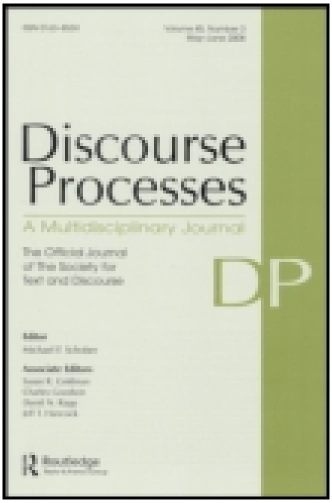

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A Narrative-Expectation-Based Approach to Temporal Update in Discourse Comprehension

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A Narrative-Expectation-Based Approach to Temporal Update in Discourse Comprehension

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This study concerns the mechanisms involving temporal update in discourse comprehension, comparing traditional approaches based on *Aktionsart* and Iconicity against an approach based on narrative expectations. Our experiments suggest that readers pay more attention to fine-grained discourse properties (such as salient temporal boundaries and event complexity) pertaining to the eventualities they encounter in the narrative in determining whether narrative time will be moved or not as opposed to strictly adhering to coarse-grained defaults imposed by *Aktionsart* and Iconicity. These results suggest a more active view of discourse comprehension, where readers actively generate expectations about *when* the next-mentioned eventuality is likely to take place.

INTRODUCTION

Narratives consist of sequences of sentences describing eventualities. Eventualities relate to each other in various ways; otherwise, the narrative would be incoherent. Eventualities can, for example, follow or overlap with one another. Following

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previous literature, we refer to *temporal update* as the process by which readers/narrators decide whether or not the next eventuality they read about or describe follows the eventuality they just read about or described and, if it follows it, how much time elapsed between the two eventualities. When readers/narrators decide that the next eventuality follows the just described eventuality, we say that narrative time (where the story is; cf. Reichenbach's [1947] *reference time* or Klein's [1994] *topic time*) was moved forward. The purpose of this article is to investigate the mechanisms underlying temporal update, focusing on two issues: (1) what discourse factors determine the movement of narrative time and (2) how much narrative time is moved, when it moves. Our overarching goal is to use the results of four experiments to compare two approaches to temporal update: a traditional, principle-based approach and a narrative-expectations-based approach.

Temporal update is generally assumed to be ubiquitous, with comprehenders routinely updating narrative time irrespective of task demands (Therriault, Rinck, & Zwaan, 2006). Principle-based approaches to temporal update assume that a set of general principles govern how narrative time is moved. A wide variety of psycholinguistic research sheds light on how discourse comprehension is affected by general principles that are linked to the sentence's tense (Carreiras, Carriedo, Alonso, & Fernandez, 1997), aspect (Madden & Therriault, 2009; Madden & Zwaan, 2003; Magliano & Schleich, 2000), or *Aktionsart* (Pickering, McElree, Frisson, Chen, & Traxler, 2006; Todorova, Straub, Badecker, & Frank, 2000). *Aktionsart*, also known as lexical aspect, is of particular importance to this study. It refers to the inherent temporal structure of the description of situations or eventualities (or verbs, depending on the author; Comrie, 1976; Vendler, 1957). Descriptions of situations or eventualities are categorized as either states (i.e., it is true at an instant, e.g., *crave ice cream*) or events (i.e., it is true only over a period of time, e.g., *run a marathon*). Events can be further subdivided, but we only focus on the distinction between states and events in this article, because this distinction has been claimed to be crucial for temporal update (Kamp & Reyle, 1993; Partee, 1984). According to these authors, the *Aktionsart* of the eventuality described in a sentence S_1 is critical to temporal update: If S_1 describes an event, the eventuality described by the next sentence S_2 will be associated with a time that follows the time of S_1. If S_1 describes a state, the eventuality described by S_2 is understood to temporally overlap the time of S_1.[1]

Several studies have also investigated temporal update by considering how eventualities are explicitly linked in narratives and have stressed the role of temporal connectives (de Vega, Robertson, Glenberg, Kaschak, & Rinck, 2004;

[1]In determining temporal movement, Partee takes as critical the *Aktionsart* of S_1, whereas in Kamp and Reyle's view it is the *Aktionsart* of S_2 that determines temporal update. Crucially for our purposes, in both cases the determinant of temporal update is the *Aktionsart* of the described eventualities: *all* states lead to temporal overlap, *all* events lead to moving narrative time forward.

Hoeks, Stowe, & Wunderlink, 2004), temporal adverbials (Bestgen & Vonk, 2000; Kelter, Kaup, & Claus, 2004), and Iconicity (Chafe, 1979; Fleischman, 1990; Givón, 1992). The latter is another focus of our study. The idea here is that while updating narrative time, readers/narrators assume that the chronological order of the described eventualities mirrors the order of the descriptions. The effect of this assumption is illustrated in (1) and (2). Although logically equivalent, the orders of events described by these two statements seem to be different, as (1) is commonly interpreted as describing two events where John and Mary got married *and then* had a child, whereas (2) is commonly understood as describing the same two situations but occurring in reverse order.

(1) John and Mary got married and had a child.
(2) John and Mary had a child and got married.

Several studies lend support to the role of Iconicity in temporal update. Temporally, iconic narratives are found to be more common typologically (Greenberg, 1963), are remembered easier (Clark & Clark, 1968), and facilitate processing of causal relations (Briner, Virtue, & Kurby, 2012). Furthermore, children acquiring language seem to use an order-of-mention strategy in comprehension, until they can fully grasp the meaning of lexical items that can override these defaults (Clark, 1971).

A stronger version of Iconicity holds that successive sentences in narratives describe by default not only successive but also *contiguous* eventualities. Dowty (1986, p. 45) states that the reference time of each sentence S_i is interpreted to be temporally located *immediately* after the reference time of the previous sentence S_{i-1}, positing not only that successive sentences describe successive situations by default but also that in the absence of contradicting temporal adverbial information, each described eventuality is assumed to *immediately* follow the previously described eventuality. Zwaan (1996) provides supporting experimental evidence for this claim. In his view, readers by default assume that strong Iconicity holds in narratives and that this assumption is only violated by the presence of temporal adverbs explicitly signaling a deviation from iconicity. Support for Zwaan's claim came from the longer reading times that were observed in narratives in which sequences of sentences described successive yet noncontiguous situations when compared with narratives in which sequences of sentences described successive and contiguous situations.

We propose a different approach to temporal update, one where readers rather than making use of *general* principles are making use of *particular* expectations engendered by properties of the situation that was just described. A narrative-expectation-based approach assumes that temporal updates follow from expectations that readers generate about how the discourse will unfold. Each discourse segment has salient properties, which, together with their narrative knowledge, allow readers to generate expectations about what information they might encounter next. This approach follows a long tradition of research on anticipatory processes in sentence and discourse comprehension. Readers expect upcoming syntactic structure (Kamide, Altmann, & Haywood, 2003; Van Berkum, Brown, & Hagoort, 1999) as well as highly constrained upcoming words (Federmeier & Kutas, 1999; Otten & Van Berkum, 2008) and even generate predictive inferences (Calvo, Castillo, & Estevez, 1999; Campion, 2004; Graesser, Singer, & Trabasso, 1994). In this study, we hypothesize that there are properties of S_1 that can lead readers to expect narrative time to be moved. Hence, contrary to principle-based approaches, a narrative-expectation-based approach claims that temporal update depends on whether S_1 allows readers to generate an expectation that the narrative time will be moved, and if it is moved, by how much.

The rest of the article tests competing predictions of both approaches to temporal update. Experiment 1 tests whether the state/event difference is all that is needed to determine movement of narrative time, as an *Aktionsart*-based approach would have it, or whether readers generate temporal expectations by paying attention to more fine-grained semantic differences among described eventualities. Experiment 2 investigates when readers make use of Iconicity and, more precisely, what described eventuality properties might lead readers to expect Iconicity to be overridden. Experiment 3 investigates whether readers always expect next eventualities to immediately follow the first described eventuality, as Strong Iconicity would have it, or whether readers expect the time interval between two described eventualities to vary with the properties of the first eventuality. Finally, Experiment 4 tests whether these temporal expectations play a role in on-line discourse comprehension.

EXPERIMENT 1: TEMPORARINESS OF STATES CAN OVERRIDE *AKTIONSART* BIASES

Experiment 1 tests whether readers move narrative time uniquely on the basis of the distinction between states and events or whether readers are sensitive to more fine-grained semantic differences between eventuality types. An *Aktionsart*-based approach predicts that readers move narrative time forward if the current sentence describes an event but hold narrative time constant if it describes a state. This prediction ensues from the traditional analysis that state descriptions are temporally unbounded and have no inherent start and end points (Dalton, 1984; Vendler, 1957). Because there are no end points, readers/narrators are not biased to "move on" and talk about the next-occurring event (cf. Madden & Zwaan, 2003; Magliano & Schleich, 2000).

In contrast, a narrative-expectation-based approach allows more fine-grained eventuality properties to influence temporal update. For example, whether the state described by the first sentence evokes salient temporal boundaries may make a difference as to whether narrative time is moved or not and might therefore be a better predictor of temporal update than the coarse-grained distinction between events and states. To test whether properties more fine-grained than the distinction between states and events influence temporal update, we made use of the difference between so-called temporary and permanent states (Dalton, 1984; Ismail, 2001; Quine, 1960). Only temporary states (e.g., *a baby requiring a vaccination*, *Bobby needing a nap*) can evoke salient temporal boundaries. One's prior knowledge of the world typically tells us that at some point, these states will cease to be true: The baby will be vaccinated, and Bobby will have gone asleep. Temporary states differ from permanent states in that respect (e.g., *whales are mammals*, *Mary loves ice cream*): We know that whales will always be mammals, and there is no obvious reason why Mary would stop loving ice cream. A narrative-expectation-based approach predicts that readers are more likely to expect narrative time to be moved on encountering temporary states than on encountering permanent states. These predictions differ from those made by an *Aktionsart*-based approach, which predicts that only temporally overlapping continuations will occur for both kinds of states and that they will occur equally for both, because they are states, after all. Table 1 provides a summary of these competing predictions.

TABLE 1
Predictions Made by *Aktionsart*-, Iconicity-, and Expectation-Based Models of Temporal Update, When the First Sentence Describes Temporary and Permanent States (as in Experiment 1) or Simple and Complex Events (as in Experiment 2)

	Predictions for Experiment 1	
	Basis of Predictions	
	Aktionsart	*Narrative Expectations*
No movement	Permanent = temporary	Permanent > temporary
Forward movement	Permanent = temporary	Temporary > permanent
Backward movement	Permanent = temporary	Temporary > permanent
	Predictions for Experiment 2	
	Basis of Predictions	
	Iconicity	*Narrative Expectations*
No movement	Complex = simple	Complex > simple
Forward movement	Complex = simple	Simple > complex
Backward movement	No prediction	No prediction

Temporal update patterns are predicted to occur more on the state/event type on the left of the inequality symbol more often than the ones on the right.

Methods

The first three experiments make use of the story-continuation paradigm. In this production task, participants are asked to provide natural continuations to experimentally manipulated context sentences. Responses are annotated for whether the narrative time was moved or not. It should be pointed out that even though the data are generated through participants' production, the results are interpreted from the perspective of comprehension. This paradigm first requires participants to comprehend the prompts before producing a continuation. By manipulating experimentally what participants have first to comprehend, we can examine whether our experimental manipulations on context sentences have an effect on participants' discourse continuations. In line with Arnold (2001), Rohde (2008), and Rohde, Levy, and Kehler (2011), story-continuation data can be interpreted as an off-line indirect indicator of participants' mental representations after comprehending the context sentence. Although it is possible that participants may generate mental representations and entertain discourse continuations they never express, it is reasonable to assume the discourse continuations they *do* express reflect participants' mental representations that are most activated by the time they finish comprehending the prompt sentences.[2]

Participants. Forty-eight native English speakers from the University at Buffalo population participated in this experiment and received partial course credit.

Materials. Eighty experimental sentence prompts were constructed.[3] Prompts used two sets of verbs: temporary states (e.g., *crave*, *require*) and permanent states (e.g., *love*, *trust*); these are exemplified in Table 2. There were 10 verbs per set, selected using Ismail's (2001) definition of temporary and permanent states. Because of the scarcity of verbs that meet Ismail's criteria, all 20 verbs were used in four different scenarios each. Scenarios were normed for permanence judgments by asking a separate group of 64 native English speakers from the University at Buffalo, who received partial course credit for their participation, to judge the permanence of state verbs using a seven-point Likert scale, with 1 being very temporary (i.e., *The time is 12:01 PM*) and 7 being very permanent (i.e., *Whales are mammals*). Two example scenarios were presented to anchor the end points of the scale. Permanent states were judged as more permanent than temporary states ($U = 307050.5$; $p < .001$).

[2]As an anonymous reviewer correctly points out, the story-continuation paradigm provides only an indirect means of examining temporal update processes, and paradigms that tap onto online behavioral measures (as used in Experiment 4) are ultimately needed to fully investigate expectation processes on temporal update.

[3]Test items used in all experiments can be found in at http://bit.ly/1ss8FcC.

TABLE 2
Examples of Materials Used for Sentence Continuation Tasks in Experiments 1–3 and the Self-Paced Reading Task in Experiment 4

	Example Stimuli for Experiment 1
Temporary states	The baby required a vaccination.
	Alex craved spicy chicken wings.
Permanent states	Andy loved science fiction movies.
	Claire trusted her bank.
	Example Stimuli for Experiments 2–3
Simple events	William picked up his tennis racket. (Then, ...)
	Joshua buttoned his coat. (Then, ...)
Complex events	Washington DC reduced the rate of violent crime. (Then, ...)
	The research hospital tested the new vaccine. (Then, ...)
	Example Stimuli for Experiment 4
Simple events	Mary poured water in a glass. After a few seconds$_{short}$/weeks$_{long}$, she drank it.
Complex events	The hospital collected DNA sample from AIDS patients. Several minutes$_{short}$/months$_{long}$ later, they tested them and analyzed the data.

Prompts described temporary and permanent states in Experiment 1 and simple and complex events in Experiment 2. Experiment 3 used identical materials with the addition of the forward-moving temporal connective *then*. Materials for Experiment 4 used the simple and complex events used in Experiments 2–3, followed by a second sentence describing an event that is plausible to happen next. Temporal connectives describing both short and long temporal intervals connect both sentences.

These scenarios were distributed across four different lists; each participant only saw a verb once. Each list contained 20 sentences that described either a temporary or permanent state. Sentences were presented in random order, as a simple active sentence in the past tense.

Procedure and data coding. Participants were instructed to write what they believed was a natural continuation for each sentence, writing the first eventuality that came to mind. They were instructed to treat each item separately. We elicited 960 responses, which were annotated by two trained judges (the first author and a research assistant who was naive to the goal of the experiment) for coherence relations holding between the eventualities described by the sentence prompts and the elicited continuations, following a procedure similar to one described in Rohde (2008). Coherence relations impose temporal constraints, for example, discourses where a relation of *Occasion* or *Result* holds must move the narrative time forward, as the second clause describes what happens next or as a result, whereas an *Explanation* relation implies that the narrative time moves backward, as the second clause describes a cause (Kehler, 2002). Judges determined temporal movement patterns by looking at the coherence relations as well as any temporal expressions that may have been present in the continuations. Judges coded the data independently. Inter-rater agreement was 78.8% ($\kappa = .7$). Judges resolved disagreements through discussion, following Stevenson, Crawley, and Kleinman (1994) and Rohde (2008). Judges did not agree on 18 responses (1.8% of the total responses) that were therefore deemed ambiguous; these items were discarded. Forty additional responses (4% of the total responses) were removed because the responses were invalid (i.e., participant didn't follow directions) or blank. Analysis was conducted on the remaining 902 data points.

Results

Table 3 summarizes the number of responses according to type of temporal movement. A two-way chi-square analysis showed the distribution of temporal update differed as a function of state type, $\chi^2(2) = 113.76$, $p < .001$. Binary logistic mixed-effects regressions were conducted for each temporal category. All three tests revealed that state type was a significant predictor of temporal update patterns: Continuations holding narrative time static were less likely after temporary states than permanent states ($b = -1.46$, odds ratio [OR] = .23, $z = -8.65$, $p < .001$). In contrast, continuations moving narrative time forward or backward were elicited more by temporary states than permanent states ($b = 1.17$, OR = 3.22, $z = 6.49$, $p < .001$; and $b = .7$, OR = 2.01, $z = 3.89$, $p < .001$, respectively).

Discussion

Experiment 1 was designed to test whether participants are only sensitive to the state/event distinction when producing narrative continuations or are sensitive to more fine-grained semantic properties, such as whether a state is temporary or not. We observed that permanent states lead to more discourse continuations that hold narrative time static, whereas temporary states lead to more continuations

TABLE 3
Raw Counts of Elicited Responses Grouped According to Temporal Movement and State Type for Experiment 1 and Temporal Movement and Complexity Type for Experiment 2

	Forward	*Backward*	*Static*
	Experiment 1: temporary and permanent states		
Permanent states	63	101	287
Temporary states	155	166	130
	Experiment 2: simple and complex events		
Simple events	414	203	156
Complex events	304	177	314

that move the narrative time. These results demonstrate that participants do not exclusively rely on the coarse-grained difference between states and events when updating narrative time while generating discourse continuations. The salience of a state's temporal boundaries can also influence whether the narrative time is moved or not, even when *Aktionsart* is controlled for.

These results suggest the possibility that readers make use of the differences between temporary and permanent states (i.e., the fact that temporary states are transient). Temporary states (but not permanent states) have salient boundary points, and it is possible the salience of these boundaries biases readers to evoke situations that either started or ended the state. In terms of temporal update, situations that start or end a state move the narrative time backward or forward, because causes typically occur *before* the situations they cause and effects typically occur *after* the situation that caused them. Because boundary points are not evoked for permanent states, readers are less likely to think about what happened before or after permanent states. Hence, elicited continuations are more likely to describe situations that temporally overlap, usually by providing added information about the state described by the context sentences. These continuations hold the narrative time static.

Results from Experiment 1 refine the predictions of *Aktionsart*-based theories of temporal update. Although the intuition behind *Aktionsart* is correct, the event/state dichotomy is too coarse-grained to capture differences in temporal movement patterns. An *Aktionsart*-based approach to temporal update predicts that only overlapping continuations will occur irrespective of the type of state and that they will occur equally across conditions. Experiment 1 shows that the event/state distinction is not the only relevant distinction when deciding to move narrative time or not. Instead, readers distinguish *within* states and are aware of more fine-grained properties of the described eventuality, in particular whether or not it evokes salient temporal boundaries. These results support an expectation-based approach to temporal update: Readers seem to be sensitive to more fine-grained properties of states and, as a result, generate predictions about how the discourse will unfold (cf. Rizzella & O'Brien, 2002; Yekovich & Walker, 1986).

EXPERIMENT 2: DIFFERENCES IN SCENE COMPLEXITY CAN OVERRIDE ICONICITY

Experiment 2 tests another general principle of temporal update, Iconicity. Iconicity-based theories predict that by default, narrative time moves forward and to a moment in time that immediately follows the eventuality described by the current sentence (Dowty, 1986; Zwaan, 1996). In contrast, a narrative-expectation-based approach predicts that discourse information can lead readers to expect movement of narrative time in some cases but no movement in others. More precisely, differences in the properties of the events described are predicted to modulate the strength of the Iconicity default. Just as Experiment 1 showed that not all state descriptions are created equal when it comes to temporal update, the goal of Experiment 2 is to show that not all event descriptions are created equal either. To test this prediction, Experiment 2 makes use of the difference between two event types: *simple* and *complex*. In this and the remaining experiments, we define *simple* events as events involving single agents and having relatively short temporal duration (e.g., *William picked up his tennis racket*) and *complex* events as events involving collective or multiple agents, having relatively long temporal duration, and having salient subevents (e.g., *Washington DC reduced the rate of violent crime*). Crucially, only complex events in our stimuli had multiple or collective agents, took a longer time to complete, and had salient subevents. In this and the following experiments, we use the terms *simple* and *complex* simply as proxies for the just mentioned criteria. We leave the validation of an explicit *measure* of event complexity to another venue.

What is critical for our purposes is that an expectation-based approach to temporal update predicts that the differences we manipulated in our simple versus complex event descriptions would lead to differences in the degree to which readers/narrators are willing to violate Iconicity. This is because the extended duration of complex events, the salience of subevents, and the multiple agents make it easier for the subsequent sentence to *elaborate* on the situation described in the first sentence (see Asher and Lascarides, 2003) by providing more detailed information about that situation (including some of its subevents) rather than moving narrative time forward. Conversely, we expect simple events to lead to more forward motion of narrative time, because the short temporal duration as well as the absence of subevents make it harder to elaborate on the aspect of the situation described in the first sentence. Finally, we assumed there would be no significant differences in the propensity to move the narrative time backward across both conditions, because neither event type has salient properties that would bias readers to expect the next sentence to describe a situation preceding the current situation. Table 1 summarizes these predictions.

Methods

Participants. Twenty-four native English speakers from the University at Buffalo population participated in the experiment and received partial course credit. None participated in Experiment 1.

Materials. Seventy-two experimental scenarios were used. Each scenario was either a *simple* or *complex* event; these are exemplified in Table 2. Scenarios were normed for temporal duration by asking a separate group of 57 native

English speakers from the University at Buffalo, who had not participated in Experiment 1 and who received partial course credit for participation, to estimate their temporal duration. Participants provided durations as responses to open-ended questions (e.g., *How long does it typically take a person to pick up a tennis racket?*). Responses were categorized into temporally ordered groups. *Complex* events were judged to take a longer time to complete than *simple* events ($t = 22.89$; $p < .001$). Sentences were presented in random order in a single list as a simple active sentence in the past tense.

Procedure and data coding. Instructions and data annotation procedures were identical to those for Experiment 1. We elicited 1,728 continuations. Interjudge agreement before discussion was 74.5% ($\kappa = .9$). Judges did not agree on 34 responses (1.9% of the total responses) that were therefore deemed ambiguous; these items were discarded. One hundred twenty-six additional responses (7.2% of the total responses) were removed because the responses were invalid (i.e., participant didn't follow directions) or blank. Analysis was conducted on the remaining 1568 data points.

Results

Table 3 summarizes the number of responses according to type of temporal movement. A two-way chi-square analysis showed that the distribution of temporal updates differed as a function of scene complexity, $\chi^2(2) = 71.45$, $p < .001$. Binary logistic mixed-effects regressions were conducted for each temporal category. Two tests revealed that scene complexity was a significant predictor of the pattern of temporal update: Continuations holding narrative time static were more likely after complex events than simple events ($b = .94$, OR $= 2.58$, $z = 8.22$, $p < .001$), whereas continuations moving the narrative time forward were more likely after simple events than complex events ($b = -.62$, OR $= .53$, $z = -6.06$, $p < .001$). Finally, scene complexity did not affect the likelihood of continuations featuring backward movement of narrative time ($b = -.21$, OR $= .80$, $z = -1.84$, $p = .065$).

Discussion

Experiment 2 was designed to test the hypothesis that differences in scene properties (e.g., single vs. multiple agents and event duration) can lead readers to generate discourse continuations whose temporal pattern deviates from the default Iconicity. Continuations holding the narrative time static were observed to be elicited more frequently after complex events than simple events, demonstrating that differences in various scene properties can bias readers toward expecting temporal update patterns that override Iconicity.

Iconicity is easier to violate when the context sentence describes events that have multiple/collective agents and have long durations, because readers can elaborate on aspects or parts of these long, complex events in ways they cannot when the event is simple and short and elaborations do not move narrative time forward.

EXPERIMENT 3: DIFFERENCES IN SCENE COMPLEXITY CAN VARY THE MAGNITUDE OF TEMPORAL UPDATE

Experiment 2 shows that differences in event complexity can lead readers to violate defaults imposed by Iconicity. Because complex event descriptions made the option of elaborating on the previous situation more salient, readers were more likely to prefer upcoming discourse that describe elaborations and hold the narrative time static, overriding Iconicity. However, even after complex event descriptions, readers provided many continuations that moved the narrative time forward. The question is whether complex events can lead readers to violate *strong* Iconicity more than simple events can in that case too. Dowty (1986) stipulates that the narrative time (reference time, in Dowty's terms) of a sentence S_i is interpreted to be a time that *immediately follows* the narrative time of the previous sentence S_{i-1}, unless there are temporal adverbials that say otherwise. Experiment 3 investigates whether complex event descriptions lead readers to violate that strong Iconicity assumption.

Whereas Experiment 2 showed that scene complexity can cause readers to expect the narrative time not to be moved, Experiment 3 aims to determine whether the size or magnitude of the temporal interval by which narrative time is moved can be affected by scene complexity. We predict that contrary to the predictions of strong Iconicity, readers will expect the narrative time of situations that follow complex events to be more temporally removed from the previous situation than the narrative time of situations that follow simple events. In other words, we predict that scene complexity can affect the reader's notion of what counts as *immediately after*, that is, that what counts as *immediately after* may not be a matter of absolute chronological distance. The temporal location that counts as *immediately after* may be a few seconds later after simple events but a few months later after complex events. *Immediately after* is relative and varies with the temporal granularity of the described eventuality: We predict that the magnitude of the interval by which the narrative time was moved would differ as a function of event complexity, such that the interval between the situations described by the current and previous segments would be larger if the previous situation is a complex event than if it is a simple event.

Methods

Experiment 3 uses a story-continuation task, followed by a temporal estimation task. To determine the size of the temporal interval between the current and previous situations, a story-continuation paradigm forcing forward movement of narrative time was used. Participants were forced to say what happens next, by including a *then*, ... in the prompt, as well as explicitly instructing them that their continuations should reflect what they believe will happen next. When this task was completed, participants had to complete a second task, estimating the time that elapsed between the end of the first event (as described by the prompts) and the beginning of the second event (as described in their continuations). The goal of the second task was to elicit a direct measure of the size of the temporal interval by which narrative time is moved forward by readers.

Participants. Fifty-six native English speakers from the University at Buffalo participated in the experiment and received partial course credit. None participated in Experiments 1 and 2.

Materials. Materials were identical to those in Experiment 2, differing only in that the connective *then,* ... was used to force a continuation describing what happened next. Sentences were divided into four lists, each containing 18 randomly presented items.

Procedure and data coding. Instructions for the continuation task were similar to those in Experiments 1 and 2, the only difference being the instruction to write the first natural continuation that came to mind that described *what happens next*. Participants then estimated how much time elapsed between the events described in the prompt sentences and the events they described in their continuations. There were a total of 1,008 elicited responses. Temporal responses were grouped into nine different ordered groups and was fitted to a nine-point scale, depending on the temporal unit that was given in the response: 1 = *immediately/less than a second*, 2 = *seconds*, 3 = *minutes*, 4 = *hours*, 5 = *days*, 6 = *weeks*, 7 = *months*, 8 = *years*, and 9 = *decades or longer*. No responses used a smaller temporal unit but would typically be described using a larger temporal unit (e.g., for an interval of 2 years, all the responses were *2 years* instead of *24 months* or *104 weeks*). Seven responses (less than 1% of the total responses) were ambiguous (e.g., *ongoing* or *yesterday*); these were discarded.

Results

The remaining 1,001 data points were analyzed using a proportional odds logistic regression model (Agresti, 2007) to test whether the magnitude of forward temporal motion differed as a function of scene complexity.[4] The model revealed that the distribution of the sizes of temporal intervals between prompts and continuations differed as a function of event complexity ($t = 21.29$, $p < .001$). Participants were likely to describe events occurring after smaller intervals (i.e., preferred intervals were measured in seconds) after simple events ($M = 2.39$, $SD = .74$) and to describe events occurring after larger intervals (i.e., preferred intervals were measured in weeks) after complex events ($M = 6.69$, $SD = 1.46$). Figure 1 shows the distribution of temporal interval size between the situations described by prompt sentences and by the participant-provided continuations.

Discussion

Experiment 3 was designed to test the hypothesis that the size of the temporal interval between the current and the previous situation differs as a function of the complexity of the situation described in the first sentence. We observed that descriptions of complex events bias readers to expect the narrative time to move forward by larger intervals (e.g., a few months later), whereas descriptions of simple events bias readers to expect the narrative time to move forward by smaller intervals (e.g., a few seconds later).

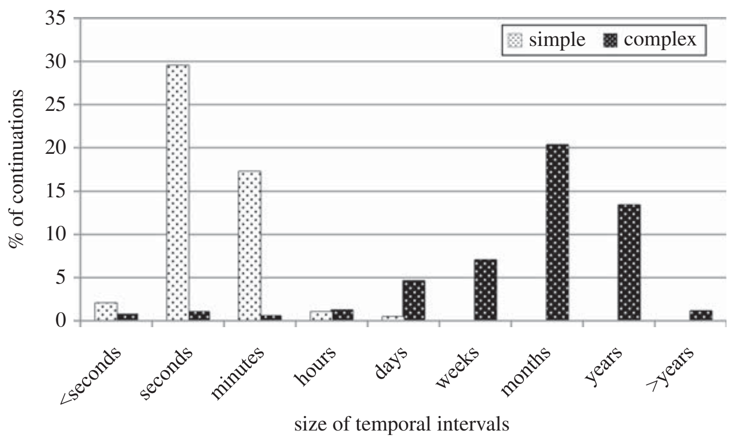

FIGURE 1 Distribution of size of temporal intervals between eventualities described in the continuations and the previous discourse segment in Experiment 3.

[4]This type of regression is capable of modeling nonparametric yet ordinal data, such as temporal units, where one can order temporal phrases with respect to size (*seconds* are smaller than *minutes*, which are in turn smaller than *hours*, etc.), but one cannot assume that the distances between each resulting group are equal.

Partee (1984) and Dowty (1986), after Kamp (1981), state that the reference time of sentence S_i is interpreted as a time which is *immediately after* the reference time of the previous sentence S_{i-1} (at least when the narrative time moves forward). The results of Experiment 3 suggest that what counts as "immediate" is influenced by the granularity of the narration. Because complex events last longer, their effects are longer lasting and may not even be seen for a while. So, whereas the effect of picking up a tennis racket (e.g., the ability to hit the ball) becomes clear just as the event finishes, the effect of cleaning up an oil spill (e.g., a safer environment for animals) might not be immediate. To the extent the "next" event to be described is often related to the effect of the previous event, complex events are predicted to bias participants to produce continuations that describe events taking place after longer intervals than simple events. Thus, the size of narrative time forward motion is predicted to be partially dependent on the complexity of the event described by S_1: The size of the interval between the event described by S_1 and the event described by the upcoming discourse segment tends to be larger when the scene described by S_1 is more complex.

EXPERIMENT 4: CONGRUENCE EFFECTS IN NARRATIVE TIME SHIFTS

The goal of Experiment 4 was to demonstrate that moving narrative time by a large interval does not always result in increased processing cost. As a reminder, principle-based approaches to temporal update predict increases in processing cost when the relevant principle is violated. The *Event-Indexing Model*, for example, predicts that narratives where narrative time is moved by a large interval are always harder to process (Zwaan & Radvansky, 1998). This model's prediction stems from the assumption that readers expect described sequences of events to adhere to strong Iconicity and that therefore, two contiguous sentences must describe two contiguous events (Ditman, Holcomb, & Kuperberg, 2008; Dowty, 1986; Zwaan, 1996). Discourses where narrative time must be moved by a large interval violate this strong Iconicity assumption and therefore lead to a processing cost.

In contrast, our narrative-expectation-based approach predicts that moving the narrative time by large intervals is not costly per se. Rather, processing cost is incurred if the interval size by which narrative time is moved is incongruent with the reader's expectations about *when* the event about to be described would occur. The notion that the reader has an active role in narrative comprehension is not new: It was previously demonstrated that readers' expectations about a narrative's temporal properties can also be guided by top-down reader-driven preferences pertaining to how a story should unfold (Rapp & Gerrig, 2002, 2006). In our study, because Experiment 3 suggests that complex events bias readers to expect large intervals between events, whereas simple events bias readers to expect small intervals between events, a processing cost should be incurred only when a dispreferred interval is encountered (i.e., when a large interval follows a simple event description or when a small interval follows a complex event description).

Methods

We used a moving-window self-paced reading task to examine the effects of different temporal update biases associated with simple and complex events in online discourse comprehension. The stimuli from Experiments 2 and 3 were adapted to create a 2 × 2 experiment that varied two levels of scene complexity and temporal size, as exemplified in Table 2. The temporal connective and the subject of the following clause were the regions of interest. Given the results of Experiment 3, we predicted a congruence effect to emerge sometime after reading the temporal connective. For first sentences describing simple events, faster reading times were expected in short interval conditions than in long interval conditions. The reverse pattern is expected when the first sentence describes a complex event. Hence, we predict an interaction of scene complexity with size of temporal interval. In contrast, the Iconicity-based approach predicts that temporal updates involving longer intervals *always* result in longer reading times (a main effect of temporal interval).

Participants. Thirty-nine native English speakers from the University at Buffalo participated in the experiment and received partial course credit. None participated in Experiments 1 through 3.

Materials. Twenty-eight discourse items were selected from the materials of Experiment 2, each consisting of two consecutive sentences separated by a forward-moving temporal connective. The first sentence described either a *simple* or *complex* event. All sentences had the form of a simple active sentence in the past tense. The second sentence described a plausible next event, created using story continuations collected in Experiment 3. The temporal connective belonged to one of two interval conditions (*short* and *long*), indicated by the temporal unit appearing in the temporal connective. The temporal units used for the short temporal connective condition were *seconds* and *minutes*, whereas the long temporal connective condition used *weeks* and *months*. To obscure any systematicities in the experimental items, multiple forms of the temporal connective were used: *after a few* [temporal unit], *several* [temporal unit] *later*, *after several* [temporal unit], and *a few* [temporal unit] *later*.

This 2 × 2 factorial design resulted in congruent and incongruent conditions: Temporally congruent conditions were either simple events followed by short intervals or complex events followed by long intervals. Temporally incongruent conditions were created by switching the interval size. Incongruence was only signaled by the temporal connective. If the connectives were deleted or if it was replaced with an interval-neutral connective (e.g., *then*), the two sentences would constitute a plausible discourse.

We used 56 distractors that resembled the experimental items as much as possible. They consisted of two sentences, each describing an event, and were linked with nontemporal connectives. Half of the distractors described infelicitous event sequences to discourage participants from forming strategies as they proceeded through the experiment. Participants were instructed to read normally, making sure they understood the complete discourse. Reading times were recorded for each region.

Additional model predictors. We included in the model the probability of the continuations being an elaboration of the first sentence, which was estimated from the results of Experiment 2. This predictor was included because elaborations typically do not move narrative time forward. If S_2 is an elaboration of S_1, then it is typically the case that both segments describe the same event, but the elaboration describes it from a different perspective or at a different level of detail (Kehler, 2002). An elevated reading time after encountering a temporal connective signaling that the narrative time was moved forward could also result from readers expecting the discourse to elaborate on the first sentence and *not* move the narrative time forward. Hence, an elevated reading time may be due to a violation of this expectation and not to an incongruently long or short interval. The probability of an elaboration was included in the model to account for this possibility. Because this probability is correlated with scene complexity (i.e., there were more continuations that provided elaborations and did not move the narrative time forward after complex events in Experiment 2), the elaboration probability was residualized against scene complexity. Hence, this predictor reflects the influence of the probability of elaboration on reading times once scene complexity is taken into account.

Procedure. The participants' task consisted of reading, at their own pace, two sentences presented region-by-region, through a moving window display (Just, Carpenter, & Woolley, 1982). Programming and presentation of the experimental stimuli was done using E-Prime (Psychology Software Tools, Pittsburgh, PA). Each trial began with a sequence of dashes representing all the nonspace characters in the sentences. Pressing the space bar caused the dashes corresponding to the first region to be replaced by words. Subsequent bar presses revealed the next region, whereas the previous region reverted to dashes. Reading times between each pair of button presses were recorded. After half of the distractor items, a comprehension question was presented and participants made a yes or no response that was recorded. At the start of the experiment, participants were asked to read instructions that described the task. Then they completed eight practice trials to familiarize themselves with the task. The experiment immediately followed the practice trials. Each session lasted approximately 20 minutes.

Results

The mean percentage of correct responses for the comprehension questions was 86.6%, suggesting that participants paid attention to the task. We excluded reading times that were less than 100 ms and more than 1,500 ms long, because these data presumably do not reflect natural reading behavior. This procedure resulted in the removal of 55 data points for the region corresponding to the temporal phrase and 19 data points for the spillover region corresponding to the subject noun phrase of the second clause (5% and 1.7% of the data points for the temporal phrase and the spillover region, respectively).[5] Data points that were greater or less than 2.5 standard deviations from each participant's mean were replaced with these boundary values.

To compensate for the influence of region length on reading time, analyses were performed on residual reading times, which were computed by subtracting from the actual reading time for a region the reading time predicted by a regression equation (computed separately for each participant, using all regions in the experimental and distractor items) relating word length to reading time (Trueswell, Tanenhaus, & Garnsey, 1994). Residual reading times account for individual differences in reading speed among participants. Table 4 shows residualized reading times for the temporal phrase region and the spillover region.

We used a linear mixed-effects regression analysis, with subjects, items, and lists as random effects, to test whether incongruent temporal phrases took longer to process than congruent temporal phrases (Baayen, 2008; Bates, 2005; Bates, Maechler, & Bolker, 2011). The temporal connective and the subject of the second clause were analyzed. There were two categorical predictors (levels in parentheses, with the reference level in italics): scene complexity (simple, *complex*) and temporal size (short, *long*). The probability of an elaboration continuation as estimated in Experiment 2 was a numeric predictor. The interaction between scene complexity and temporal size was also included in the

[5]Following Mitchell (1984), Vasishth and Lewis (2006), and others who report that reading time effects can also appear in the regions immediately after the critical region, the spillover region is included in the analysis, particularly because the temporal connective region in this experiment varies considerably in length.

TABLE 4
Residualized Reading Times and the Fixed-Effect Structure of the Regression Models for the Temporal Connective and the Subject of the Second Clause in Experiment 4

Reading Times (ms)

	Event Type			
	Simple		*Complex*	
Region	*Short*	*Long*	*Short*	*Long*
Temporal connective	352	350	396	390
Subject of second clause	371	383	390	362

Model Summaries

	Estimate	*SE*	*t*	*p*
	Temporal connective			
(intercept)	371.85	16.06	23.16	
Complexity	43.22	30.32	1.43	.154
Temporal size	−3.47	14.72	−.24	.814
Probability of elaboration	7.53	15.2	.49	.621
Complexity × temporal size	−5.09	29.44	−.17	.863
	Subject of second clause			
(intercept)	378.8	18.12	20.91	
Complexity	2.91	26.4	.11	.912
Temporal size	−9.75	10.59	−.92	.357
Probability of elaboration	.75	13.28	.06	.955
Complexity × temporal size	−45.99	21.18	−2.17	.0301*

Subjects, items, and lists are random effects.
*Predictors that reached significance.

model.[6] All predictors were centered, and elaboration probability was residualized against scene complexity.

Temporal phrase. The model incorporated three random-effect factors: a by-subject adjustment to the intercept ($SD = 32.97$), a by-item adjustment to the intercept ($SD = 70.13$), a by-list adjustment to the intercept ($SD = 0$), and the

[6]Interactions that would have involved the probability of an elaboration continuation were not included in the model. Because the probability of elaboration continuations for all items in the Simple Event condition was zero, there were not enough data points for a model that included interaction with elaboration probability to converge.

residual error ($SD = 236.68$). A summary of the fixed-effect structure can be found in Table 4.

The model revealed no significant effects on the temporal phrase (for all predictors, $|t| < 2$). However, there is evidence that discourse-level processes can be delayed (Rayner, Warren, Juhasz, & Liversedge, 2004), prompting us to analyze the spillover region, corresponding to the subject region of the second clause.

Subject of the second clause. The model incorporated three random-effect factors: a by-subject adjustment to the intercept ($SD = 73.5$), a by-item adjustment to the intercept ($SD = 63.98$), a by-list adjustment to the intercept ($SD = 5.62$), and the residual error ($SD = 173.26$). A summary of the fixed-effect structure can be found in Table 4.

The probability of an elaboration was not significant ($t = .06$). Hence, reading time differences were more likely to be caused by a violated expectation pertaining to the size of the temporal update, rather than a violation of an expectation that the upcoming discourse segment would be an elaboration of the previous situation.

The model also revealed no significant main effects of scene complexity or temporal size (for both predictors, $|t| < 2$). However, there was a significant interaction between scene complexity and temporal size ($\beta = -45.99$, $t = -2.17$, $p = .0301$). For simple events, reading times were longer in the long interval condition than in the short interval condition (370 ms vs. 382 ms). However, the reverse pattern was observed for complex events. Reading times were longer in the short interval condition than in the long interval condition (390 ms vs. 362 ms). A simple-effects analysis testing the effect of interval size revealed that although the 12-ms difference in the simple event condition was not statistically significant ($t = .91$), the 28-ms difference in the complex event condition was ($\beta = -33.22$, $t = -2.08$, $p = .0378$), suggesting the significant interaction is primarily driven by the complex event condition. Contrary to previous findings, readers did not systematically prefer short temporal conditions over long temporal conditions (Ditman et al., 2008; Zwaan, 1996). Instead, the opposite was observed for complex events: Longer intervals were preferred over shorter intervals. It should be pointed out that a crossover interaction was not observed, suggesting that long intervals after simple events are less incongruent than short intervals after complex events. It seems easier to imagine a *plausible* situation following a simple event after a long interval than a plausible situation following a complex event after a short interval.

Discussion

Experiment 4 was designed to test the hypothesis that moving narrative time by large temporal intervals only leads to processing costs if the long intervals are incongruent with readers' expectations. We predicted and confirmed that simple events bias readers toward expecting a subsequent event that is temporally contiguous, whereas complex events bias readers toward subsequent events that are not temporally contiguous. Processing cost occurs only in cases where readers encounter temporal information that is incongruent with these biases. These results support the view that processing difficulty in reading temporal phrases in narratives is due to incongruence with readers' expectations rather than the presence of a large temporal interval between two event descriptions per se.

These results are inconsistent with principle-based approaches to temporal update that appeal to strong Iconicity (e.g., Dowty, 1986; Zwaan, 1996). If readers assume by default that subsequent discourse segments relate subsequent and contiguous events, then a general preference for shorter temporal intervals should have been observed, irrespective of scene complexity. The fact that reading times were higher after shorter intervals than after longer intervals for complex events suggests that readers generate expectations about how the event described by the upcoming discourse segment relates temporally to the previously described event. These expectations are likely to be due to their long-term prior knowledge about these events and narratives: how long events take to complete, what types of events are likely to follow, and when these subsequent events occur given the previous event. The exact nature of prior knowledge that causes the difference we observed remains the goal of future research, however. As we used the opposition between *simple* and *complex* events only as proxies for several orthogonal situation properties, we cannot be sure which property or properties are directly influencing readers' behavior, although we know from prior research that there is evidence for the interactivity across the various text dimensions that readers monitor (cf. Levine & Klin, 2001; Rapp & Taylor, 2004) and that readers are likely to be monitoring the difference between human agents and organization/nonhuman entities as well as their actions and goals (Zwaan & Radvansky, 1998). However, and crucially for our purposes, the congruence effect we observed suggests that readers use their prior knowledge of situations to generate expectations of how the discourse will unfold.

GENERAL DISCUSSION

Understanding discourse involves building a representation of a sequence of situations from a sequence of sentences. One important component of building such a representation is locating temporally the situation each sentence describes. Thus, readers must decide where the narrative is at temporally, that is, decide whether narrative time should move or not; if it is to move, whether it should be moved forward or backward; and finally by how much it should be moved. Traditional accounts of this process have assumed that speakers rely on very general principles, at least by default, and use these principles as guides when updating narrative time. Two such principles have been proposed, one based on *Aktionsart*, the other on Iconicity. The first principle relies on a very general distinction between states and events. The second assumes that narration is "transparent" in that the structure of narrative time mirrors the structure of real time. In this article, we propose another view of temporal update, according to which readers (1) pay attention to more specific properties of situations than the mere distinction between events and states and (2) are aware of the "opacity" of narration, that is, that narration as an activity imposes constraints of its own on narrative time (e.g., that there can be gaps between the narrative times of the situations described by two adjacent sentences).

The four experiments we report compared the traditional approach with the approach we advocate. The results of Experiments 1–3 showed that states as well as events do not behave uniformly when it comes to temporal update. Experiment 1 demonstrated that some states evoke their temporal boundaries, biasing readers to expect movement of narrative time. Experiment 2, on the other hand, showed that although readers typically adhere to Iconicity as a default and expect forward movement of narrative time, complex events lead readers to expect the upcoming discourse to violate this default more often and hold the narrative time static instead. Additionally, Experiment 3 demonstrates that when narrative time is indeed moved forward, the size of the temporal interval by which narrative time is moved forward also depends on the complexity of the situation that has just been described. Readers expected larger temporal intervals to follow complex events and smaller intervals to follow simple events. Finally, Experiment 4 shows that readers have a harder time processing discourses that are incongruent with the temporal expectations associated with simple and complex events.

Overall, our results suggest the need to at least refine our understanding of the role of general principles like *Aktionsart* and Iconicity in discourse understanding. An approach to temporal update based solely on *Aktionsart* is too coarse to be a good predictor of temporal update, and default principles stemming from Iconicity tend to be violated more in discourse describing complex situations than ones describing simple situations. More generally, our results suggest that instead of general default principles based on *Aktionsart* and Iconicity, readers are sensitive to more fine-grained properties of described situations such as the salience of boundaries for temporary states, as well as differences in event duration and between single and collective agents (Carreiras et al., 1997; Zwaan & Radvansky, 1998).

Theories of temporal update that do not take into account the role of the narrator's or audience's prior knowledge would be hard pressed to explain the results from Experiments 3 and 4. For example, Iconicity-based theories simply state that in moving the narrative time forward, it is moved to a point *immediately after* the end of the event described by the previous sentence (Dowty, 1986;

Zwaan, 1996). Experiment 3 suggests the notion of *immediacy* differs as a function of the complexity of the event described by the previous sentence: What counts as *immediately after* for complex events can differ from what counts as immediately after for simple events. In other words, the notion of *immediately after* is relative; *a few seconds* may count as immediately after for simple events, but *a few weeks* is immediately after for complex events. Additionally, Experiment 4 suggests that not all temporal shifts lead to processing costs. Although previous research has shown that temporal update is effortful (i.e., increased reading times indicate difficulty; cf. Radvansky & Copeland, 2010), we show that only incongruent shifts lead to difficulty in processing, reducing cohesion (Scott Rich & Taylor, 2000) and causing a break in local coherence (Hakala & O'Brien, 1995). Dowty's (1986) Temporal Discourse Interpretation Principle can only account for this observation if the narrator's prior knowledge is taken into consideration. Prior knowledge is what accounts for the fact that what counts as *immediately after* can differ as a function of the kinds of properties that underlie our distinction between simple and complex situations.

Finally, our results suggest a more active view of discourse comprehension than is sometimes assumed. In constructing mental representations of the unfolding narrative, readers activate their prior knowledge associated with the situation being described and generate expectations about how the narrative will unfold. Part of this prior knowledge includes information about what situations would be described next and the temporal relationship between these situations and the situation previously described. Thus, readers seem to do more than monitor temporal change in narratives. Because readers are more active and engage in predicting what will be described next, we surmise that, contrary to the predictions of the Event-Indexing Model, movement of the narrative time does not always incur a processing cost (Zwaan, Langston, & Graesser, 1995; Zwaan & Radvansky, 1998). Processing cost only arises when the discourse unfolds in a way that contradicts readers' narrative expectations, suggesting an adequate model of discourse comprehension must include some top-down mechanisms to appropriately model the role of readers' expectations about *what comes next* in discourse understanding.

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