Transitive and periphrastic sentences affect memory for simple causal scenes

Melissa Kline[1] (mekline@mit.edu)

Paul Muentener[1] (pmuenten@mit.edu)

Laura Schulz (lschulz@mit.edu)
Department of Bran and Cognitive Sciences, MIT
77 Massachusetts Avenue
Cambridge MA 02139

Abstract

Can linguistic structures influence how people perceive and remember causal events? Using a change-detection method, we presented participants with direct causal scenes paired with either transitive (*He stretched the toy*) or periphrastic sentences (*He made the toy stretch*.) Participants then viewed movies with changes to the manner of action (stretching the toy with palms up vs. down), the result (stretching it a shorter vs. longer distance), or no change. Participants judged whether the two movies were identical. Reading periphrastic sentences made people more likely to notice a change in manner than a change in result. Reading transitive sentences had the reverse effect – participants were more likely to notice changes in result. This work provides an important advance in our understanding of how rich conceptual representations map into the grammatical structures of language. We discuss how this novel method can provide insight into the nonlinguistic representations recruited by particular sentence structures.

Keywords: Causal language; event structure, change blindness, memory and language

Introduction

How do speakers map between richly structured event representations and structured linguistic descriptions? For many kinds of events, speakers have a wide range of options. A speaker who sees a boy breaking a window with a baseball can choose to say: "The window broke"; "The boy broke the window"; "The boy broke the window with a baseball"; "The boy broke the window with a baseball during a Little League game" or, if the event was unintentional, "The boy accidentally broke the window." Each of these choices selectively highlights some aspects of the event (the result, the cause, the manner, the context, the intent, etc.) perhaps at the cost of neglecting others ("The boy broke the South Rose window of Notre-Dame"). Many theories of verb argument structure and event representation have been proposed to explain the conceptual primitives that might underlie these descriptions (Gleitman 1990; Jackendoff 1990; Levin & Rappaport-Hovav 2005; Pinker 1989; Talmy 1985).

Although all of these sentences describe the same actual occurrence, how the speaker represents the event will influence the type of description chosen. Conversely of course, the way an event is described influences how people represent it. Fausey and Boroditsky (2010) showed for instance that listeners were more likely to attribute blame and financial responsibility to the perpetrator of a causal event following agentive descriptions ("He broke the vase") than non-agentive descriptions ("The vase broke"). Other studies of event representations involved in language have focused on generalizations above the level of individual event-description pairings (Fausey and Boroditsky 2011; Lakusta & Landau 2012). For instance, Fausey and Boroditsky show that English speakers are more likely than Spanish speakers to remember the perpetrator of an accidental causal event, even when the events are presented non-linguistically. They suggest that this may be because typical descriptions of accidental causal events in English ("He broke the vase") focus on the agent whereas typical descriptions of accidental causal events in Spanish do not ("*Se rompió el florero",* roughly "the vase broke itself"). However, because this was a purely nonlinguistic task, we cannot conclude whether the memory differences in this study were primarily an effect of these particular sentences, as opposed to other effects of language or culture.

Nonetheless, when different sentences include different components of the event (i.e., by including or omitting reference to the causal agent) it seems evident that linguistic descriptions might influence event representation (and vice versa). However, in some cases, more than one sentence is available even to describe the same components of the event (e.g., "The boy broke the window"/"The boy made the window break").

What nonlinguistic event representations might underlie linguistic distinctions like these? One factor known to influence event descriptions is the *directness* of the causal event. In *direct* causal events, the causal agent immediately impacts the causal patient. By contrast, in *mediated* causal events, the causal agent's action on the causal patient is less direct; for example, acting through an intermediary (e.g., a tool used to bring about the effect).

Work comparing direct and mediated causal events has predominantly examined two types of linguistic structures: lexical causatives and periphrastic causatives. While lexical causatives encode the result in the main verb of a transitive sentence ("The boy broke the window"), periphrastic

[1] The first two authors contributed equally to this work

causatives ("The boy made the window break") are multi-clausal and encode the result in the embedded verb. The exact syntactic differences between these sentence types are subject to the particular linguistic framework used, but the situations under which speakers tend to use each type have been studied extensively. Research has shown that adults both prefer and produce transitive sentences more often to describe direct causal events than mediated events (Wolff, 2003; Song & Wolff 2005).

Here, we look at the impact of specific syntactic structures on adults' memory for events. We examine transitive and periphrastic descriptions because unlike agentive and non-agentive sentences, these two sentence types both encode the causal agent and the result. When both transitive and periphrastic sentences are acceptable, does sentence choice affect participants' visual memory for causal scenes?

We used a change blindness paradigm (Pashler 1988; Simons & Levin 1998; Simons & Chabris 1999) in which we asked participants to report whether a movie changed between the first and second viewing. Our hypotheses concerned the effect that reading different sentences would have on change detection. Wolff (2003) suggests that causal transitive sentences should lead listeners to expect direct causal scenes. Motivated by this hypothesis, we predicted that when viewing intentional, direct causal scenes, participants who read transitive sentences (e.g., "*The boy stretched the accordion"*) would be relatively better at detecting result changes (e.g. stretching an accordion toy a little vs. a lot) and relatively worse at noticing changes in manner (e.g. stretching an accordion toy with hands facing up vs. down). In contrast, since periphrastic (but not transitive) causal sentences can be used to describe mediated causal events, we expected that participants who read these sentences would be better at detecting manner changes.

Experiment

Method

Participants 329 adult participants took part in the experiment, which was conducted on Amazon's Mechanical Turk platform. Participants were screened to be located in the United States and self-reporting as native English speakers. Testing was conducted over several days, and care was taken (by monitoring user ID numbers assigned by

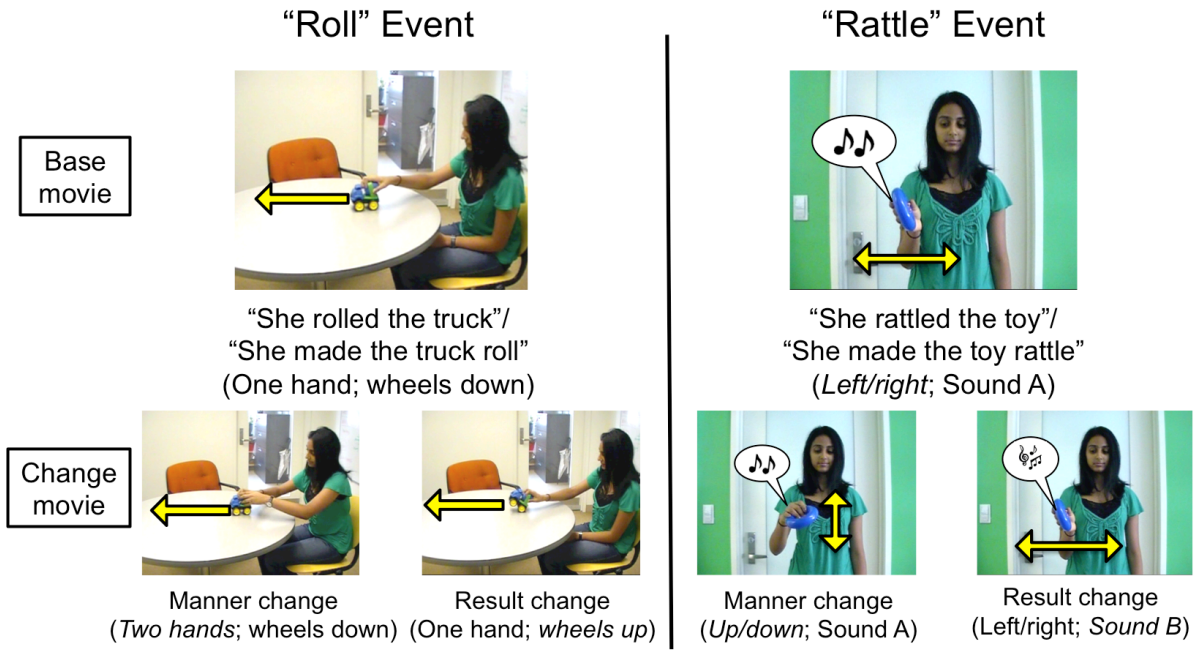

Figure 1. Sample stimuli images from 2 events. Each of 12 events had a base movie and 2 change movies (manner change, result change). In the "Roll" event, the manner change involved the woman switching from using one hand to using two hands. In the result change, the toy truck rolled across the table with its wheels up, rather than its wheels down. In the "Rattle" event, the manner change involved the woman changing the direction she shook the toy ring. The result change involved changing the sound the rattle made. The 10 additional event type triads were Bend, Bounce, Close, Drop, Tip Over, Ring, Rotate, Spill, Spin and Stretch. In addition to the critical movies, all participants received 6 control 'base-movie/no-change' trials (not depicted).

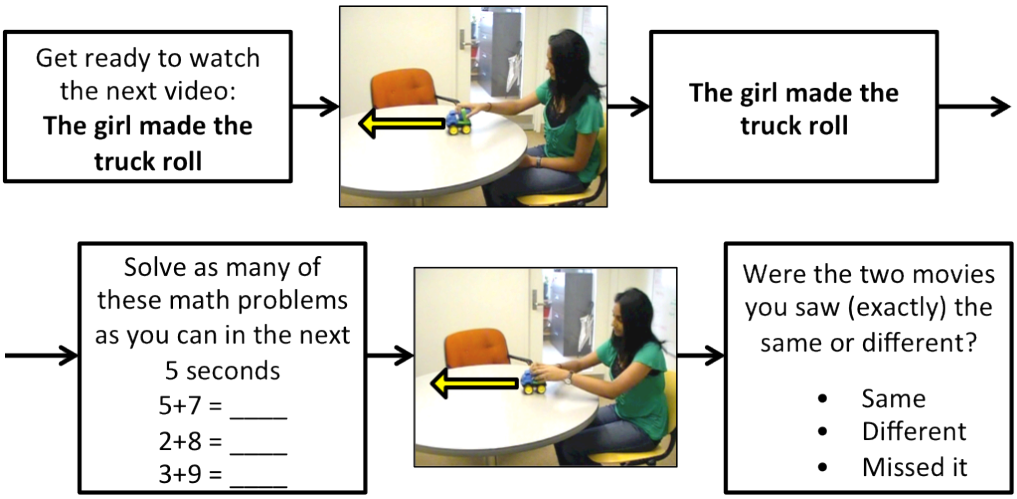

Figure 2. A visual depiction of the procedure for a stimulus (ROLL) in the Periphrastic x Manner-Change condition. Notice how the woman's hands are positioned in each movie. For each experimental trial (n = 12), participants viewed the target sentence followed by a base movie. After a 5-s delay they saw the altered movie followed by the detection question.

Amazon) that participants did not take the survey more than once.

Materials We constructed 12 stimulus movie sets, each based around a simple, intentional causal action that could be described in a simple transitive sentence. Two example stimulus sets are shown in Figure 1, and videos of all stimuli used the experiment are available online at http://mit.edu/~mekline/www/KMS_cogsci13.html. In addition to the base movie, each set included a manner-change version and a result-change version. In addition to the twelve target stimuli, six movies used in a previous study of direct, intentional causal actions (Muentener & Lakusta, 2011) were included as control 'no-change' stimuli.

Stimuli were presented online using the Python package EconWillow (http://econwillow.sourceforge.net).

Procedure Each participant was randomly assigned to one of six conditions, crossing sentence type (Transitive, Periphrastic, Baseline/no sentence) and change type (Manner, Result) in a between-subjects design. To ensure that participants were able to view and hear the movies presented over the Internet, and to check language skills, all participants first watched a movie similar to the experimental stimuli and provided a short description. Participants were informed that they would view pairs of movies and be asked to report whether they were the same or different.

A schematic of a sample trial is shown in Figure 2. On each trial, participants were first instructed to get ready for the next movie, with the target sentence (or no sentence, in the Baseline condition) printed below. Then they saw the base movie for that stimulus – playback controls were disabled so that participants could not watch movies more than once. After reading the target sentence again, participants performed math problems during a 5 second delay. Finally, they viewed a second movie. In the no-change trials, they simply saw the initial movie a second time. In the change trials, they saw the altered version of the movie that was appropriate for their condition (Manner or Result.) Participants were asked whether they thought the second movie was the same or different from the first, and feedback was given after every trial. In total, participants saw 12 change trials and 6 no-change trials.

Results

To ensure that participants were not simply reporting that all movies contained changes, performance on the no-change trials was used as criteria for inclusion in the analysis. 206 participants (mean 34.3 per condition) answered at least 5 of 6 no-change trials correctly and were included in all analyses below.

Figure 3 plots participants' accuracy on change trials. There was a significant Change x Sentence interaction ($F(2, 200) = 4.54$, $p < 0.02$) as well as a significant main effect of Change type ($F(1, 200) = 8.22$, $p < 0.01$.) In the Transitive condition, participants were significantly better at noticing Result changes than Manner changes ($t(75) = 3.53$, $p < 0.01$); this difference was marginal in the Baseline condition $t(63) = 1.74$, $p = 0.086$.) For Periphrastic sentences, there was no difference in accuracy between Manner and Result conditions ($t(62) = 0.61$, $p = 0.55$). As predicted, a planned comparison showed that result changes were detected more often following transitive sentences and manner changes were detected more often following periphrastic sentences ($t(200) = 3.22$, $p < 0.01$).

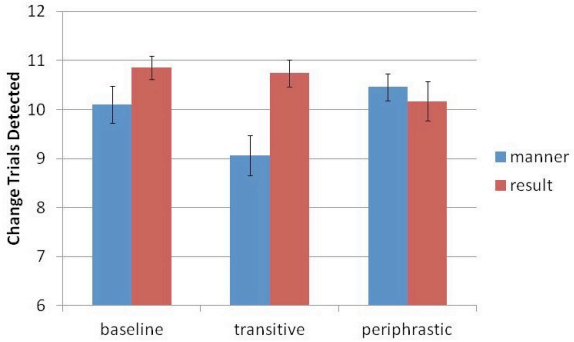

Figure 3. Participants' accuracy on the 12 change trials

Because there was an unanticipated difference in detection rates for the Baseline (no sentence) conditions, we examined detection rates on each of the 12 individual 'change' items. This difference was almost entirely due to just three items where the salience of the manner and result changes were not well matched. For these three items, the result change was easier to detect at baseline than the manner change. (*Close* – $X^2 = 7.79$, $p < 0.01$; *Drop* – $X^2 = 7.61$, $p < 0.01$; *Tip-Over* – $X^2 = 8.90$, $p < 0.01$). To clarify the nature of the differences observed for Transitive and Periphrastic sentence conditions, we removed these three items from subsequent analyses.

Following this removal of salience-mismatched items, the only significant omnibus result was a significant Change x Sentence interaction ($F(1, 200) = 4.14$ $p < 0.02$). Again, the planned comparison was significant: result changes were detected with greater success after reading transitive sentences, while manner changes were detected more often following periphrastic sentences ($t(200) = 2.99$, $p < 0.01$). These results are depicted in Figure 4.

Discussion

As predicted, the choice of transitive or periphrastic descriptions had a marked impact on participants' memory for scenes. Participants who heard transitive sentences were more likely to detect changes in the result of a direct causal event than changes in the manner. Participants who heard periphrastic causal sentences showed the reverse pattern, showing better performance when detecting manner changes. This pattern persisted when three items which were not matched on baseline manner/result salience were removed.

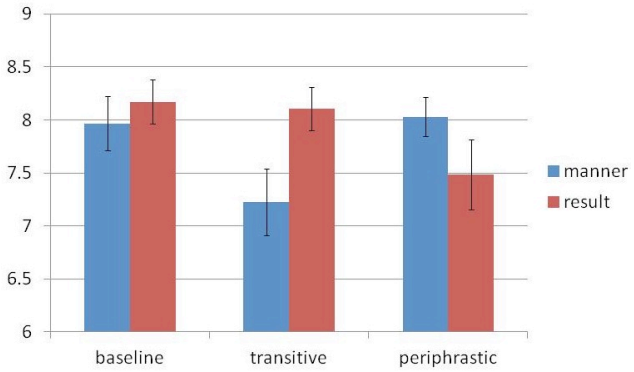

Figure 4. Accuracy on the 9 trials which did not show a significant baseline difference in detection rate between Manner and Result changes.

One concern with these results is that the periphrastic is a less frequent and more complex linguistic description than the transitive. As a result, participants may have simply been more attentive to the events after they were described with periphrastic sentences. Arguing against this interpretation however, participants in the periphrastic conditions were not more attentive to event changes across the board: indeed, they were more likely to neglect result changes. However, to further address this alternative explanation, we are currently investigating participants' memory for manner and result changes when they read other complex or infrequent sentences.

Note that the effect of sentence structure on scene representation in this experiment consists of relative *inattention* to particular change categories. While the manner and result detection rates are different for transitive and periphrastic sentences, the more frequently detected change in each case is statistically identical to the baseline detection rate ($t(63) = 0.96$, $p = 0.34$; $t(79) = 0.23$, $p = 0.82$.) This finding is consistent with the within/between category effect found for color words (Winawer et al 2007.) Russian speakers, who have separate basic color words for light and dark blue (*goluboy* and *siniy*), showed a between-category advantage for color perception. When they were asked to distinguish between color chips that were both *siniy* or both *goluboy*, they showed decreased performance compared to color chips which were equally similar but crossed the naming boundary. English speakers showed no such advantage for dark blue vs. light blue colors.

Together with Winawer et al's study, the current results suggest that event perception helps us identify the conceptual categories that are mapped to particular linguistic structures. When no sentence is presented, both manner and result changes are considered potentially relevant. However, when people read a sentence description, a particular perspective is imposed on their event representation which seems to make some categories important and some less important. For transitive sentences, manner changes which preserve the result (e.g. bending a toy with right vs. left hand, but reaching the same final position) seem to constitute a relatively unimportant difference, and changes are neglected. In contrast, the result of the action is central to the event representation, and participants continue to notice these changes. For periphrastic causal descriptions, the reverse is true: minor changes in the result are seen as relatively unimportant whereas minor changes in the manner are seen as central to the event.

Note that Wolff's theory of causal descriptions suggests that lexical (transitive) causatives are used only for direct causal events, while periphrastics are also used to describe mediated events. Wolff focuses on how people choose between the two sentence types for different scenes but does not make specific reference to how these descriptions affect attention to the manner in which a causal event is brought about. In this study, we are able to extend this work by showing that these descriptions have a specific effect on event perception. Even when considering events that can be described with either type of sentence, participants pay more attention to *how* an event took place after reading periphrastic causal descriptions than after reading transitive descriptions. With this change-detection method, it will also be possible to test other event aspects that have to do with the types of events Wolff has studied, such as changes in instrument or type of agent-patient contact.

Moving beyond causal descriptions, this method can also be used to test other hypothesized correspondences between syntactic structures and particular event features or semantic concepts. After viewing sentence-event pairings, the prediction is that participants will be more sensitive to changes that have to do with the event feature representations that map to the sentence. In contrast, when changes of the same salience are made to event aspects that are *not* central to the sentence-event mapping, participants will fail to notice these changes. Thus, patterns of memory and attention can allow us to discover the specific semantic content of particular sentence types.

This work provides an important advance in our understanding of how rich conceptual representations map onto the grammatical structures of language, a key problem in the study of language and thought. The mapping between language and thought goes in both directions – language provides the tools to describe a wide range of event construals, and in turn, the specific descriptions we use can influence event perception, altering which components of event representations are seen as most important. By testing how memory for events changes when people encounter different types of sentences, we can experimentally discover the underlying event features which structure our cognitive and linguistic representations, and begin to understand how these representations are used in the moment to understand and describe events in the world.

Acknowledgments

This project was supported by funding from National Science Foundation and the John Merck Scholars Fund. Thanks also to Daniel Friel and Tara Venkatesan for their assistance with stimuli creation, and to the entire Early Childhood Cognition Lab at MIT for helpful discussion and feedback.

References

Fausey, C. M., & Boroditsky, L. (2010). Subtle linguistic cues influence perceived blame and financial liability. *Psychonomic Bulletin & Review*, *17*(5), 644–650. doi:10.3758/PBR.17.5.644

Fausey, C. M., & Boroditsky, L. (2011). Who dunnit? Cross-linguistic differences in eye-witness memory. *Psychonomic Bulletin & Review*, *18*(1), 150–157. doi:10.3758/s13423-010-0021-5

Gleitman, L. R. (1990). The structural sources of verb meanings. *Language Acquisition*, *1*, 3–55.

Jackendoff, R. (1990). *Semantic structures*. Cambridge, MA: The MIT Press.

Lakusta, L., & Landau, B. (2012). Language and Memory for Motion Events: Origins of the Asymmetry Between Source and Goal Paths. *Cognitive Science*, *36*(3), 517–544. doi:10.1111/j.1551-6709.2011.01220.x

Levin, B., & Rappaport Hovav, M. (2005). *Argument realization*. Cambridge, UK: Cambridge University Press.

Muentener, P., & Lakusta, L. (2011). The intention-to-CAUSE bias: Evidence from children's causal language. *Cognition*, *119*(3), 341–355. doi:10.1016/j.cognition.2011.01.017

Pashler, H. (1988). Familiarity and visual change detection. *Perception & Psychophysics*, *44*(4), 369–378. doi:10.3758/BF03210419

Pinker, S. (1989). *Learnability and Cognition: The acquisition of Argument Structure*. Cambridge, Mass.: MIT Press.

Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: sustained inattentional blindness for dynamic events. *Perception*, *28*(9), 1059–1074. doi:10.1068/p2952

Simons, D. J., & Levin, D. T. (1998). Failure to detect changes to people during a real-world interaction. *Psychonomic Bulletin & Review*, *5*(4), 644–649. doi:10.3758/BF03208840

Song, G., & Wolff, P. (2005). Linking perceptual properties to the linguistic expression of causation. In M. Achard & S. Kemmer (Eds.), *Language, Culture, and Mind* (pp. 237–250). Stanford, CA: CSLI Publications.

Talmy, L. (1985). Lexicalization patterns: Semantic structure in lexical forms. *Language typology and syntactic description*, *3*, 57–149.

Winawer, J., Witthoft, N., Frank, M. C., Wu, L., Wade, A. R., & Boroditsky, L. (2007). Russian blues reveal effects of language on color discrimination. *Proceedings of the National Academy of Sciences*, *104*(19), 7780–7785.

Wolff, P. (2003). Direct causation in the linguistic coding and individuation of causal events. *Cognition*, *88*(1), 1–48. doi:10.1016/S0010-0277(03)00004-0