 3

The third experiment used cued recall task in which participants explicitly produced the text they remember having read. This allowed them to report both the aspect they remembered and the verb that was used.

Method

Participants. A total of 35 adults (24 female) were recruited using the Mechanical Turk system and were reimbursed $.15 for their participation. Ages ranged from 19 to 63 years old (M = 38.71, SD = 13.11). Six participants were eliminated from analysis because they completed the task faster than 3 standard deviations of completion time, indicating that they were not paying attention. All were native English speakers. The sample size used in Experiment 3 was also smaller than that for Experiment 1 because pilot data revealed that recall produced a much larger effect, obviating the need for such a large sample size.

Materials and Procedure. Again, the same pleasantness ratings task was used during encoding as in Experiments 1 and 2. The difference was that a cued recall task was used at retrieval rather than a recognition task. For the cued recall task, the first two words of a sentence were provided (e.g., "The mother") and the task was to type in the remainder of the sentence with what had been read earlier. Responses were sorted into three categories: (a) correct, (b) incorrect, and (c) other. A response was considered *correct* if the verb was the same as or synonymous with the original verb and was in the same aspect as the original verb. If a person read "The mother was laughing at the joke." an example of a correct synonymous sentence the participant produced would be "The mother was laughing at her son's joke." A response was considered *incorrect* if participants produced the incorrect verb aspect. If a person read "The mother was laughing at the

joke," and produced "The mother laughed at the joke," this would have been scored as incorrect. Finally, responses that were not the same as nor synonymous with the original verb, or with the aspect, were classified as *other*.

Results and Discussion

The cued recall data were submitted to a one-way repeated measures ANOVA. There was a significant effect, $F(1,34) = 40.62$, $MSE = .08$, $p < .01$, $\eta^2 = .54$, with participants being more accurate for the perfective aspect ($M = .54$; $SE = .04$) than for the imperfective aspect ($M = .10$; $SE = .02$) , like Experiments 1 and 2. The 'other' responses were equally likely to be provided for verbs presented in perfective ($M = .33$, $SE = .06$) or imperfective ($M = .35$, $SE = .06$) aspect. Again, better memory for presented perfective aspect is more consistent with the idea that the event model is being moved forward in time.

The data in Experiment 3 add to the evidence accrued across the first two experiments. Participants were more accurate for sentences that had originally been conveyed in the perfective aspect than the imperfective aspect. However, overall performance was lower than for the previous two experiments, due to the more demanding nature of the task to actually produce a response rather than simply select one that was presented.

For 'other' responses, participants provided verbs that were different from the ones that were initially provided. Participants failed to recall the correct verb at insignificant rates across aspects, indicating that the presented aspect did not affect overall verb memory.

General Discussion

The results of our three memory experiments using various memory measures to assess the state of the retrieved event models consistently show that people were more likely to retrieve an event model of a completed event, regardless of the original presentation of the grammatical aspect. Readers showed themselves as systematically more likely to remember the sentences they read earlier as having been in the perfective aspect. Given a bias to progress forward in time, these event models would have been played forward. Participants then retrieved these events as having been completed, whether they were originally or not. This tendency led participants to be more likely to accept a previously encountered event as having been completed than as still being on-going (especially if it was originally described in perfective). This resulted in a memory bias favoring responses that conveyed a completed event, as captured by the perfective aspect.

Alternative accounts

The current study was aimed at determining which of the two accounts described in the introduction better supports memory for the situations described by grammatical verb aspect. However, there are unstudied mechanisms that could also explain these data, which we explore here. Grammatical verb aspect conveys the temporal status of a verb. Yet it may also be that information read about or learned about in the past, whether the action was complete or incomplete, is likely to be perceived as happening in

the past, because that was when the reader was exposed to that action. For example, Miller and Johnson-Laird (1976) and Reichenbach (1947) illustrate the temporal locations at which different aspects are rooted. They note that the action itself occurs at a different time than when the action is referenced. For the perfective, the time of reference comes after the action is complete, but for the imperfective, the time of reference is before the action is completed. Given that native English speakers understand these temporal dimensions when comprehending aspect, readers are inherently aware of the passage of time. This passage of time may prompt readers to close the event.

Additionally, given that aspect highlights the temporal status of a verb, and readers similarly experience text in their own temporal frame as they experience the passage of time. The real-world passage of time that the reader experiences may bias readers to remember verbs as being completed. For a reader, the passage of time may lead the reader to misremember events that were not completed as being completed. Indeed, the grammatical markers of verb aspect constrain the amount of action thought to take place in a given period of time. To a reader, an action that was ongoing when experienced (rather, read) has surely been completed by the time of the recognition task, causing a bias to misremember verbs as complete.

Other explanations may be present. For example, memory for the events may have only been remembered as perfective because all of the actions were listed as being in the past. Participants may have simplified memory load by remembering only that the actions happened in the past, not the specific aspect. Also, for imperfective sentences, participants may have focused more attention onto the subject of the sentence at encoding, and not the actual aspect. Finally, because most narrative is written in the perfective aspect, and is considered normal for English speakers, readers may be more likely to remember reading a text in the perfective aspect, although that may not have been the case in the text they were most recently exposed to, as shown in these studies. Imperfective aspect is somewhat awkward, and used less than the perfective aspect. Although it seems more plausible that readers would remember reading a sentence that had an odd or low frequency verb phrase (von Restorff, 1933), it could be argued that these verb phrases are more easily forgotten due to low frequency, and as such, would need to be investigated. Indeed, of the stimuli used, the perfective versions of the words have a higher frequency than the imperfective version (shown in **Table 1**).

Future Work

The current study presents a method of examining superficial or verbatim memory via the structure of the retrieved event models. Future work could examine this more thoroughly in a variety of ways, by means of methods, manipulations, or materials, and address some of the alternative explanations for this pattern of results.

To begin, additional types of methods could be used to assess memory for the information conveyed by grammatical verb aspect. One example would be to have readers provide talk-aloud protocols at the time

Table 1: Frequency Table of verbs appearing in Perfective or Imperfective aspect (Google Books Corpus).

	Imperfective	Perfective
begin	17,955,022	27,634,137
complete	1,025,413	7,038,949
concern	9,004,066	11,626,673
cost	432,251	21,145,409
die	4,128,519	18,996,092
eat	4,264,186	2,441,057
expect	1,286,856	14,271,574
finish	1,034,065	6,762,438
have	38,996,741	430,205,685
head	1,683,459	3,516,664
kick	467,351	804,726
kill	2,593,743	8,877,735
laugh	2,346,873	4,045,854
let	1,914,272	26,867,091
mean	15,576,273	9,962,964
mind	91,907	2,100,427
shoot	1,964,193	6,983,500
sit	6,806,802	10,555,338
smile	2,367,118	4,025,060
start	5,045,360	12,322,278
stop	1,608,953	7,658,285
suit	51,561	2,191,826
suppose	809,009	8,692,758
win	1,895,220	12,825,942

of retrieval. This approach would allow readers to more explicitly consider the information captured in their event models when they engage in the process of describing it to an experimenter. This may provide an opportunity to more closely understand these systematic memory errors for the imperfective aspect found in the current study. Another approach would be to include various delays between reading and memory testing. These delays would be a tool to measure whether the passage of real time influences the passage of narrative time. That is, are the dynamic event models influenced by the passage of real world time in a way that would make participants even more likely to remember an event as completed, with greater amounts of time between reading and testing corresponding to increased likelihood of completion?

The types of verbs used in this experiment could be even more finely defined. The current study did not manipulate verb/action type in any specific way. However, future work could investigate whether memory for grammatical aspect interacts with other factors contributed by verbs. For example, the event models retrieved from memory may vary for verbs that have natural endpoints ('He was running to her') versus those that do not ('He was running'). Intuitively, it seems that readers would be more likely to complete the event in memory for verbs that have a natural endpoint (telic verbs) compared to those that do not (atelic verbs). Additionally, our findings would predict that telic verbs ('He was speaking with her') should be remembered in the same way that atelic verbs ('He spoke to her') would be because both events would

be remembered as having been complete. Further work would be necessary to investigate how readers remember the events described by these sentences and if they are in any way distinct.

Conclusion

The findings we present in this study regard a single aspect of language within a presented sentence. Effects regarding memory for aspect and other sentence-level factors have shown to have small effect sizes, as this may be due to nuanced effects of other discourse features, or the task at hand (Eerland et al., 2016; Sherrill, Eerland, Zwaan, & Magliano, 2015). More research is needed to explore how people remember verbs and action completion. The verbs given in the current experiments were all actions, but varied in action type. Also, including longer narratives instead of one-sentence passages, may affect a participant's memory for the text they encountered. For example, if a sentence in imperfective aspect is followed by a sentence in the perfective aspect, does that make it even more likely that a reader will remember the prior sentence as containing a perfective verb? Alternatively, a longer narrative could also facilitate a richer event model, making an incomplete action (as expressed in the imperfective aspect) more salient. Finally, work examining the verbs themselves may reveal that people have tendencies in judging what verbs are more likely to be recalled in perfective and what verbs are more likely to be recalled as imperfective. In conclusion, this research sheds light on how readers remember actions and events. Actions that occurred temporally in the past are more likely to be recalled as having been completed, even if the conveyed action was incomplete. Overall, readers' bias to the mental passage of time, through event models, may explain a reader's tendency to inaccurately remember the imperfective verb aspect as having been completed.

Note

[1] Readers forget verbatim surface form information very quickly, often within a few seconds of reading or hearing a sentence (e.g., Sachs, 1967, 1974). For example, people have difficulty remembering whether an original sentence was in the active or passive voice (e.g., Anderson, 1974; Sachs, 1974, 1967). What is remembered over long periods of time is the event model of the situation described by the text (Kintsch, Welsch, Schmalhofer, & Zimny, 1990; Radvansky, Zwaan, Curiel, & Copeland, 2001).

Data accessibility statement

Data files can be found at https://osf.io/wmv56/

Competing Interests

G. A. Radvansky is a Handling Editor at Collabra: Psychology. He was not involved in the peer review of this article.

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