aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

The Benefits of Cognitive Disfluency

Current Directions in Psychological Science
22(6) 437–442

DOI: 10.1177/0963721413498894
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Abstract
People process new information along a continuum, from very fluently (with great ease) to very disfluently (with great difficulty). Researchers have long recognized that people prefer fluently processed stimuli across a broad range of dimensions. A more recent stream of research suggests that disfluency sometimes produces superior outcomes. In this review, I suggest that disfluency prompts people to process information more carefully, deeply, and abstractly, and mitigates the social problems of overdisclosure and reflexive xenophobia. I conclude by raising several remaining questions that warrant empirical attention.

Keywords
fluency, disfluency, metacognition, processing depth, judgment and decision-making

In a classic *Psychological Review* article, Kimble and Perlmuter (1970) asked the following five questions:

> What do we call a tree that grows from acorns? [OAK]
>
> What do we call a funny story? [JOKE]
>
> What sound does a frog make? [CROAK]
>
> What is another word for a cape? [CLOAK]
>
> What do we call the white part of an egg? [???]

If you answered correctly with *albumen*, you're in the tiny minority of respondents who consider but ultimately reject *yolk*. *Yolk* rhymes with the four preceding responses, so it comes to mind so effortlessly that you can answer *albumen* only with deliberate reconsideration.

The "yolk phenomenon" shows that people are seduced by easily formed conclusions, and much of the research that examines the subjective experience of mental ease, or *cognitive fluency*, shows that people similarly rate easily processed stimuli more highly across an array of dimensions (for a review, see Alter & Oppenheimer, 2009b; for exceptions, see Bornstein & D'Agostino, 1994; Schwarz, 2004). For example, they tend to perceive fluently processed stimuli as more likable (Laham, Koval, & Alter, 2012; Reber, Winkielman, & Schwarz, 1998), more valuable (Alter & Oppenheimer, 2006, 2008a), more moral (Laham, Alter, & Goodwin, 2009), more frequent (Hertwig, Herzog, Schooler, & Reimer, 2008), and more true or accurate (McGlone & Tofighbakhsh, 2000; Reber & Schwarz, 1999; Unkelbach, 2006) than similar stimuli that are processed with greater difficulty, or *disfluency*. Whereas this early research showed that fluency elevated people's evaluations of a particular stimulus directly, more recent research has shown that disfluency generates other benefits indirectly by influencing how people process and represent new information. Those benefits fall into two broad categories: cognitive and social.

Cognitive Benefits of Disfluency

Deeper processing

Humans fall prey to the "yolk phenomenon" and similar cognitive shortcomings in part because they are cognitive misers, preferring to process information as superficially as possible while reaching minimally acceptable conclusions (Fiske & Taylor, 1991). One solution, then, is to introduce cognitive roadblocks that signal a need for deeper processing. For example, participants in one

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experiment (Alter, Oppenheimer, Epley, & Eyre, 2007, Experiment 1) completed the three-item Cognitive Reflection Test (Frederick, 2005). Like the opening example, each question in the Cognitive Reflection Test inspires an incorrect solution that can be corrected only with deliberate reconsideration. According to the first question, "A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?" The intuitive response—the bat costs $1 and the ball costs 10 cents—is incorrect (the difference between these is 90 cents, not $1), and the correct response is that the ball costs 5 cents (and the bat $1.05).

When we printed the questions in standard 12-point font, participants answered an average of 63% of the questions correctly. In contrast, when we made the process of reading the questions more disfluent, by printing them in a gray, italicized, 10-point font, participants scored an average of 82% (and committed 56% fewer intuitive errors). Researchers have also shown that people process information more deeply when they experience cognitive disfluency in other contexts (see Fig. 1). For example, when asked how many animals of each kind Moses took aboard the ark, 90% of people erroneously respond with *two* (Erickson & Mattson, 1981; Reder & Kusbit, 1991; Song & Schwarz, 2008). The correct answer is *none*, because Moses was not associated with the ark, but people succumb to this so-called Moses illusion despite declaring later that Noah built and sailed the ark. The illusion traps most people because they glide fluently over the name *Moses*, and focus instead on how many animals boarded the ark. In contrast, Song and Schwarz (2008) found that the error rate fell from 88% to 53% when they presented the question in a disfluent 12-point gray Brush Script font. When the researchers repeated the experiment, asking a separate sample of participants what sort of animal swallowed Joshua in the biblical story, 40% succumbed to the illusion when the question was printed clearly, whereas only 23% failed to notice that the whale swallowed Jonah, not Joshua, when the questions were printed in the disfluent font. People are more likely to reconsider their misleading intuitions when they encounter mental roadblocks (see also Simmons & Nelson, 2006).

The benefits of disfluency apply beyond illusions and parlor tricks, and disfluent processing sometimes stimulates significant real-world value. In one study, students in six advanced-placement classes at a school in Ohio learned new material from worksheets and PowerPoint

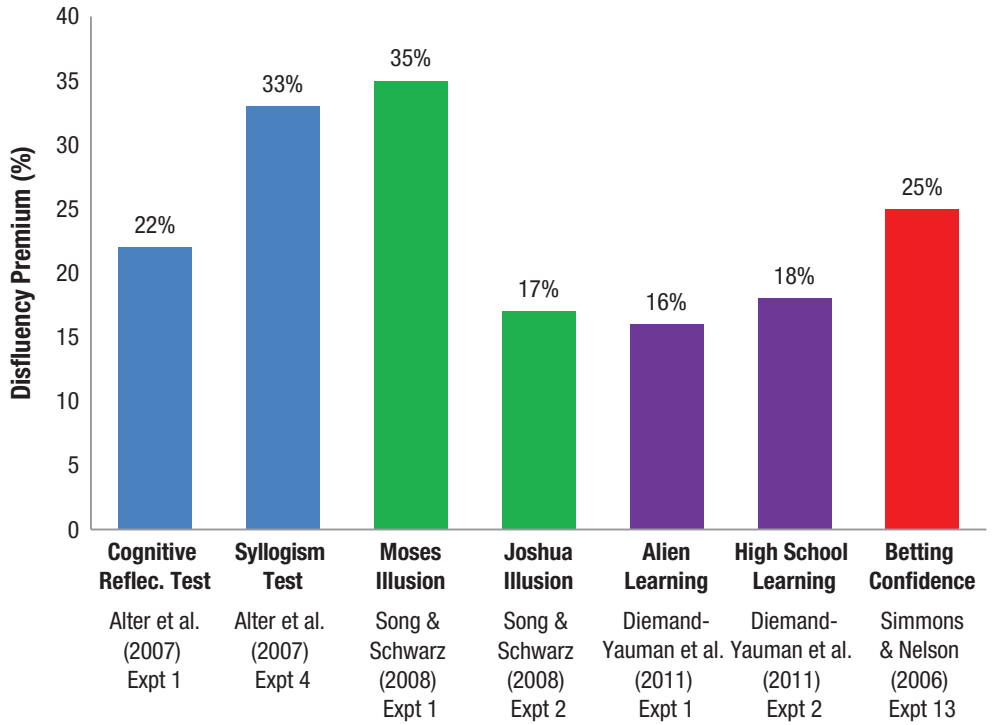

Fig. 1. Increase in performance when participants experienced disfluency rather than fluency while completing mental puzzles (the disfluency premium). Disfluency improved responses to mathematical and logic problems (blue bars), intuitive illusions (green bars), and learning tasks (purple bars) and dampened the lure of intuitively appealing favorites over underdogs in a betting context in which the two teams were equated by a handicap spread (red bar).

slides (Diemand-Yauman, Oppenheimer, & Vaughn, 2011). The experimenters randomly assigned certain sections of each class to learn the material from fluent or disfluent versions of the same worksheets. The fluent versions were printed in a standard font, whereas the disfluent versions were printed in one of four harder-to-read formats. When the students completed their exams, those who had learned from the disfluent materials achieved significantly higher scores. These striking results replicated an earlier laboratory experiment in which college students remembered new information about a fictitious alien race more accurately when the information was presented disfluently.

Generalization and abstract processing

Disfluency similarly encourages a second hallmark of learning: the ability to generalize or abstract from specific concrete examples. Just as solving complex problems requires deeper thinking, so does looking beyond a target's surface features to focus on its deeper structure. This sort of abstraction is critical to learning, because it enables students to distill general (or abstract) principles from limited examples while ignoring their irrelevant superficial (or concrete) features. When children learn the alphabet, for example, they come to recognize that the same letter can be written in uppercase and lowercase, by people with good and bad handwriting, and printed in thousands of fonts. Chess players who master the rudiments of the game similarly learn to apply those rules to novel board positions (because there are billions of possible configurations after the first several moves).

People also have the capacity to represent the same stimulus relatively concretely or relatively abstractly. For example, one might perceive Shakespeare's *Hamlet* concretely, as a play of 5 acts, 20 scenes, and 29,551 words, or abstractly, as a tragic exploration of death, uncertainty, betrayal, and revenge. When stimuli are difficult to process, they seem further away in time and space, and because they become progressively fuzzier, perceivers focus on their global, abstract properties rather than their narrower, concrete features (Alter & Oppenheimer, 2008b). In one set of experiments, participants who experienced disfluency described New York City more abstractly, preferred a more abstract mix of descriptions for Los Angeles, and generated relatively more abstract definitions for hard-to-pronounce obscure words (e.g., *euneirophrenia*) than for easy-to-pronounce obscure words (e.g., *beestings*; Alter & Oppenheimer, 2008b). The same relationship between disfluency and abstract representation held regardless of whether the disfluent stimuli were difficult to read, remember (because they had not been presented earlier), or pronounce.

Social Benefits of Disfluency

Dampening the tendency to overdisclose

Beyond its role in promoting deeper and abstract thinking, disfluency has the capacity to ameliorate a range of social problems that arise when people process information too superficially. For example, identity theft affects roughly one in every thousand Americans, and costs each victim an average of almost $2,000 (Finklea, 2012). Up to three quarters of all cases arise because victims share their credit card information with the perpetrator, which suggests that victims underestimate the risk of identity theft. Several studies have shown that disfluency sensitizes people to risk in the same way that it dampens their mental confidence. For example, people tend to believe that amusement park rides (e.g., *Heammawihio*) and food additives (e.g., *hnegripitrom*) with hard-to-pronounce names are more dangerous than rides (e.g., *Ohanzee*) and additives (e.g., *magnalroxate*; Song & Schwarz, 2009) with easy-to-pronounce names. They also report a greater willingness to engage in risky behaviors—such as having unprotected sex and smoking marijuana—after processing information quickly (Chandler & Pronin, 2012) and tend to share personal information more readily when the solicitation is printed fluently rather than disfluently (Alter & Oppenheimer, 2009a).

Oversharing is particularly dangerous over the Internet, and in one field study, we examined whether the fluency of a Web site's format influenced the willingness of contributors to disclose embarrassing personal information (Alter & Oppenheimer, 2009a, Study 4). Over the course of a decade, the now defunct Web site www.grouphug.us elicited a wide range of anonymous confessions, ranging from trivial peccadilloes to punishable crimes. The site originally featured a disfluent combination of grey font against a black background, but in August 2008, the webmaster replaced the dark background with a more fluent white alternative (Fig. 2). We collected confessions disclosed immediately before and after the change, and found that contributors were far more candid when the format was fluent. As in Alter and Oppenheimer's (2009a) three laboratory studies described in this article, disfluency tempered participants' willingness to reveal potentially self-relevant damaging information online, suggesting that cognitive roadblocks might dampen the problem of oversharing on the internet. Because people disclose less readily when they experience disfluency, perhaps Web browsers could automatically lessen the fluency of potentially dangerous Web pages that seek personal information. For example, keywords such as "social security number" or "credit card number" could be presented in a smaller, lighter, or more elaborate font.

Fig. 2. Original disfluent format of www.grouphug.us (left) and revamped fluent format (right), with a sample confession from the site.

Grappling with complexity

Although humans perceive risk in disfluency, we also have the capacity to embrace and derive benefit from complexity. Indeed, some of the most impressive traits that distinguish us from lower-order animals rest on our drive to think more deeply than mere survival demands. Humans perceive great meaning in the cultural relics of Shakespeare, Plato, Dostoevsky, and Pollock precisely because they alienate perceivers, encouraging them to invest greater cognitive effort to reach relatively obscure conclusions (e.g., Alter & Oppenheimer, 2008b; Bullot & Reber, 2013). Our tendency to persevere in the face of these cognitive hurdles explains in part why we are capable of mastering difficult tasks, such as touch-typing or driving, that might fell lower-order animals (e.g., Baddeley & Longman, 1978).

This same process also allows us to embrace people who differ from ourselves despite the xenophobic instinct to avoid them. For example, although social majorities fear minorities in part because they present cognitive challenges (Rubin, Paolini, & Crisp, 2010), other evidence suggests that disfluency encourages people to reconsider default stereotypes. To examine that effect, we (Alter et al., 2007) adopted a classic paradigm devised by Kahneman and Tversky (1973).

In demonstrating the representativeness heuristic, Kahneman and Tversky (1973) asked a sample of American adults to read a description of Tom W., an American graduate student who sounded suspiciously like a stereotypical computer science or engineering student. Among other traits, Tom W. was "highly intelligent, but lacking in true creativity," he had a "need for order and clarity," and his writing was "dull and mechanical, occasionally enlivened by corny puns and flashes of imagination of the sci-fi type" (p. 238). At the same time, these adults knew that computer science and engineering were uncommon college majors in the early 1970s, so base rates alone suggested that Tom W. was more likely to be studying social sciences or social work. Nonetheless, they tended to ignore those diagnostic base rates, simply matching Tom W. to his stereotype and assuming he was an engineer or a computer scientist.

Like many other researchers, we replicated this basic effect when we administered the same questionnaire almost 4 decades later (Alter et al., 2007, Experiment 3). In contrast, however, when we asked a second group of participants to estimate Tom W.'s major while they furrowed their brows—a facial feedback manipulation that simulates mental difficulty, or disfluency—they were significantly more likely to abandon stereotypes in favor of base rates. When they experienced disfluency, they thought more carefully about the task, overcoming the urge to rely on superficial stereotypes at the expense of more diagnostic information. With a subtle experimental nudge, they formed an impression of Tom W. only after exerting the effort to incorporate information that most people overlook. Sometimes, then, disfluency encourages people to delay their impressions of strangers until they gather additional information.

Outstanding Questions

Over the past decade, fluency researchers have shown that disfluency deepens and broadens thinking and dampens risky overdisclosure and stereotyping. Nonetheless, several questions about the benefit of disfluency remain unexplored.

Like other forms of hardship, disfluency takes a physiological toll, raising the perceiver's heart rate and blood pressure (von Helversen, Gendolla, Winkielman, & Schmidt, 2008) and depleting limited cognitive resources (e.g., Anderson, 2003). The existing literature focuses almost entirely on processing difficulty in the immediate term, with tasks extending no more than a few minutes from beginning to end. How, then, should researchers, educators, and policymakers balance cognitive ease and difficulty across time? One possible solution is to inject brief bursts of disfluency at carefully selected moments during an extended task, encouraging perceivers to pay closer attention when their limited mental resources are most valuable (see Fig. 3). This option rests on the

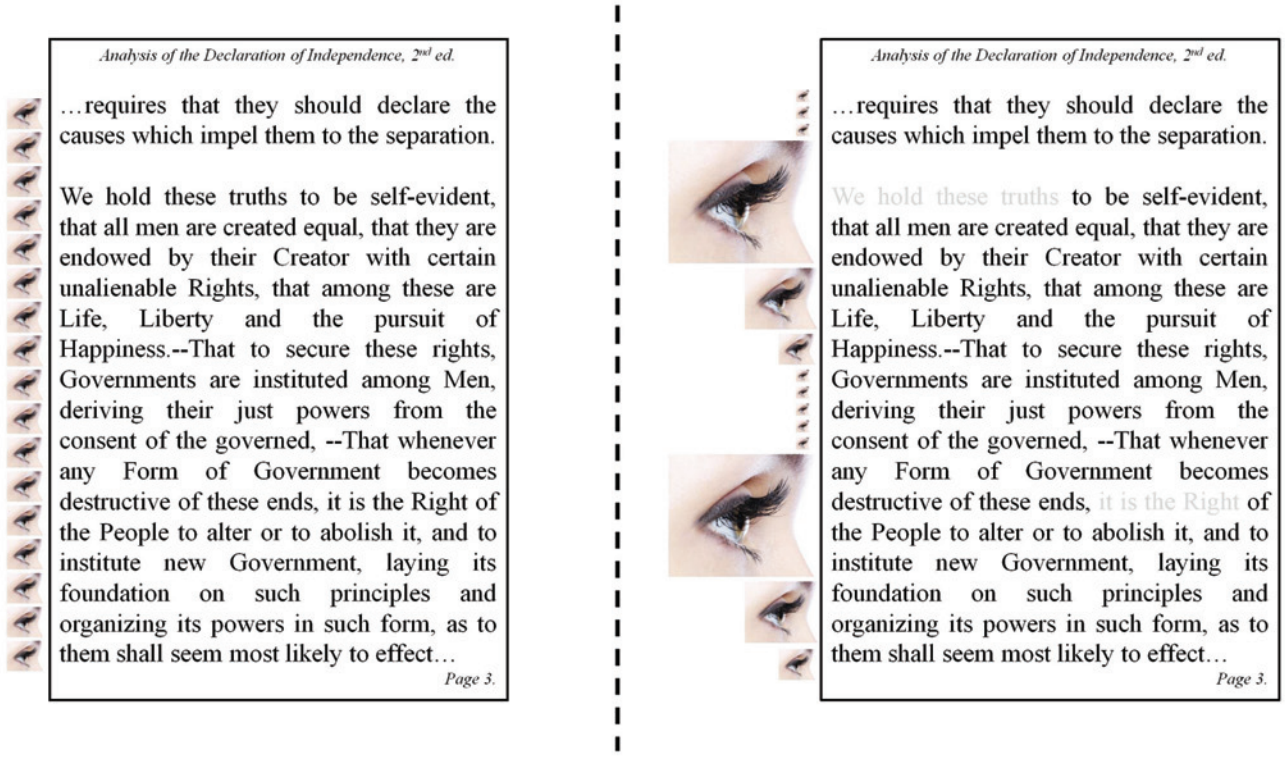

Fig. 3. In the absence of additional cues, readers pay equal (and limited) attention to an entire passage (left). Bursts of disfluency at strategic points in the text might encourage readers to attend closely to what follows and allow them to devote less attention to relatively unimportant passages.

untested assumption that people move fluidly between periods of deeper and shallower processing rather than settling into a deeper or shallower mode for the duration of the task (or until their attention wanes, or their resources are depleted). Bursts rather than extended periods of disfluency are ideal, because they allow perceivers to recover depleted cognitive resources while encouraging them to think more carefully when the task demands closer attention.

A second, related question is whether and how these results should be applied in educational and policy settings across time. Most existing research examines the immediate consequences of disfluency (that people transiently process information more deeply and broadly), but a more important practical question is whether disfluency benefits students in the long term. Students who are encouraged to overcome the artificial cognitive roadblocks imposed by disfluent experiences might, in time, become inoculated against greater mental challenges in the same way that a vaccination inoculates children against disease. According to this hypothesis, students might develop grit or perseverance as their cognitive muscles are strengthened by repeated exposure to challenging cognitive tasks (see, e.g., Duckworth, Peterson, Matthews, & Kelly, 2007). This question becomes more important over time, as smartphones and other gadgets perform the simple mental tasks that once forced humans to think, remember, and decide for themselves. As machines eliminate our need to remember phone numbers, add restaurant checks, and weigh the pros and cons of vacation destinations, we might become progressively less prepared for legitimate cognitive challenges that cannot be delegated to a machine. In time, then, without an occasional dose of cognitive disfluency, people might be tempted not to think very hard at all.

Recommended Reading

Alter, A. L., & Oppenheimer, D. M. (2009b). (See References). A comprehensive review of how researchers have manipulated fluency; suggests that these diverse approaches engender similar consequences despite mapping onto a vast range of cognitive processes.

Alter, A. L., Oppenheimer, D. M., Epley, N., & Eyre, R. N. (2007). (See References). Direct demonstration of the central result discussed in this article: that disfluency deepens processing when people complete tasks from four diverse domains.

Oppenheimer, D. M. (2008). The secret life of fluency. *Trends in Cognitive Sciences*, *12*, 237–241. An accessible review that explores the cognitive processes that bridge fluency

and judgment; explains why the same fluency experience sometimes prompts different outcomes.

Schwarz, N. (2004). (See References). Review article suggesting that people perceive and respond to fluency experiences depending on their naïve theories of what fluency suggests in that particular context.

Acknowledgments

I thank Hal Hershfield, Tom Meyvis, and Danny Oppenheimer for their invaluable feedback.

Declaration of Conflicting Interests

The author declared no conflicts of interest with respect to the authorship or the publication of this article.

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