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Brief article

Disfluency effects on lexical selection

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ABSTRACT

Recent research has suggested that introducing a disfluency in the context of written composition (i.e., typing with one hand) can increase lexical sophistication. In the current study, we provide a strong test between two accounts of this phenomenon, one that attributes it to the delay caused by the disfluency and one that attributes it to the disruption of typical finger-to-letter mappings caused by the disfluency. To test between these accounts, we slowed down participants' typewriting by introducing a small delay between keystrokes while individuals wrote essays. Critically, this manipulation did not disrupt typical finger-to-letter mappings. Consistent with the delay-based account, our results demonstrate that the essays written in this less fluent condition were more lexically diverse and used less frequent words. Implications for the temporal dynamics of lexical selection in complex cognitive tasks are discussed.

"That's not writing, that's typing."

[Truman Capote]

1. Introduction

Recent research has suggested that in some circumstances, introducing a disfluency can benefit performance (e.g., Ball, Klein, & Brewer, 2014; Mueller & Oppenheimer, 2014). A surprising example of this general phenomenon was recently reported in the context of written composition by Medimorec and Risko (2016), who found that decreasing transcription fluency (or typing speed) by having individuals type with one hand resulted in more lexically sophisticated essays. This finding is surprising theoretically because transcription fluency is typically thought to be positively correlated with writing quality as the automatization of transcription arguably affords the re-distribution of resources to higher level writing processes such as planning (Fayol, 1999; Kellogg, 1999). Thus understanding how transcription disfluency influences aspects of writing provides a unique opportunity to gain a deeper understanding of the basic mechanisms underlying lexical selection in written composition (and language use in general). Here we provide a strong test between two potential theoretical accounts of the effect of disfluency on lexical sophistication.

1.1. Typing disfluency and cognition

In Medimorec and Risko (2016), transcription disfluency was introduced by having participants typewrite essays using one hand (vs. standard typing). When essays were computationally analyzed, the results demonstrated that essays typewritten in the less fluent (or slower) condition were more lexically sophisticated (i.e., they exhibited increased lexical diversity and decreased word frequency). Medimorec and Risko (2016) interpreted these results as consistent with the idea that typewriting may be too fluent (Heidegger, 1992; Norman 2002). For example, Norman (2002) suggested that handwriting encouraged more thoughtful writing compared to typewriting because the former was slower. Medimorec and Risko (2016) proposed a time-based account of the effects of disfluency on lexical sophistication whereby decreasing transcription fluency allowed more time for lexical processes, such as lexical access, to unfold. Such a mechanism is consistent with the general underpinnings of most theories of lexical processing, which posit that accessing infrequent words takes more time than accessing more frequent words, both in speech and writing (Forster & Davis, 1984; Navarrete, Basagni, Alario, & Costa, 2006). For example, Crowe (1998) used a verbal fluency task to investigate lexical selection and found that participants first generated the more available frequent words followed by infrequent words. According to the time-based disfluency account, the critical variable in producing this effect on lexical sophistication should be the delay in transcription speed caused by disfluency.

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While writing with one hand (relative to two) certainly slows down transcription, it also interferes with writing in other ways. For example, relatively skilled typewriting involves specific pairings of fingers and keyboard keys (Purcell, Napoliello, & Eden, 2011), and switching to one-handed typing would disrupt those mappings. This disruption could in theory influence lexical selection during writing. For example, there is evidence that individuals exhibit different letter preferences when typing on a QWERTY keyboard across different input modalities depending on whether they use both hands or only one hand (Pelleg, Yom-Tov, & Gabrilovich, 2015). Thus the way that we type can influence what we type. An effect on lexical sophistication would occur if lexical selection was influenced by the frequency of motor production (i.e., a bias towards selecting often typed words) and one-handed typing interfered with such an effect. In other words, the decreased lexical sophistication in the more fluent (or standard) typing condition could potentially be explained by a habitual combination of more rapid word access and the more automatized typing of those words (compared to infrequent words), with the latter being disrupted when we type one-handed.

In order to test between the two accounts described above, it is necessary to find a manipulation that could slow down regular (both-handed) typing without disrupting the finger-to-letter mappings. To this end, we had software developed that allowed us to introduce a delay between keypresses. Thus we could, relatively directly, control typing speed while individuals used their familiar two-handed typing (and thus maintained the same finger-to-letter relations across conditions). To our knowledge, this is the first time that the effects of such a manipulation have been reported.

In addition to the two accounts described above, we also examined the idea that fluency effects in composition could result from effects on participants' subjective task experience. Previous work has provided evidence that conscious experience of low effort or high speed, referred to as subjective fluency (Winkielman, Schwarz, Fazendeiro, & Reber, 2003), can influence cognitive processing. For example, subjective fluency can elicit a positive affective reaction (Schwarz & Clore, 1996) and facilitate creativity (Nadler, Rabi, & Minda, 2010). Moreover, individuals can perceive the same objective experiences as more or less fluent depending on previous experience and expectations (Whittlesea, 1993). Thus many fluency effects can involve a subjective fluency component. To test this notion, participants' responses to the NASA Task Load Index (NASA-TLX; see Hart & Staveland, 1988), a multidimensional scale providing measures of subjective fluency, were examined. Finally, since increased lexical sophistication represents one of the predictors of better essay quality (Crossley & McNamara, 2011), we investigate whether disfluency effects on lexical sophistication extend to human essay quality judgements.

2. Method

2.1. Participants

A total of 202 university students participated, but two participants did not complete the study. Sample size was determined using the effect size of 0.40 (based on Medimorec & Risko, 2016), and power of 0.80 (Faul, Erdfelder, Buchner, & Lang, 2009).

2.2. Design

A 2 (standard vs. keyboard delay condition) between-subject design was used.

2.3. Stimuli and apparatus

The essays were written using a QWERTY keyboard and software that controlled the minimum time delay between keystrokes. Based on piloting, we set this minimum delay to 100 ms.[1] Subjective fluency measures were collected using NASA-TLX, which has scales that range from −10 (i.e., low) to +10 (i.e., high) for six dimensions: mental, physical, and temporal demand, performance, effort, and frustration. Keystroke activity was recorded using our delay application and the Inputlog key-logger (Leijten & Van Waes, 2013).

2.4. Procedure

Participants wrote a timed (50 min) argumentative essay regarding cellphone use in schools (Medimorec & Risko, 2016). Participants were asked to write at least 500 words and were informed that their essays would be graded. Participants were given a 3-min practice session to get familiarized with the keyboard by typing a sentence. After the writing task, participants filled out the NASA-TLX scale.

2.5. Measuring transcription fluency and linguistic features of essays

Transcription fluency was determined by calculating times between consecutive lower case letters recorded by our delay application. We removed 1.42% of keystrokes within individual participants exceeding 2.5 SD of the mean (for 199 participants; one participant used all caps).

Essays were analyzed using the Coh-Metrix text analyzer (McNamara, Graesser, McCarthy, & Cai, 2014). We also report corresponding language indices using the Tool for the Automatic Analysis of Lexical Sophistication (TAALES; Kyle & Crossley, 2015), and the Tool for the Automatic Analysis of Cohesion (TAACO; Crossley, Kyle, & McNamara, 2015). We focus on two relatively independent lexical sophistication indices affected by the transcription fluency manipulation in Medimorec and Risko (2016), specifically, lexical diversity and word frequency.

2.5.1. Lexical diversity

Lexical diversity is the range of vocabulary in a text. Coh-Metrix computes the type–token ratio (TTR; Templin, 1957), the measure of textual lexical diversity (MTLD; McCarthy & Jarvis, 2010), and vocd-D (Malvern, Richards, Chipere, & Duran, 2004). In general, these indices measure the ratio of unique words relative to the number of words in the text. Higher lexical diversity indicates greater lexical sophistication (McNamara et al., 2014). TTR results were also derived from TAACO.

2.5.2. Word frequency

Word frequency is a measure of how often individual words occur in the English language. Coh-Metrix derives the log-frequency for all words and the raw word frequency for content words from the CELEX database (Baayen, Piepenbrock, & Gulikers, 1996). Word frequencies from the SUBTLEXus (Brysbaert & New, 2009) and British National Corpus (BNC; BNC Consortium, 2007) databases are derived by TAALES. Texts with infrequent words are considered more lexically sophisticated (Crossley & McNamara, 2011).

[1] Note that this does not necessarily lead to a 100 ms decrease in typing speed because the majority of keypresses in regular typing already exceed 100 ms (~73% in our standard condition). Thus the introduced delay could be roughly conceptualized as a removal of all sub 100 ms interword keypresses from standard typing.