NIH Public Access
Author Manuscript
Mem Cognit. Author manuscript; available in PMC 2014 January 01.

Published in final edited form as:
Mem Cognit. 2013 January ; 41(1): 137–151. doi:10.3758/s13421-012-0248-7.

The Psychologist Said Quickly, "Dialogue Descriptions Modulate Reading Speed!"

Mallory C. Stites[1,2], **Steven G. Luke**[4], and **Kiel Christianson**[2,3]

[1]Department of Psychology, University of Illinois, Urbana-Champaign

[2]Beckman Institute for Advanced Science and Technology, University of Illinois, Urbana-Champaign

[3]Department of Educational Psychology, University of Illinois, Urbana-Champaign

[4]Department of Psychology, University of South Carolina

Abstract

The current study investigates whether the semantic content of a dialogue description can affect reading times on an embedded quote to determine if the speed at which a character is described as saying a quote influences how quickly it is read. Yao and Scheepers (2011) previously found that readers were faster to read direct quotes when the preceding context implied that the talker generally spoke quickly, an effect attributed to perceptual simulation of talker speed. The current study manipulated the speed of a physical action performed by the speaker independently from character talking rate to determine if these sources have separable effects on perceptual simulation of a direct quote. Results showed that readers spent less time reading direct quotes described as being said quickly compared to slowly (e.g., *John walked/bolted into the room and said energetically/nonchalantly, "I finally found my car keys")*, an effect that was not present when a nearly identical phrase was presented as an indirect quote (e.g.*, John…said energetically that he finally found his car keys*). The speed of the character's movement did not affect direct quote reading times. Furthermore, fast adverbs were themselves read significantly faster than slow adverbs, an effect we attribute to implicit effects on the eye movement program stemming from automatically activated semantic features of the adverbs. Our findings add to the literature on perceptual simulation by showing that these effects can be instantiated with only a single adverb, and are strong enough to override effects of global sentence speed.

Introduction

When reading a story, readers often have the phenomenological experience of hearing the voices of the characters in their heads. Dating back to Huey (1908), psychology researchers have considered this inner speech to play an important role in reading comprehension (Rayner & Pollatsek, 1989). However, studying the form of the inner voice experimentally has proven difficult. The current study seeks to address one aspect of inner speech, particularly whether the 'speed' of inner speech can be affected by the content of a narrative currently being read, and whether the effect is reflected in the speed of eye movements during silent reading.

The amount of perceptual detail represented during silent reading has recently been the focus of considerable research. It has been shown that at the word level, some phonetic

Address correspondence to: Mallory C. Stites, Department of Psychology, University of Illinois, 603 E. Daniel St., Champaign, IL 61820, Phone: 636.208.5809, stites2@illinois.edu.

aspects of the speech signal are represented during reading. For example, words with more stressed syllables, which take longer to say aloud than words with fewer stressed syllables, receive longer gaze durations (Ashby & Clifton, 2005). In terms of sentence-level prosody, Fodor (2002) proposed the Implicit Prosody Hypothesis, which states that readers generate a default form of prosody that plays a key role in parsing sentence structure, especially for resolving syntactic ambiguities. However, this hypothesis does not address how detailed the default prosody that readers automatically generate is with respect to portions of a text that are not critical choice points in the ongoing parse.

Recent work in the domain of embodied cognition, also known as perceptual simulation (Barsalou, 1999), has provided reasons to speculate that readers may simulate much more detailed representations than those specifically required for parsing, based on the findings that readers mentally simulate physical actions described in a text. For example, when reading verbs describing simple physical actions, readers show increased brain activity in the areas of the motor cortex responsible for controlling those movements (Hauk, Johnsrude, & Pulvermuller, 2004). In addition to brain activity, reading about actions can facilitate one's future performance of those actions, either in terms of broad movement towards or away from the body (Glenberg & Kaschack, 2004), or for quite specific movements involving manual rotation in a particular direction (Zwaan & Taylor, 2008).

Psycholinguistic researchers have extended the perceptual simulation literature to ask which aspects of a story character's linguistic experience are simulated during silent reading. Two recent studies by Klin and Drumm (2010; Drumm & Klin, 2011) showed that readers mentally represent the modality in which information is presented to a story character. They found that when an identical utterance is presented to a character within modalities (i.e. written note and email), participants' reading times on the repeated line are facilitated. However, when the same utterance is presented to the character across modalities (i.e. written note and voicemail), the repetition effect is eliminated, even though both lines were presented to participants visually.

Several recent studies have suggested that readers go beyond modality to also represent the speaking rate of particular story characters, and that representation can in turn affect reading speed. Alexander and Nygaard (2008) showed that after listening to a fast talker, readers were faster to read a passage they were told was "written" by that talker than one they were told was "written" by a slow talker. These effects held in both oral and silent reading, although the effects in silent reading depended heavily on passage difficulty and individual differences in imaging abilities. Additionally, this study could not determine whether readers can generate the talker's speed from text alone, or whether an explicit spoken cue is necessary for the effect.

This work led to the question of whether quotations from a character may also hold special importance for readers and encourage additional perceptual simulation of a character's voice. Yao, Belin, and Scheepers (2011) tested the claim originally made by Clark and Gerrig (1990) that direct speech (e.g. *Mary said, "I'm hungry"*) is more perceptually vivid to readers, because it is a demonstration of what a character actually said, compared to indirect speech (e.g. *Mary said that she was hungry*), which functions simply as a description of the gist of what was said. In an fMRI study, Yao et al. (2011) found that brain activation in voice-selective areas of the auditory cortex was greater while participants read direct speech versus indirect speech. These findings suggest greater perceptual simulation of the direct speech acts during silent reading. To follow up, Yao and Scheepers (2011) investigated how an implicit description of a story character's speaking rate modulates online reading speed of direct compared to indirect quotations. The protagonists' speech rate was implied by a three-to-four sentence passage preceding the speech act that set up a context in which the speaker would plausibly be expected to speak quickly or slowly (see Table 1a for an example). The quoted line was held constant across the four contexts (fast or slow speaker, and direct or indirect speech act). Interestingly, they found that readers spent less time reading direct quotes said by fast-talking story characters than slow-talking ones, but found no differences between reading times for these same characters' indirect speech. These findings suggest that readers were using contextual information to perceptually simulate a character's voice while reading, and that this representation of the fast-talkers' speaking rates modulated the speed of their eye movements.

The current study extends the intriguing findings of Yao and Scheepers (2011) in the following ways. First, we seek to understand the nature of the context that is necessary to produce perceptual simulation effects. In the materials used by Yao and Scheepers (2011), readers received multiple implicit cues, spread over several sentences, indicating that a particular character would more plausibly speak faster or slower. Given this stimulus configuration, it is possible that readers need multiple exposures to speaking rate cues, and/or sufficient time, to build an internal representation of a character that includes his or her likely speech rate. The spacing of the implicit cues over several sentences allowed the expectation of speech rate to build up over the passage preceding the direct quotation, so that readers could activate their previously constructed character representation when they encountered a direct quote, and no explicit speed adverb was necessary to induce perceptual simulation of talker speed. The current study probes whether readers require this gradual build-up of context information about a character in order to produce perceptual simulation on direct quotations, or if only one explicit speed-related adverb immediately preceding a direct quote can produce similar perceptual simulation effects. We address this question by embedding direct (Experiment 1) and indirect (Experiment 2) quotations in sentences that are immediately preceded by an adverb describing the speed at which they were uttered (see Table 1b and 1c for example stimuli). We seek to understand whether the semantic content of a speed-related adverb can integrated during online reading to generate perceptual simulation of a direct quote immediately following the adverb itself, even as quickly as the very next fixation following the adverb. This marks an interesting distinction from Yao and Scheepers (2011), who showed that readers can apply previously constructed expectations about character talking rate to perceptually simulate direct quotes, but not whether they can initiate perceptual simulation mere milliseconds after receiving a speed-specific adverb.

Secondly, we ask whether readers perceptually simulate the speed at which physical actions are performed by a character, and whether a conflict between the speed of physical action being performed and the rate at which a quote is being uttered might produce different effects from when these two speeds coincide. Given the evidence that readers activate motor programs involved in actions they read about (Glenberg & Kaschack, 2004; Zwaan and Taylor, 2008), it remains an open question whether readers' eye movements are sensitive to any type of fast or slow action being performed by characters in a sentence, or whether the perceptual simulation effects observed by Yao and Scheepers (2011) might be limited to only linguistic actions. For example, in the sentence *John walked <u>into the room</u>*, will readers read the phrase *into the room* faster if it was instead preceded by the verb *bolted* rather than *walked*? Furthermore, we ask whether the speed at which a character performs an action has an effect on quote reading times later in the sentence, particularly if the speed of the action conflicts with their speaking rate. For example, in the sentence *John <u>bolted</u> into the room and said <u>energetically</u>, "I finally found my car keys,"* the speeds of the action verb (*ran*) and talking-rate adverb (*energetically*) are congruent. Compare this to the sentence, *John <u>bolted</u> into the room and said <u>nonchalantly</u>, "I finally found my car keys,"* in which the speed of the action verb (*bolted*) conflicts with that of the talking-rate adverb (*nonchalantly*). In the present stimulus set, we fully cross the speed of the action verb (fast or slow) with the speed of the talking-rate adverb (fast or slow). If perceptual simulation effects seen on quote reading times simply reflect the summation of the effects from speed-related words seen in the preceding context, we would expect to see larger effects of perceptual simulation when the character is moving and speaking at the same rate, and weaker effects when these two cues are incongruent. On the other hand, if perceptual simulation reflects simulation of the speech act alone, then only those words in the preceding context pertaining to the character's speaking rate (i.e. the adverbs) should affect reading times on the direct quote region. This physical action manipulation marks another major departure from the stimuli used by Yao and Scheepers (2011), in which implicit cues were consistent with each other in terms of speed. Thus, our stimulus set can begin to tease apart whether eye movements can serve as indicators for perceptual simulation of physical actions, whether the perceptual simulation effects observed by Yao and Scheepers (2011) are limited to direct speech acts, and if these two possible forms of simulation interact.

We predict that if readers can use the semantic content of dialogue descriptions to simulate talker speed, we will see faster reading times for the entire quote region for direct quotes described as being said quickly relative to those described as being said slowly. This result would provide evidence that readers are using the adverbs' semantic content online to guide their perceptual simulation of talker speed, and that this simulation can modulate eye movements to reflect the character's speaking rate over the duration of the quote. If, on the other hand, the semantic content of the adverb affects reading speed in a more implicit way (i.e., by temporarily accelerating or suppressing eye movements without inducing perceptual simulation *per se*), then we might expect to see effects of the adverb's speed on only the next word following the adverb without lasting effects over the duration of the direct quote. Additionally, we predict that if readers also perceptually simulate the speed at which a character performs a physical action, we may see faster reading times on the prepositional phrase immediately following a fast action verb relative to a slow one (i.e. *John bolted <u>into the room</u>…*). If the speed of the action performed interacts with the character's talking rate on quote reading times, we would expect to see the fastest reading times for quotes that are said quickly by a fast-acting character, the slowest reading times for quotes said slowly by a slow-acting character, and intermediate reading times when these two factors are incongruent (i.e., a fast-acting character speaking slowly or a slow-acting character speaking quickly). By manipulating these two factors independently, we can answer whether the semantic content of an adverb can be used online to affect perceptual simulation of direct versus indirect quotes, whether physical actions might also be subject to perceptual simulation effects, and whether action speed and character talking rate have interactive effects on the perceptual simulation of direct quotations.

Experiment 1

Methods

Materials—Critical sentences described a character who performed an action and then said a quote (e.g., *John <u>walked/bolted</u> into the room and said <u>energetically/nonchalantly</u>, "I finally found my car keys."*); see Appendix A for a full list of stimulus materials. Two factors were independently manipulated: the main verb describing action verb speed (e.g., *walked* / *bolted* above), and the adverb describing the talking rate (e.g., *energetically* / *nonchalantly*), both of which could have either a fast or a slow meaning. Verb and adverb speed were independently manipulated in order to determine if there are separable effects of verb speed (describing the physical action) and adverb speed (describing speaking rate). These materials allowed us to examine three critical regions of interest: the direct quote, the adverb, and the post-verbal prepositional phrase (see Figure 1). Twenty-four sentence frames were created that could appear in four conditions (fast verb/fast adverb, fast verb/slow adverb, slow verb/fast adverb, slow verb/slow adverb), creating a total of 96 items.

Every subject saw all 24 sentence frames in only one condition, and saw six of these items in each speed condition.

The average lengths of the fast (9.50) and slow (8.79) adverbs were compared in a paired-samples t-test. Pairings were determined by comparing the two adverbs that alternated appearing across different versions of an item (i.e. *energetically* and *nonchalantly* in Item 1; see Appendix), so that an adverb appeared in the test once for every item in which it was used (nine adverbs were used once, 18 adverbs ere used twice, and one adverb was used three times). The paired-samples t-test showed that the lengths of the fast and slow adverbs did not differ significantly, $t(23) = 0.69$, $p = .50$. The frequency of the fast (17.38 per million, taken from the CELEX database [http://celex.mpi.nl/]) and slow (26.63 per million) adverbs also did not differ significantly in a similar paired-sample t-test, $t(23) = -0.96$, $p = .35$. Furthermore, the adverbs did not differ in the number of syllables in the fast (3.42) and slow (3.21) groups, $t(23) = -0.62$, $p = .54$. The critical quote region varied from 4–7 words (mean = 5.83). Even though these regions differed in length between items, the same 24 quotes were seen in all four conditions, such that the differences in reading times between the four conditions could be attributed to the verb and/or adverb preceding it.

Participants—Sixty-eight University of Illinois undergraduates participated for course credit or $7. All were native speakers of English, with normal or corrected-to-normal vision.

Apparatus—Eye movements were recorded via an SR Research Ltd. Eyelink 1000/2000 eye tracker, which records the position of the reader's eye once every millisecond (1000 Hz sampling rate), and has a high spatial resolution of 0.01°. Text was displayed in 12 point Courier New font. Participants were seated 69 cm away from a 20-inch monitor. At this distance, approximately 3.5 characters subtended 1° of visual angle. Head movements were minimized with chin and head rests. Although viewing was binocular, eye movements were recorded from the right eye.

Procedure—After signing informed consent, each participant's eye movements were calibrated using a 9-point calibration screen. In the testing session, each trial involved the following sequence: trials began with a gaze trigger, consisting of a black circle presented in the position of the first character of the text. Once a stable fixation had been detected on the gaze trigger, the sentence was presented in full. The participant pressed a button on a standard game controller to indicate that s/he had finished reading the sentence. At this point, the sentence disappeared. After this, a question about the content of the sentence appeared, which participants answered by pressing the appropriate button on the controller. The question never asked about the content of the critical quote region. Then, the next trial began. Sentences were presented in a random order for each participant. In addition to the 24 experimental trials, each list contained 148 other sentences with a variety of structures, all of which were also followed by comprehension questions.

Data Analysis—Within the Eyelink 1000 data analysis package, consecutive fixations shorter than 80 ms and less than 0.5° apart were merged into a single fixation, while other fixations shorter than 80 ms were deleted from analysis. In addition, fixations longer than 1200 ms were also deleted from the analysis because these typically indicate track loss. For the direct quote region, less than 1% of trials were excluded due to track loss or skipping; for the individual adverb analyses, 5.9% of the trials were excluded due to readers skipping the adverb.

Results

Overall accuracy on the comprehension questions was 95.1%, which showed that participants were paying attention to the sentences. We had no *a priori* predictions about how verb or adverb speed would affect comprehension question accuracy, and as such, further analyses will not be discussed.

The eye-tracking data for both Experiments 1 and 2 were analyzed using linear mixed effect models (Baayen, Davidson, & Bates, 2008), in order to model the random effects of subjects and items together in a single analysis. Models were created using the *lmer()* function of the *lme4* (Bates, Machler, & Dai, 2008) package in R (R Core Development Team, 2011). Because the quotations differed in length, residual reading times were used as the dependent measure, as advocated by Trueswell, Tanenhaus, and Garnsey (1994). Residual reading times were calculated by fitting a separate linear mixed model for each reading time measure, with length (in characters) of the region as the fixed effect and with random intercepts and slopes for each participant. (Note that although analyses were performed on residualized reading times, raw reading times are reported in all tables for ease of interpretation; analyses performed on raw reading times yielded no patterns of significant differences from analyses of residualized reading times.) Using the residual reading times, different models were fit for each reading time measure using restricted maximum likelihood resimation (REML) through the *lme4* package in R. Models included the fixed effects of verb speed and adverb speed (which were contrast coded), as well as random intercepts for subjects and items[1]. Only interactions that were significant ($p < .05$), as determined by using Markov chain Monte Carlo sampling, were retained in the models.

Reading measures for the entire quote region will be examined first. Because the quote region was always sentence-final, our definitions of these measures will vary slightly from standard usage. Reading measures included first fixation duration on the region, gaze duration on the region (the time spent reading the region before either regressing to the left, or ending the trial if no regressions were made), go-past time (which included all time from when the eyes first entered the region until subjects ended the trial, including regressions to earlier parts of the sentence), and total reading time on the region (excluding regressions).

Examining reading times on the direct quote region, illustrated in Table 2, both first fixation durations and gaze durations were unaffected by adverb speed (see Table 3 for model output). However, there was a marginal effect of verb speed, such that both of these measures were numerically longer for quotes following slow relative to fast action verbs. On the other hand, go-past times and total times on the direct quote were significantly longer when the quote followed a slow adverb relative to a fast adverb. Preceding verb speed did not have an effect on go-past or total times, nor did it interact with adverb type on any of the reading measures considered (all *p*s > .61). These results indicate that the speed at which a quote is described as being "said" in the text significantly influenced how quickly that quote was read, with readers spending less time reading quotes described as being said quickly than those described as being said slowly.

[1]In order to avoid the risk of inflated type-1 errors that could be associated with using random intercept-only models, at a reviewer's suggestion, we re-ran every model using the maximal random effects structure justified by our design (i.e., with random slopes for every fixed effect and interaction, for both subjects and items). These models produced no changes of significance for any of the measures. The maximal models were clearly overfitted, with large correlations between the random slopes and intercepts, so we next used likelihood ratio tests to fit the random slopes in a stepwise fashion, as recommended by several experts in the field (Baayen, Davidson & Bates, 2008; Baayen, 2008; Jaeger, 2008). This also did not change the significance of any of the measures. Each stepwise model had a slightly different random effects structure, making reporting cumbersome, so for the sake of clarity we report the intercept-only models here.

Given the effect of adverb speed on go-past and total times for the direct quote region considered as a whole, we next separated the quote region into its individual words to examine whether the effect of adverb speed was present at all quote positions. This analysis was designed to rule out the possibility that the effect on quote reading time may have been driven by reading time for just the first word of the quote. This pattern would be expected if automatic activation of the adverb's semantics simply accelerated or suppressed eye movements temporarily, affecting reading times on the word immediately following the adverb, but without enduring effects. If this were the case, we would expect adverb speed to interact with sentence position, which would indicate that the effect of adverb weakened as the quote progressed.

We limited the scope of this analysis to total time, in order to focus on the perceptual simulation effects just for fixations occurring within the quote region, whereas go-past time includes fixations to all earlier parts of the sentence, including those that occurred outside of the quote region. All quotes were sentence-final, meaning that in this case total time is equivalent to selective go-past time (because there is no sentence region following the quote for readers to move into). Because the quotes ranged from four to seven words, and wrap-up effects are present on sentence-final words (which were also the quote-final words; Just & Carpenter, 1980), we extracted the last word from every quote and grouped these together in a quote-final bin. Thus, every quote contributed words to the first three bins as well as the final (7th) bin, leaving unequal numbers of items contributing to quote positions 4–6 (bin 4: 23 items, bin 5: 17 items, bin 6: 4 items). However, linear mixed models are robust to unequal cell counts (Baayen et al., 2008), so these analyses still serve to answer the intended question. The sentence positions were dummy-coded, so that each was compared to the quote-initial word position.

Analyses revealed that adverb speed did not interact with any sentence position, indicating that the effect of adverb speed was not driven by any single word position within the quote (all *p*s > .50). However, there was a significant effect of adverb speed when the total time for each word of the quote was included individually, $p < .01$, showing that the effect of adverb speed was distributed over the entire quote region. The speed of the preceding action verb did not affect reading time at any position, $p = .56$. These results show that the effect of perceptual simulation was present over the entire quote region, rather than being driven by any particular word of the quote (see Figure 2). Additionally, certain quote positions exerted a significant effect (positions 2, 4 and 5, $p < .001$), indicating that they were read significantly longer than the quoteinitial word. This result is tangential to our main question, however, and importantly does not detract from the significance of the adverb effects.

In addition to the quote region, reading times for the individual adverbs were analyzed to determine how quickly their semantic content comes online and affects eye movements. All reading time measures were residualized on adverb length in the manner descried above. Centered adverb frequency was used as a continuous predictor to test for effects of adverb frequency on reading time effects as well. Additionally, one fast adverb was excluded from the analyses due to a spelling error in the materials. Results revealed that for all four measures, there was a significant effect of adverb speed, indicating that reading times on slow adverbs were significantly longer than those on fast adverbs (see Table 4 for output). Interestingly, this finding goes against what might be expected if reading times were determined by adverb frequency alone, as the fast adverbs were numerically (although nonsignificantly) less frequent than the slow adverbs. The speed of the preceding action verb did not affect reading times on any measure considered. Furthermore, for gaze duration and total time, adverb frequency significantly interacted with the effect of adverb speed, indicating that the effects of adverb speed were reduced for adverbs of higher frequency. However, even with the interaction in the model, the main effect of adverb speed was still significant. These findings suggest that the semantic content of the adverbs did not only affect reading times on the following quote region, but came online quickly enough to affect reading times even on the adverbs themselves.

Because action verb speed exerted a weak effect on the first fixation and gaze duration to the quote region, but not on later measures or adverb reading times, the possibility remains that the action verb could have induced some level of perceptual simulation that later became swamped by the effects of adverb speed. If this was the case, then we might expect to see similar effects of perceptual simulation on the prepositional phrase directly following the action verb, because it continues to describe the action being carried out (i.e. *John walked into the room*), making it plausible that readers might perceptually simulate this action, which could affect their eye movements to this phrase as well. However, when similar models were constructed for reading times on these prepositional phrases (again using residualized reading times), no effects of action verb speed were found (all ps> .15). Thus, action verb speed did not induce readers to perceptually simulate the action it described, at least not in a way that affected their eye movements.

Discussion

The results of Experiment 1 revealed that an explicit description of a character's speaking rate can affect reading times on a direct quote from that character, as indicated by shorter go-past times and total reading times on quotes following a semantically "fast" adverb than a semantically "slow" adverb. These results replicate and extend the findings of Yao and Scheepers (2011), who also found effects of perceptual simulation on go-past times for the entire quote region, providing additional evidence that readers create detailed perceptual simulations of direct speech acts during silent reading. Interestingly, the effect of the action verb speed on direct quote reading times was marginal, and limited to measures on which there were no effects of adverb speed. For the measures on which adverb speed did exert an effect – go-past and total times—action verb speed was not significant and did not interact with adverb speed. This finding suggests that the speed at which a character is performing an action may have a subtle effect on direct quote reading times, but it is outweighed by the effect of explicit adverb speed. As a better test of whether the action verb encouraged perceptual simulation, we examined reading times on the post-verbal prepositional phrase that described the action being performed. We found no reading time effects on this phrase as a function of action verb speed, suggesting that readers were not perceptually simulating the action (or if they were, it did not affect their eye movements).

The results of Experiment 1 also show that readers do not require an extended context over which they can construct expectations about character talking rate in order to produce perceptual simulation effects. Rather, the semantic content of a single speed-specific adverb can be integrated during online language comprehension to generate perceptual simulation of talking rate for a direct quote. This effect was present over all quote positions, not just the first word following the adverb. The semantic content of the adverb also affected reading times on the adverb itself, with semantically "fast" adverbs being read faster than semantically "slow" adverbs. However, there is one caveat to this conclusion. In Experiment 1, the adverb was always followed by a direct quote. The fact that the adverb's effect comes online so quickly and has such a strong impact leaves open the possibility that simply reading a speed-specific adverb may implicitly accelerate (or suppress) eye movements for the remainder of the sentence, regardless of whether it is followed by quoted speech or not. This possibility, together with the findings fromYao et al. (2011) and Yao and Scheepers (2011) that readers represent direct speech acts in a perceptually more vivid manner than indirect speech, naturally provides the motivation for Experiment 2. The next step is to ensure that the observed effects on the direct quote are in fact perceptual simulation and not an artifact of an accelerated or suppressed motor program after seeing a fast or slow adverb, respectively. This can be accomplished by showing that the effect on quote reading times is not present when the speed-specific adverb is followed by indirect speech. In Experiment 2, direct quotations in the materials for Experiment 1 were replaced by nearly identical sentential complements describing the same idea expressed as an indirect quotation. For example, the sentence *John bolted into the room and said energetically, "I finally found my car keys"* was replaced with the sentence *John bolted into the room and said energetically that he finally found his car keys*. In this way, we can determine if the speed effects on the quote region observed in Experiment 1 were caused by perceptual simulation of the quoted speech, in which case we would not predict speed effects on the indirect quotes in Experiment 2, as perceptual simulation would not need to take place for an indirect speech act. On the other hand, if the speed effects on the direct quote are simply an artifact of implicitly accelerated or suppressed eye movements following a speed-specific adverb, then we would predict speed effects similar to those from Experiment 1 on the indirect quote in Experiment 2 as well.

A second motivation for Experiment 2 is to further test the unexpected effects of adverb speed on adverb reading times with a different group of participants. One possibility for this effect, as expressed above, is that the semantic features of the adverb quickly come online to affect eye movements. It could also be the case that adverb reading times were affected by their semantic content only because they preceded a direct speech act. In other words, when the adverb precedes a direct quote, is it very likely that readers simultaneously process the visual cues highlighting the fact that a direct quote is coming up (i.e. __,"___). When readers receive these cues, they might start ramping up their voice-related representations in anticipation of the upcoming information (Kukona, Fang, Aicher, Chen, & Magnuson, 2011). An interesting test of the effects on adverb speed will be to see whether they are still present when the adverb precedes an indirect quote, which would suggest that they stem from automatically activated semantic features of the adverb. Alternatively, if these effects were being driven by the perceptual simulation of the upcoming quoted material, we would expect these effects on adverb reading speed to be reduced or eliminated in the presence of indirect speech.

Experiment 2

In Experiment 2, indirect quotes were embedded in sentences nearly identical to those in Experiment 1, in which the indirect quotes were descriptions of speech said by a character who was moving either quickly or slowly. By manipulating action speed separately from character speaking rate before indirect speech, we attempt to disentangle the effects of implicit effects on the eye movement program stemming from automatic activation of the adverbs' semantics from the effects of perceptual simulation of speech during silent reading.

Methods

Materials—The critical sentences were nearly identical to those in Experiment 1, with the important difference that in Experiment 2, the speech was represented as an indirect rather than direct quotation (e.g., *John walked/bolted into the room and said energetically/ nonchalantly that he finally found his car keys*). The 24 items from Experiment 1 were altered to change the direct quotes to indirect quotes (see Appendix B for a full list of stimuli). Both main verb and adverb speed were again independently manipulated, creating four versions of each experimental item (fast verb/fast adverb, fast verb/slow adverb, slow verb/fast adverb, slow verb/slow adverb), resulting in a total of 96 different sentence frames. Every subject saw all 24 items in only one condition, and saw six of these items in each speed condition.

The critical quote region varied from 5–8 words (mean = 6.83), but as in Experiment 1, the same 24 quotes were seen in all four conditions, such that the differences in reading times between the four conditions can be attributed to the verb and/or adverb preceding it. In addition to the 24 experimental items, subjects saw 122 other sentences with varying syntactic structures, for a total of 146 items overall.

Participants—Forty-four University of Illinois undergraduates participated for course credit or $7. All were native speakers of English and had normal or corrected-to-normal vision. None had participated in Experiment 1.

Apparatus and Procedure—Same as Experiment 1.

Data Analysis—As in Experiment 1, fixations shorter than 80 ms and less than 0.5° apart were merged into a single fixation, and other fixations shorter than 80 ms or longer than 12000 ms were deleted from analysis. Less than 1% of the trials containing indirect quotes were excluded due to track loss or skipping; for the individual adverbs, 4.8% of trials were excluded due to track loss or because the reader skipped the adverb.

Results

Overall accuracy for the comprehension questions was 95.5%, indicating that subjects were attentively reading the experimental items. As in Experiment 1, we did not have *a priori* predictions about the effect of verb or adverb speed on comprehension question accuracy.

Reading measures on the entire indirect quote region were examined first (listed in Table 5). The measures used were first fixation duration, gaze duration, go-past time, and total time; all measures were defined the same as in Experiment 1. Data were again analyzed using linear mixed effect models, (Baayen et al., 2008), and were constructed in the same manner as in Experiment 1. For reading times on the entire indirect quote region, results revealed that adverb speed did not have an effect on first fixation, gaze duration or total time, (see Table 6 for model output), nor were there any interactions with verb speed (ps > .22). These findings differ from Experiment 1, in which effects of adverb speed on go-past and total times were observed, suggesting that the readers in Experiment 2 were not perceptually simulating talker speed for indirect quotations. However, different from Experiment 1, there was a significant effect of adverb speed on gaze durations, indicating that readers spent *more time* reading sentences following fast relative to slow adverbs. The current results are in the opposite direction from what would be predicted by perceptual simulation. Generally, results support the idea that readers were not perceptually simulating the indirect quotes. When total times were examined for each position of the indirect quote region, we found no effect of adverb speed ($p = .71$) nor any interaction with quote position (ps > .11). This result reveals that at no point over the indirect quote did adverb speed exert a significant effect on total reading times. This finding differs from the results in Experiment 1, in which adverb speed did have a significant effect when the individual words of the quote were considered separately.

We also examined reading times on the adverbs themselves to see if the effects seen on adverb reading times in Experiment 1 replicated to a different group of subjects in a different reading environment (i.e., preceding indirect as opposed to direct quotes). For all measures, there were significant effects of both adverb speed and adverb frequency (see Table 7), but no significant effects of preceding verb speed and no significant interactions (all ps > .06). Results show that reading times on fast adverbs were significantly shorter than reading times on slow adverbs. Additionally, reading times on high frequency adverbs were shorter relative to lower frequency adverbs, although frequency did not interact with the effects of adverb speed. These findings replicate those seen in Experiment 1, providing further evidence that the semantic content of an adverb can affect reading times on the adverb itself, even when the adverb is not seen in the context of a direct quote.

Even though reading times over the entire indirect quote region were unaffected by adverb speed, we wanted to rule out the possibility that the adverb may have exerted weaker perceptual simulation effects in the presence of an indirect quote that may have extended only into the spillover region of the adverb (i.e., the first word of the indirect quote). These phrase-initial words are particularly interesting, because in all 24 items adverbs were directly followed by function words (71% *that*, 21% *if*, and 8% *where*), which lack rich semantics of their own and thus may be more susceptible to exhibiting spillover effects from the adverb. Model outputs indicated that for all reading measures, there was no effect of adverb (ps > .29) or verb (ps > .29), and no interaction between the two (ps > .10). Thus, even though reading times on the adverbs themselves were affected by their semantic content, these effects did not extend into their spillover region, further suggesting that readers were not perceptually simulating the indirect quotes.

Finally, as in Experiment 1, we wanted to test the possibility that readers might perceptually simulate the action described in the prepositional phrase following the action verb. If perceptual simulation was taking place over this phrase, we would expect to see shorter reading times for the phrases when following fast relative to slow main verbs. However, as in Experiment 1, we found no evidence that the speed of the main verb affected any of the four reading measures considered (all ps > .37).

Discussion

Overall, reading times for indirect speech in Experiment 2 showed that readers were not perceptually simulating the indirect quotations, as there were no effects of adverb speed over the quote region. These findings are consistent with those of Yao and Scheepers (2011), who also found faster reading times on direct, but not indirect, quotes attributed to speakers with a faster implied speaking rate. The speed effects were still present on the adverb itself in Experiment 2, however, indicating that the reading time differences on the fast and slow adverbs also observed in Experiment 1 were likely due to automatic activation of the adverb's semantics that implicitly affected fixations on the adverb, and not the ramping up of voice-related representations in anticipation of a direct quote. Because the effects were isolated to only the adverb and did not extend to the rest of the indirect quotation, we conclude that readers did not perceptually simulate the indirect speech act. Furthermore, no effects of action verb speed were observed on either the indirect quote or on the prepositional phrase directly following the action verb, suggesting that readers also did not simulate the speed at which that action was performed.

General Discussion

The current study found that readers spent less time reading direct quotes described as being said "quickly" than "slowly," but that these effects were not present on a nearly identical region of text when it appeared as an indirect quote. Our findings are consistent with those of Yao and Scheepers (2011), and likewise suggest that readers generate detailed perceptual representations of characters' speech in natural reading. This representation includes the speaking rate of the character and influences the amount of time participants spend reading direct quotes said by that character. Interestingly, speaking rate in the current study was instantiated by a single adverb preceding the quote, rather than a three-to-four sentence passage as in Yao and Scheepers (2011). As such, our study is the first to show that perceptual simulation of character speaking rate can be triggered by a single adverb, and yet still persist throughout the quote. These findings are not only an important theoretical replication of the work by Yao and Scheepers (2011), but they extend those findings by showing that readers do not need to have a previously constructed expectation of character talking rate, created from receiving multiple well-spaced cues to implied talker speed, in order to generate perceptual simulation effects. Rather, readers can integrate information about an adverb's semantic content quickly enough to affect not only eye movements over the direct quote region, but also reading rate on the adverb itself. The speed effects observed on quote reading times in Experiment 1 were not an artifact of implicitly accelerated or suppressed eye movements following the comprehension of a speed-specific adverb, as there were no similar effects on the indirect quotes in Experiment 2, even though they were preceded by the same adverbs. That the effect in Experiment 1 was distributed over the entire direct quote, not just on the first fixation or first word following the adverb, adds further support to the claim that the effect reflects perceptual simulation rather than a simple speeding of the motor program induced by seeing a "fast" adverb.

Notably, in both the current study and in Yao and Scheepers (2011), the speed effects on the quote region were only present on go-past and total reading times. Together, these studies suggest that perceptual simulation may not affect initial lexical access to words in the simulated region (as seems to be the case on the adverbs themselves, since these effects are present even on first fixation duration), but rather exerts its effect in determining how much time is spent upon subsequent, later fixations on the words in the direct quote region, as well as regressions out of the region. It could be the case that on their first pass through the region, readers focus on the fundamental tasks of reading, such as lexical access and syntactic parsing, and that only during later stages of reading do they generate their perceptual simulations and impose the character-specific voice-related representations.

In addition to speed effects observed over the direct quote region, fast adverbs themselves were read significantly faster than slow adverbs on all reading measures considered in both Experiments 1 and 2, which served as an internal replication across two different groups of participants. This finding is unique, as Yao and Scheepers (2011) manipulated speaking rate implicitly, and thus did not use explicit speed-related adverbs directly before their quotations. To our knowledge, the present study is the first to demonstrate that the semantic content of a speed-specific adverb can affect online reading times of the adverb itself. Furthermore, that these effects were present when the adverbs preceded both direct and indirect quotes suggests that they do not represent a ramping up of voice-related representations in anticipation of the upcoming perceptual simulation, but likely stem from a different, more implicit, mechanism. While other factors may be at play in determining reading times on the adverbs (i.e., predictability, degree of speed instantiation, pronunciation rate), our data strongly indicate that when the sentence frame is held constant leading up to the adverb, its semantic features can quickly come online and implicitly affect its reading time.

We also manipulated the speed at which the character performed a physical action in the sentence orthogonally to their speaking rate. This allowed us to ask whether readers might perceptually simulate the speed at which the character performed the action, as well as whether action speed and character talking rate have interactive effects on the perceptual simulation of direct quotations. Results showed that action verb speed did not affect reading times over the subsequent prepositional phrase that described the continuation of the action (i.e. *John walked* <u>*into the room*</u>), suggesting that action verbs did not generate the same type of perceptual simulation effects as those produced for voice representations. This is not to say that those actions were not producing motor resonance of some kind – in fact, many past studies have shown brain activation of areas involved in actions described in text (Hauk et al., 2004), as well as behavioral facilitation for performing actions after reading about them (Glenberg & Kaschack, 2004; Zwaan & Taylor, 2008). The measures used in the current

NIH-PA Author Manuscript

NIH-PA Author Manuscript

study cannot speak to whether different levels of motor resonance may occur for character actions of different speeds or intensities. However, we can conclude from the current dataset that eye movements over the post-verbal prepositional phrase were not influenced by action speed, nor were reading times on either the direct or indirect quote significantly affected by the semantics of the main verb. Thus, readers likely treat the speed at which a character is acting as independent from that character's speaking rate.

The current study suggests several future research directions. First, it is still unclear how the "fast" and "slow" adverbs moved reading times away from baseline, as our manipulation always included a speed-related adverb. It will be interesting to know if one adverb type or the other has the greater impact on direct quote reading times, or if both adverb types were equally effective in influencing reading speed. Secondly, although the global effect of character speed induced by the sentence's main verb did not significantly affect direct quote reading times, the physical distance of a speed-related lexical item from the quote may play a role in determining perceptual simulation effects. In the current study, the adverb always directly preceded the quote, leaving open the question of whether the adverb would exert as strong of an effect if it were farther away than the verb (e.g., *John said energetically as he walked into the room, "I finally found my car keys."*), or whether the speed-related word closest to the quote has the largest effect. However, we do know that the action verb was unsuccessful at affecting eye movements on its subsequent prepositional phrase, and so may not be expected to significantly affect quote reading times when it directly precedes them. Additionally, previous studies have found that individual differences in imaging abilities influence readers' ability to engage in auditory imagery (Alexander & Nygaard, 2008), so it is possible that certain readers may engage in more perceptual simulation than others, which could modulate their reading times on the direct, and possibly indirect, quotations.

In sum, we found that direct quotes described as being said "quickly" are read faster than those described as being said "slowly," an effect we attribute to perceptual simulation of character speech. Our results demonstrate that perceptual simulation can be generated with only a single adverb preceding a quote to establish a character's speaking rate. This is also the first study to show that adverbs with a semantically "fast" meaning are read faster than adverbs with a "slow" meaning, likely caused by the automatic activation of semantic features during lexical access, rather than perceptual simulation. These findings add to those of Yao and Scheepers (2011) that readers perceptually simulate direct, but not indirect, speech, and extend their findings by demonstrating that a single adverb denoting speaking rate can be integrated online and used to generate perceptual simulation of direct quotes.

Acknowledgments

This work was funded in part by NIH Training Grant T32-HD055272 and NSF Graduate Research Fellowship NSF DGE 11-44245 FLLW to MCS, and NSF CAREER Award BCS-0847533 to KC. We thank Christoph Scheepers, Kara Federmeier, Maureen Gillespie, and Brennan Payne for fruitful discussions about various aspects of this research. We also thank the members of the Educational Psychology Psycholinguistics Lab at the Beckman Institute for assistance with data collection.

References

Alexander JD, Nygaard LC. Reading voices and hearing text: Talker-specific auditory imagery in reading. Journal of Experimental Psychology, Human Perception and Performance. 2008; 34(2): 446–459. [PubMed: 18377181]

Ashby J, Clifton C Jr. The prosodic property of lexical stress affects eye movements during silent reading. Cognition. 2005; 96:B89–B100. [PubMed: 15913592]

Baayen, RH. Analyzing Linguistic Data: A Practical Introduction to Statistics Using R. Cambridge, UK: Cambridge University Press; 2008.

Baayen RH, Davidson DJ, Bates DM. Mixed-effects modeling with cross random effects for subjects and items. Journal of Memory and Language. 2008; 59:390–412.

Barsalou LW. Perceptual symbol systems. Behavioral and Brain Sciences. 1999; 22(4):577–660. [PubMed: 11301525]

Clark HH, Gerrig RJ. Quotations as demonstrations. Language. 1990; 66(4):764–805.

Drumm AM, Klin CM. When story characters communicate: readers' representations of characters' linguistic exchanges. Memory & Cognition. 2011; 39:1348–1357.

Fodor, J. Psycholinguistics cannot escape prosody. Proceedings of the SPEECH PROSODY 2002 Conference; April 2002; Aix-en-Provence, France. 2002.

Glenberg AM, Kaschak MP. Grounding language in action. Psychological Bulletin & Review. 2002; 9(3):558–565.

Hauk O, Johnsrude I, Pulvermüller F. Somatotopic representation of action words in human motor and premotor cortex. Neuron. 2004; 22:301–307. [PubMed: 14741110]

Jaeger TF. Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. Journal of Memory and Language. 2008; 59:434–446. [PubMed: 19884961]

Just MA, Carpenter PA. A theory of reading: From eye fixations to comprehension. Psychological Review. 1980; 87:329–354. [PubMed: 7413885]

Klin CM, Drumm AM. Seeing what they read and hearing what they say: Readers' representation of the story character's world. Psychonomic Bulletin & Review. 2010; 17(2):231–236. [PubMed: 20382925]

Kukona A, Fang SY, Aicher KA, Chen H, Magnuson JS. The time course of anticipatory constraint integration. Cognition. 2011; 119:23–42. [PubMed: 21237450]

Rayner, K.; Pollatsek, A. The Psychology of Reading. Hillsdale, NJ: Lawrence Erlbaum; 1989.

Taylor LJ, Zwaan RA. Motor resonance and linguistic focus. The Quarterly Journal of Experimental Psychology. 2008; 61(6):896–904. [PubMed: 18470820]

Trueswell JC, Tanenhaus MK, Garnsey S. Semantic influences on parsing: Use of thematic role information in syntactic ambiguity resolution. Journal of Memory and Language. 1994; 33:285–318.

Yao B, Belin P, Scheepers C. Silent reading of direct versus indirect speech activates voice-selective areas in the auditory cortex. Journal of Cognitive Neuroscience. 2011; 23(10):3146–3152. [PubMed: 21452944]

Yao B, Scheepers C. Contextual modulation of reading rate for direct versus indirect quotations. Cognition. 2011; 121:447–453. [PubMed: 21906731]

Appendix A: Experiment 1 Materials

Sentence	
1	John bolted/walked into the room and said energetically/nonchalantly, "I finally found my car keys."
2	The waiter whisked/came up to the table and declared hurriedly/lazily, "I'll be right back to take your back for your order."
3	The young woman sprinted/wandered onto the bus and asked frantically/calmly, "Do you go to the train station?"
4	Macy skimmed/pored over her recipe and said impulsively/idly, "I need to go grocery shopping."
5	Dan burst/walked into the office and asked urgently/sluggishly, "Has anybody seen my cell phone?"
6	Andy rushed/strolled up to his mom and announced excitedly/casually, "I just got accepted to Harvard!"
7	The professor raced/meandered up to the cheating student and remarked swiftly/unhurriedly, "You need to leave the exam."
8	Julie dashed/plodded through the room and announced hastily/lethargically, "I'm going to be late for work."
9	The woman impulsively/tentatively took her husband's hand and whispered quickly/slowly, "We're having a baby."
10	The doctor sped/went into the patient's room and declared rapidly/calmly, "Your tests came back normal."

	Sentence
11	The dad barreled/wandered into his son's bedroom and announced speedily/listlessly, "It's time to get up."
12	The student hurried/sauntered up to the teacher and said briskly/unexcitedly, "I can't make it to class Friday."
13	Joe's boss darted/ambled into his cubicle and declared excitedly/nonchalantly, "You gave a great presentation."
14	Ellen shot/walked out of the dressing room and asked insistently/carefully, "Does this dress look good on me?"
15	The stylist quickly/slowly held up a mirror and asked energetically/idly, "Do you like your new style?"
16	The lawyer glanced/stared at the jury and asserted swiftly/unhurriedly, "I know my client is innocent."
17	The coach ran/went onto the court and yelled urgently/deliberately, "You have to make your freethrows!"
18	The reporter dashed/ambled up to the politician and inquired hastily/casually, "Are you running for mayor?"
19	Amy bounded/strolled up to the store manager and asked enthusiastically/lethargically, "Where is the shoe department?"
20	Nick glanced/stared at his watch and said briskly/slowly, "The movie starts in five minutes."
21	Leslie hurried/strolled into the gym and said enthusiastically/listlessly, "I'm nervous for my first yoga class."
22	Jake hopped/climbed into his car and muttered rapidly/unexcitedly, "I need to get gas today."
23	Andrea flew/pulled into the parking lot and yelled hysterically/slowly, "Somebody parked in my space again!"
24	The cab driver speedily/sluggishly turned around and asked frantically/lazily, "Where do you need to go?"

Appendix B: Experiment 2 Materials

	Sentence
1	John bolted/walked into the room and said energetically/nonchalantly that he finally found his car keys.
2	The waiter charged/came up to the table and declared hurriedly/lazily that he'll be back for their order.
3	The young woman sprinted/wandered onto the bus and asked frantically/calmly if it goes to the train station.
4	Macy skimmed/pored over her recipe and said impulsively/idly that she needs to go grocery shopping.
5	Dan burst/walked into the office and asked urgently/sluggishly if anybody had seen his cell phone.
6	Andy rushed/strolled up to his mom and announced excitedly/casually that he just got accepted to Harvard.
7	The professor raced/meandered up to the cheating student and remarked swiftly/unhurriedly that he must leave the exam.
8	Julie dashed/plodded through the room and announced hastily/lethargically that she's going to be late for work.
9	The woman impulsively/tentatively took her husband's hand and whispered quickly/slowly that she's having a baby.
10	The doctor sped/went into the patient's room and declared rapidly/calmly that the tests came back normal.
11	The dad barreled/wandered into his son's bedroom and announced speedily/listlessly that it's time to get up.
12	The student hurried/sauntered up to the teacher and said briskly/unexcitedly that she can't come to class Friday.
13	Joe's boss darted/ambled into his cubicle and declared excitedly/nonchalantly that he gave a great presentation.
14	Ellen shot/walked out of the dressing room and asked insistently/carefully if the dress looks good on her.
15	The stylist quickly/slowly held up a mirror and asked energetically/idly if she likes her new style.
16	The lawyer glanced/stared at the jury and asserted swiftly/unhurriedly that he knows his client is innocent.
17	The coach ran/went onto the court and yelled urgently/deliberately that they have to make their freethrows!
18	The reporter dashed/ambled up to the politician and inquired hastily/casually if she's running for mayor.
19	Amy bounded/strolled up to the store manager and asked enthusiastically/lethargically where the shoe department is.
20	Nick glanced/stared at his watch and said briskly/slowly that the movie starts in five minutes.
21	Leslie hurried/strolled into the gym and said enthusiastically/listlessly that she's nervous for her first yoga class.

	Sentence
22	Jake hopped/climbed into his car and muttered rapidly/unexcitedly that he needs to get gas today.
23	Andrea flew/pulled into the parking lot and yelled hysterically/slowly that somebody parked in her space again.
24	The cab driver spun/turned around and asked frantically/lazily where they need to go.

NIH-PA Author Manuscript
NIH-PA Author Manuscript

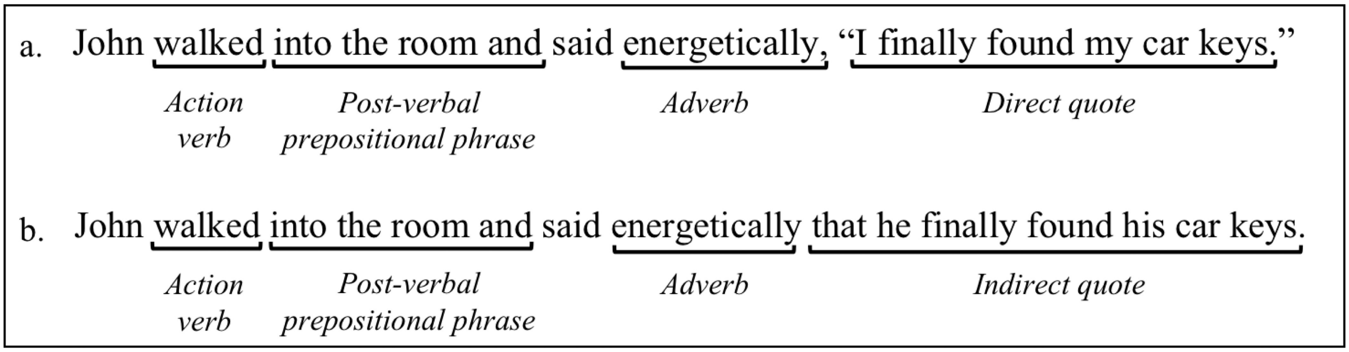

Figure 1.
Regions of interest in Experiment 1 (a) and Experiment 2 (b).

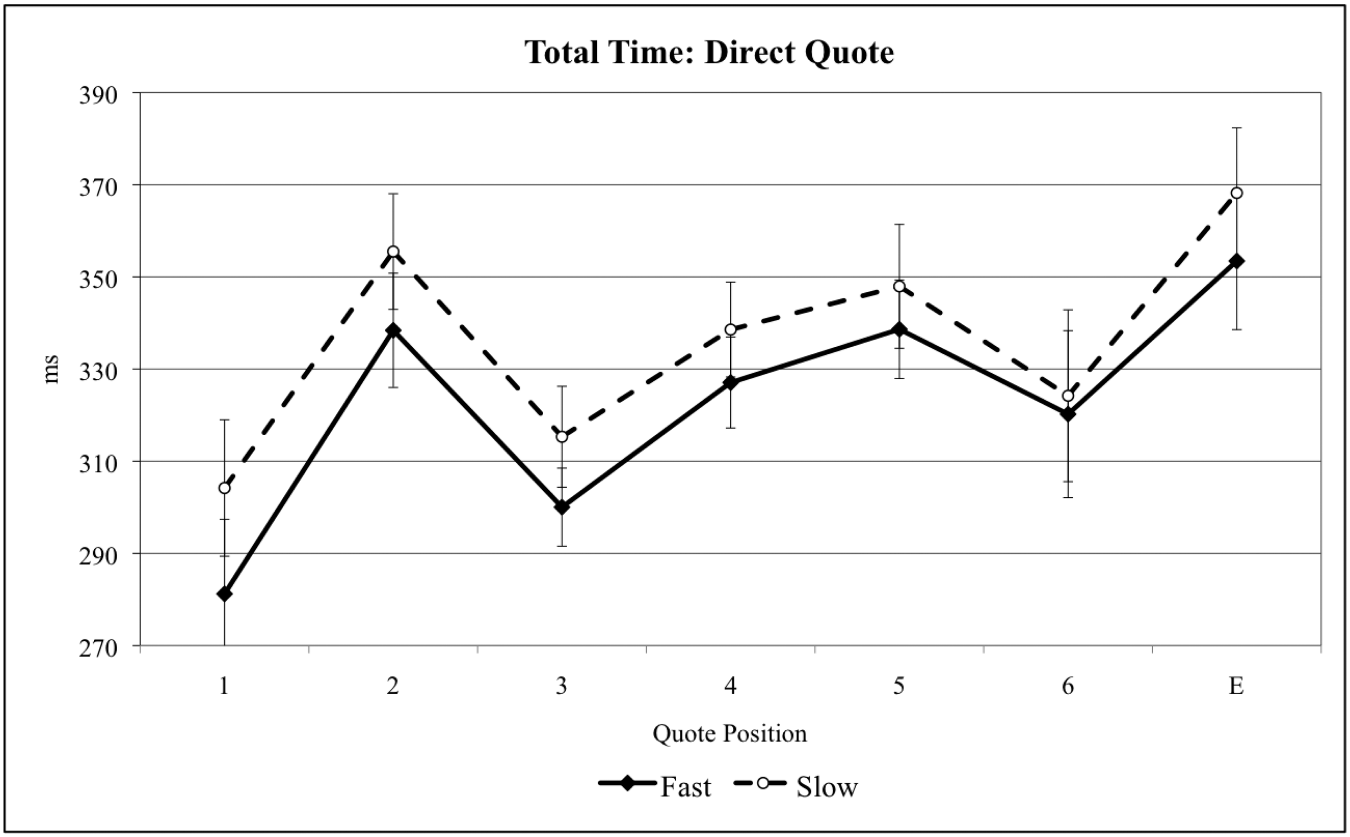

Figure 2.
Total reading times for each direct quote position as a function of adverb speed. Mean reading times were derived by averaging over subjects; error bars represent standard error.

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 1

a. Example of materials used in Yao and Scheepers (2011). Each item contained either the direct speech sentence, or the indirect speech sentence.

Region label	Fast-speaking story	Slow-speaking story
Set-up of implicit speed	It was 11am in the morning when the fire alarm went off. Hearing people running down the corridors, Mary grabbed her jacket and burst into Peter's office next door.	It was 11am in the morning when the fire alarm went off. Knowing that this was just a test, Mary put on her jacket and walked into Peter's office next door.
Direct speech	She shouted: "Peter, quick, we have **to leave immediately because the building is on fire**!"	Tongue-in-cheek, she said: "Peter, quick, we have **to leave immediately because the building is on fire!"**
Indirect speech	She urged Peter **to leave immediately because the building was on fire.**	Tongue-in-cheek, she told Peter **to leave immediately because the building was on fire.**
Conclusion	Confused, Peter replied: "Wasn't there an e-mail about a fire alarm test this morning?"	Peter just replied: "Very funny—I've seen the e-mail about the fire alarm test as well!"

b. Examples of stimulus materials used in Experiment 1.

Direct Speech	Fast Adverb	Slow Adverb
Fast Verb	John bolted into the room and said energetically, **"I finally found my car keys."**	John bolted into the room and said nonchalantly, **"I finally found my car keys."**
Slow Verb	John walked into the room and said energetically, **"I finally found my car keys."**	John walked into the room and said nonchalantly, **"I finally found my car keys."**

c. Examples of stimulus materials used in Experiment 2.

Indirect Speech	Fast Adverb	Slow Adverb
Fast Verb	John bolted into the room and said energetically **that he finally found his car keys.**	John bolted into the room and said nonchalantly **that he finally found his car keys.**
Slow Verb	John walked into the room and said energetically **that he finally found his car keys.**	John walked into the room and said nonchalantly **that he finally found his car keys.**

Table 2

Mean reading times in ms (and standard deviations) on all regions of interest in Experiment 1.

Region	Measure	Verb Speed	Adverb Speed	
			Fast Adverb	**Slow Adverb**
Direct Quotation	FF	Fast Verb	210 (63)	212 (65)
		Slow Verb	216 (63)	216 (68)
	GD	Fast Verb	1152 (533)	1152 (560)
		Slow Verb	1173 (531)	1209 (575)
	GP	Fast Verb	1925 (1088)	2051 (1250)
		Slow Verb	1857 (1044)	1990 (1268)
	TT	Fast Verb	1321 (617)	1386 (667)
		Slow Verb	1310 (607)	1390 (740)
Adverb	FF	Fast Verb	223 (82)	230 (91)
		Slow Verb	220 (75)	231 (86)
	GD	Fast Verb	271 (167)	298 (170)
		Slow Verb	267 (122)	297 (181)
	GP	Fast Verb	368 (323)	400 (297)
		Slow Verb	359 (303)	405 (313)
	TT	Fast Verb	396 (265)	464 (340)
		Slow Verb	401 (255)	459 (338)
			Fast Verb	Slow Verb
Post-Verbal Prepositional Phrase		FF	217 (85)	222 (97)
		GD	555 (326)	551 (331)
		GP	685 (451)	706 (474)
		TT	879 (529)	858 (537)

(FF = First fixation duration; GD = gaze duration; GP = go-past time; TT = total time).

Table 3

Mixed model output for direct quote region reading times (Experiment 1).

Measure	Predictor	Estimate	SE	t value	p (t)
First Fixation	Intercept	0.016	31.846	0.002	0.994
	Fast v. Slow Adverb	0.846	21.658	0.807	0.770
	Fast v. Slow Verb	5.105	21.658	1.722	0.078
Gaze Duration	Intercept	0.046	1.968	0.008	0.999
	Fast v. Slow Adverb	17.480	2.896	0.292	0.420
	Fast v. Slow Verb	37.303	2.896	1.763	0.085
Go-past Time	Intercept	−0.296	50.943	−0.006	0.995
	Fast v. Slow Adverb	126.375	47.296	2.672	0.008
	Fast v. Slow Verb	−67.751	47.296	−1.433	0.152
Total Time	Intercept	−0.081	39.331	−0.002	0.998
	Fast v. Slow Adverb	68.454	26.035	2.629	0.009
	Fast v. Slow Verb	−6.317	26.034	−0.243	0.808

Table 4

Model output for adverb reading times (Experiment 1).

Measure	Predictor	Estimate	SE	t value	p (t)
First Fixation	Intercept	−0.047	2.457	−0.019	0.985
	Fast v. Slow Adverb	10.084	3.916	2.575	0.010
	Fast v. Slow Verb	−0.125	3.904	−0.032	0.975
	Frequency	−0.075	0.059	−1.281	0.200
Gaze Duration	Intercept	0.493	4.777	0.103	0.918
	Fast v. Slow Adverb	36.547	7.042	5.190	0.000
	Fast v. Slow Verb	−0.889	0.118	−0.866	0.899
	Frequency	−0.102	7.015	−0.127	0.387
	Adverb × Frequency	−0.469	0.208	−2.252	0.025
Go-past Time	Intercept	−0.017	9.530	−0.002	0.999
	Fast v. Slow Adverb	43.377	14.812	2.929	0.004
	Fast v. Slow Verb	0.146	0.225	0.567	0.992
	Frequency	0.128	14.762	0.010	0.571
Total Time	Intercept	1.060	10.345	0.102	0.918
	Fast v. Slow Adverb	72.254	13.036	5.543	0.000
	Fast v. Slow Verb	1.598	0.236	−0.519	0.902
	Frequency	−0.123	12.976	0.123	0.604
	Adverb × Frequency	−0.879	0.395	−2.224	0.026

Table 5

Mean reading times in ms (and standard deviations in parenthesis) on indirect quote region (Experiment 2).

Region	**Measure**	**Verb**	**Adverb**	
			Fast Adverb	**Slow Adverb**
Indirect Quotation	FF	Fast Verb	214 (67)	216 (71)
		Slow Verb	215 (69)	210 (60)
	GD	Fast Verb	1243 (604)	1197 (601)
		Slow Verb	1249 (618)	1163 (592)
	GP	Fast Verb	2856 (2028)	2803 (1851)
		Slow Verb	2734 (1819)	2731 (1863)
	TT	Fast Verb	1686 (811)	1736 (931)
		Slow Verb	1678 (874)	1627 (835)
Adverb	FF	Fast Verb	217 (74)	235 (92)
		Slow Verb	229 (78)	230 (77)
	GD	Fast Verb	265 (128)	285 (149)
		Slow Verb	269 (120)	290 (156)
	GP	Fast Verb	320 (201)	346 (245)
		Slow Verb	326 (236)	357 (265)
	TT	Fast Verb	445 (325)	502 (355)
		Slow Verb	432 (284)	474 (310)
			Fast Verb	Slow Verb
Post-Verbal Prepositional Phrase		FF	215 (79)	217 (84)
		GD	573 (339)	557 (324)
		GP	774 (470)	769 (531)
		TT	1142 (702)	1110 (695)

(FF = First fixation duration; GD = gaze duration; GP = go-past time; TT = total time).

Table 6

Model output for reading time measures on indirect quotation (Experiment 2).

Measure	Predictor	Estimate	SE	t value	p (t)
First Fixation	Intercept	0.004	2.257	0.002	0.999
	Fast v. Slow Adverb	−1.159	3.692	−0.314	0.754
	Fast v. Slow Verb	−2.176	3.692	−0.589	0.556
Gaze Duration	Intercept	0.031	32.430	0.001	0.999
	Fast v. Slow Adverb	−65.051	30.360	−2.143	0.032
	Fast v. Slow Verb	−14.763	30.360	−0.486	0.627
Go-past Time	Intercept	−0.256	93.656	−0.003	0.998
	Fast v. Slow Adverb	−31.400	88.485	−0.355	0.723
	Fast v. Slow Verb	−88.975	88.485	−1.006	0.315
Total Time	Intercept	−0.050	45.948	−0.001	0.999
	Fast v. Slow Adverb	−1.005	41.521	−0.024	0.981
	Fast v. Slow Verb	−58.419	41.521	−1.407	0.160

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 7

Model output for adverb reading times (Experiment 2).

Measure	Predictor	Estimate	SE	t value	p (t)
First Fixation	Intercept	−0.156	3.627	−0.043	0.966
	Fast v. Slow Adverb	11.015	4.714	2.337	0.020
	Fast v. Slow Verb	4.106	4.669	0.879	0.379
	Frequency	−0.217	0.077	−2.838	0.005
Gaze Duration	Intercept	0.030	5.643	0.005	0.996
	Fast v. Slow Adverb	21.500	7.618	2.822	0.005
	Fast v. Slow Verb	4.252	7.548	0.563	0.573
	Frequency	−0.254	0.121	−2.091	0.037
Go-past Time	Intercept	0.065	9.364	0.007	0.995
	Fast v. Slow Adverb	33.643	13.549	2.483	0.013
	Fast v. Slow Verb	9.288	13.433	0.692	0.489
	Frequency	−0.593	0.209	−2.842	0.005
Total Time	Intercept	−0.005	12.901	0.000	1.000
	Fast v. Slow Adverb	63.657	16.753	3.800	0.000
	Fast v. Slow Verb	−17.305	16.594	−1.043	0.297
	Frequency	−0.695	0.272	−2.555	0.011