

Infectious Cognition: Risk Perception Affects Socially Shared Retrieval-Induced Forgetting of Medical Information



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Abstract

When speakers selectively retrieve previously learned information, listeners often concurrently, and covertly, retrieve their memories of that information. This concurrent retrieval typically enhances memory for mentioned information (the rehearsal effect) and impairs memory for unmentioned but related information (socially shared retrieval-induced forgetting, SSRIF), relative to memory for unmentioned and unrelated information. Building on research showing that anxiety leads to increased attention to threat-relevant information, we explored whether concurrent retrieval is facilitated in high-anxiety real-world contexts. Participants first learned category-exemplar facts about meningococcal disease. Following a manipulation of perceived risk of infection (low vs. high risk), they listened to a mock radio show in which some of the facts were selectively practiced. Final recall tests showed that the rehearsal effect was equivalent between the two risk conditions, but SSRIF was significantly larger in the high-risk than in the low-risk condition. Thus, the tendency to exaggerate consequences of news events was found to have deleterious consequences.

Keywords

cognitive processes, forgetting, social interaction, memory, open data, open materials

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During the most recent Ebola epidemic in 2014, nearly 975 news segments across all major news channels covered the outbreak during the month after the first case was reported in the United States (Gertz & Savillo, 2014). Exaggerated media coverage of disease has by no means been particular to Ebola. For example, severe acute respiratory disorder and the avian and swine flus have been presented by the media as pandemic diseases. Media coverage can affect both people's knowledge about a disease (Signorielli, 1993) and their perceptions of its associated risks (Young, King, Harper, & Humphreys, 2013). In this article, we explore how risk perception modulates the effect that mass media have on the public's memories about diseases.

Extensive research has been conducted to investigate the effects of repeated retrieval on previously encoded memories. This literature has established that selective practice of previously encoded information can result in better memory for practiced information and, at the same time, can induce forgetting of related information (Anderson, Bjork, & Bjork, 1994). In such studies, participants first learn category-exemplar pairs (e.g., *fruit-apple*,

fruit-orange; *tree-oak*, *tree-pine*) and then receive practice for half of the items from half of the categories (e.g., *fruit-a_____*). Analyses of performance on a final cued-recall test show that practiced items (Rp+ items; *apple*) are remembered better than unpracticed unrelated items (Nrp items; *oak*, *pine*)—a rehearsal effect. Unpracticed items related to those that were practiced (Rp- items; *orange*) are remembered worse than Nrp items—a retrieval-induced forgetting (RIF) effect. The rehearsal effect is thought to occur because of trace strengthening (Karpicke & Roediger, 2007; see Bäuml & Kliegl, 2013, for an alternative account), whereas RIF is thought to arise through inhibitory processes triggered by response competition during the practice phase (Anderson & Levy, 2009; see Jonker, Seli, & MacLeod, 2013, for an alternative account).

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Induced forgetting has been found in contexts that involve retrieval practice during conversation, such as when people listen to a speaker who selectively remembers previously encoded information. When listeners concurrently retrieve that information along with the speaker, they experience socially shared RIF (SSRIF; Cuc, Koppel, & Hirst, 2007). That is, they forget information related to what the speaker mentioned to a larger degree than they forget unmentioned and unrelated information. This pattern has been found in a variety of experimental contexts, from autobiographical-memory paradigms, to those involving group-relevant information and flashbulb memories (Hirst & Echterhoff, 2012). SSRIF is enhanced in situations that increase the likelihood of concurrent retrieval, such as when listeners monitor the speaker's accuracy (Cuc et al., 2007), are motivated to relate to the speaker (Coman & Hirst, 2015), and perceive that they are similar to the speaker (Barber & Mather, 2012).

Mass media's tendency to exaggerate the potential risk of contracting infectious diseases creates yet another context that may facilitate concurrent retrieval. Given the well-established finding that anxiety increases attention to threat-relevant stimuli (MacLeod, Mathews, & Tata, 1986; Mather & Sutherland, 2011), we conjectured that increasing perception of the risk of infectious diseases creates a high-threat context. We hypothesized that the instantiation of this context triggers attention processes that facilitate listeners' concurrent retrieval when a speaker selectively remembers previously learned information, and thus promotes forgetting of unmentioned, related information.

In the current study, we explored how the selective retrieval of disease-related information via a mass-media source affects people's knowledge about the disease. Participants first learned information about an existing disease (meningitis) from a reliable source and then listened to a simulated radio broadcast in which a health expert selectively presented only some of that information. The listening task was conducted in one of two conditions: Information presented before the task indicated that there was either a high risk of infection or a low risk of infection. We focused on the effect of selective retrieval on participants' subsequent memories of the disease. Building on previous research on SSRIF (Cuc et al., 2007), we predicted that participants who listened to an audio clip that selectively mentioned previously learned information would experience forgetting of unmentioned related information. More specifically, we expected that participants in the high-risk condition would experience a greater amount of concurrent retrieval, and thus a greater degree of SSRIF, than participants in the low-risk condition. The study was approved by the Princeton University Institutional Review Board.

Method

Participants

A total of 567 participants were recruited online on Amazon Mechanical Turk, a crowdsourcing marketplace (Mason & Suri, 2012). They were compensated at a rate of \$3.50 an hour for their participation in the 15-min study. We aimed for a sample size of 500 participants, so that we could detect a medium effect size of .30 with a .90 level of power. One hundred seven participants were excluded on the basis of preestablished criteria: They failed an attention check, reported experiencing a malfunction with the audio portion of the study, had a personal medical history of meningitis, had previously participated in the pilot study (see the next section), or failed to complete the study. Statistical analyses were performed on the data from a final sample of 460 participants, who had been randomly assigned to the low-risk ($n = 227$) or the high-risk ($n = 233$) condition. The average age of the sample was 38.74 years ($SD = 13.03$), and 55% of the participants were female.

Stimulus materials

A pilot study was conducted to ensure that the stimulus items were not atypical of their category or extreme in their memorability. A total of 45 participants were recruited on Amazon Mechanical Turk (mean age = 38.19 years, $SD = 12.49$; 62% female). We first asked participants to study information about meningococcal disease, serogroup B, and to rate the category typicality of six items in each of five different categories (Keller & Kellas, 1978). The categories were as follows: symptoms, risk factors, tests and procedures for diagnosis, aftereffects, and preventive measures. After a distractor task, participants completed a final cued-recall task. On the basis of the typicality ratings and recall scores, we selected four categories, each containing four exemplars.

We then proceeded to create the materials for the main study. For the study phase, we used the 16 category-exemplar facts selected after the pilot study. For example, the exemplars for the symptoms category were "severe headaches that have a rapid onset," "uncomfortable and painful stiff neck," "sensitivity to natural and artificial light," and "a skin rash that could cover the whole body." Each exemplar was accompanied by an illustration.

For the manipulation of risk perception, we created two messages. The message used in the low-risk condition focused on the prevalence of meningococcal disease, serogroup B, in the United States. It specified that the likelihood of contracting the disease was extremely small, with only one case for every 100,000 individuals in

the United States recorded yearly. The message used in the high-risk condition focused instead on the consequences of the disease and specified that in some adult age groups, the mortality rate among infected individuals was as high as 40%. These descriptions were intended to differentially affect the participants' perception of their risk for contracting meningitis. As a manipulation check, participants were asked four questions assessing their anxiety about contracting the disease (e.g., "How anxious are you about contracting the meningococcal disease (serogroup B)?" ; 5-point Likert scale from 1, *not anxious at all*, to 5, *extremely anxious*). For ethical reasons, the information presented in both the low-risk condition and the high-risk condition was consistent with the Centers for Disease Control (CDC) descriptions and guidelines.

For the retrieval-practice phase, we created four redactions. Each redaction contained two of the four items from two of the four initially studied categories. For example, in one redaction, we included two items from the aftereffects category (hearing loss and epilepsy) and two items from the symptoms category (severe headache and skin rash). In this version, the other two exemplars in the aftereffects and symptoms categories were not mentioned, nor were the exemplars from the tests-and-procedures and risk-factors categories. Each exemplar was included in one of the four redactions. We then created audio clips corresponding to these redactions, using a radio talk-show framework. The radio show was introduced as the health-and-medicine hour at a radio station. In each clip, the purported talk-show host interviewed a guest who was said to be an employee from the CDC, and as they discussed meningococcal disease, serogroup B, the employee from the CDC recounted the facts corresponding to one of the four redactions.

Each audio clip contained half of the exemplars from half of the categories, so this retrieval-practice phase created three types of items: items that were mentioned in the audio clip (Rp+), items that were not mentioned but were related to those mentioned (Rp-), and items that were not mentioned and were not related to those mentioned (Nrp). Because the four redactions were randomly assigned to our participants, each item was equally likely to constitute an Rp-, Rp+, or Nrp item across the sample. In addition, we created two versions of each audio clip, so that the gender of the CDC employee could be counterbalanced across participants. The show's host and the CDC employee were always of opposite gender (Barber & Mather, 2012).

Design and procedure

The stimulus materials were presented through Qualtrics, an online survey platform. The study consisted of seven sections: (a) preliminary forms and questions, (b) study

phase, (c) risk manipulation, (d) retrieval-practice phase, (e) distractor task, (f) cued-recall phase, and (g) debriefing. In the first section of the study, participants were asked demographic questions, signed consent forms, and then completed a knowledge quiz that contained five multiple-choice questions about meningitis. The questions included in the quiz tested for general knowledge about meningitis; we ensured that there was no conceptual overlap between the knowledge test and the stimulus materials employed in the main study.

In the study phase, participants were provided with a brief description of meningococcal disease, serogroup B, after which they were presented with the 16 category-exemplar facts (see Stimulus Materials). The items in each category were presented one item at a time within a block, with their order randomized for each participant. The title of the category was presented before the exemplars, and the order in which the four categories were presented was also randomized for each participant. Participants were asked to read the information carefully but were not told that they would later take a recall test.

Participants were then randomly assigned to one of the risk conditions and read the corresponding message. As a manipulation check, they rated their anxiety about contracting meningococcal disease.

After the risk manipulation, participants completed the retrieval-practice phase. As a cover story, they were told that the CDC had launched a public-health initiative regarding meningococcal disease in the United States, and that they would listen to an excerpt of a radio show that was part of this initiative. Participants were randomly assigned to one of the eight audio clips of the radio show (see Stimulus Materials) and were asked to pay close attention to it. Once participants finished listening to the clip, they were asked to rate how much attention they had paid and were then allowed to move forward in the study.

Finally, after a brief distractor questionnaire, participants were asked to complete a cued-recall task. They were presented with the titles of the categories from the initial study phase (e.g., "Risk Factors"), one by one, and were asked to recall as much information as they possibly could from each category. Once participants typed their responses, they were fully debriefed. Additionally, they were provided with a link to the CDC Web site containing information on meningococcal disease. This was especially important for individuals in the high-risk condition, who may have experienced heightened anxiety about contracting meningitis.

Coding

One rater coded all participants' responses on the cued-recall task. Items were coded as remembered

if participants recalled the exact information originally presented or a reasonable variation of it. For instance, participants learned that a common procedure for diagnosis is “lumbar puncture,” and responses indicating that the disease can be diagnosed by a “spinal tap procedure” were counted as correct. When participants remembered an item, but for the incorrect category, the item was not counted as recalled (less than 3% of the data); counting such items as recalled did not change the reported pattern of results. The primary rater was blind to participants’ condition assignment. A second rater, blind to the study’s hypotheses, coded 10% of the full data set. Interrater reliability was high, $k = .95$.

Using the coded responses, we calculated each participant’s proportion of recall for Rp+, Rp–, and Nrp items. The rehearsal effect was computed by subtracting the proportion of recall for Nrp items from the proportion of recall for Rp+ items. SSRIF was computed by subtracting the proportion of recall for Rp– items from the proportion of recall for Nrp items.

Results

We first investigated whether the manipulation affected anxiety about contracting the disease, as intended. We reasoned that participants in the high-risk condition would be more anxious about contracting the disease than participants in the low-risk condition. We computed the average score for the four manipulation-check questions ($\alpha = .65$). An independent-samples t test revealed that participants were significantly more anxious about contracting the disease in the high-risk condition ($M = 2.32$, $SD = 0.62$) than in the low-risk condition ($M = 1.78$, $SD = 0.53$), $t(458) = 10.14$, $d = 0.95$, $p < .001$, 95% confidence interval (CI) for the difference between conditions = $[-.65, -.44]$. These differential levels of anxiety resulted in disparities in self-reported attention to the audio recording; participants reported paying more attention to the high-risk audio clip ($M = 4.63$, $SD = 0.56$) than to the low-risk audio clip ($M = 4.48$, $SD = 0.65$), $t(458) = 2.64$, $d = 0.25$, $p < .01$, 95% CI for the difference between conditions = $[-.26, -.04]$. This pattern is consistent with previous results (MacLeod et al., 1986) showing that anxiety results in increased attention to threat-relevant information.

Scores on the five questions assessing knowledge of meningitis were low and equivalent across the two groups. On average, participants in the low-risk condition answered 1.51 questions correctly ($SD = 1.13$), as did participants in the high-risk condition ($M = 1.51$, $SD = 1.15$). These low knowledge scores suggest that our participants did not know much about meningitis, which reduced the possibility that they used previously acquired knowledge to scaffold learning during the experiment.

Inasmuch as our hypothesis was focused on concurrent retrieval processes that primarily affect SSRIF, we conducted separate repeated measures analyses of variance to test for rehearsal effects and for SSRIF effects. In the analysis testing for a rehearsal effect, risk condition was a between-subjects variable, retrieval type (Rp+ vs. Nrp) was a within-subjects variable, and proportion of exemplars recalled was the dependent variable. We found a significant main effect for retrieval type, $F(1, 458) = 119.25$, $p < .001$, $\eta_p^2 = .21$, but no significant main effect for risk condition, $F(1, 458) = 2.28$, $p = .13$, $\eta_p^2 = .005$, and no significant interaction between risk condition and retrieval type, $F(1, 458) = 0.11$, $p = .74$, $\eta_p^2 = .001$. In exploring the main effect for retrieval type, we found a significant difference between recall of Rp+ items ($M = .66$, $SD = .31$) and recall of Nrp items ($M = .52$, $SD = .25$) in the low-risk condition, $t(226) = 7.54$, $p < .001$, $d = 0.50$, 95% CI for the difference between retrieval types = $[.11, .19]$. Similarly, in the high-risk condition, recall of Rp+ items ($M = .69$, $SD = .30$) was significantly higher than recall of Nrp items ($M = .55$, $SD = .24$), $t(232) = 7.93$, $p < .001$, $d = 0.52$, 95% CI for the difference between retrieval types = $[.10, .17]$ (see Fig. 1). The magnitude of the rehearsal effect was not significantly different between the high-risk ($M = .13$, $SD = .27$) and the low-risk ($M = .15$, $SD = .30$) conditions, $t(458) = 0.33$, $p = .74$, $d = 0.04$, 95% CI for the difference between conditions = $[-.04, .07]$ (see Fig. 2).

A similar analysis of the proportion of exemplars recalled was conducted to test for SSRIF. Risk condition was a between-subjects variable, and retrieval type (Rp– vs. Nrp) was a within-subjects variable. A significant main effect was found for retrieval type, $F(1, 458) = 33.84$, $p < .001$, $\eta_p^2 = .07$, but the main effect for risk condition, $F(1, 448) = 0.29$, $p = .58$, $\eta_p^2 = .001$, was not statistically significant. As hypothesized, the interaction between retrieval type and risk condition was statistically significant, $F(1, 458) = 4.18$, $p < .042$, $\eta_p^2 = .01$. We explored this interaction by conducting separate paired-samples t tests for the high-risk and the low-risk conditions. In the low-risk condition, we found a significant difference between recall of Nrp items ($M = .52$, $SD = .25$) and recall of Rp– items ($M = .47$, $SD = .30$), $t(226) = 2.63$, $p < .01$, $d = 0.19$, 95% CI of the difference between retrieval types = $[.01, .09]$. Similarly, in the high-risk condition, recall of Nrp items ($M = .55$, $SD = .24$) was significantly higher than recall of Rp– items ($M = .45$, $SD = .28$), $t(232) = 5.64$, $p < .001$, $d = 0.37$, 95% CI of the difference between retrieval types = $[.07, .14]$ (see Fig. 1). The interaction effect was driven by the fact that the magnitude of SSRIF was significantly higher in the high-risk ($M = .10$, $SD = .27$) than in the low-risk ($M = .05$, $SD = .27$) condition, $t(458) = 2.04$, $p < .042$, $d = 0.19$, 95% CI for the difference between conditions = $[.01, .10]$ (see Fig. 2).

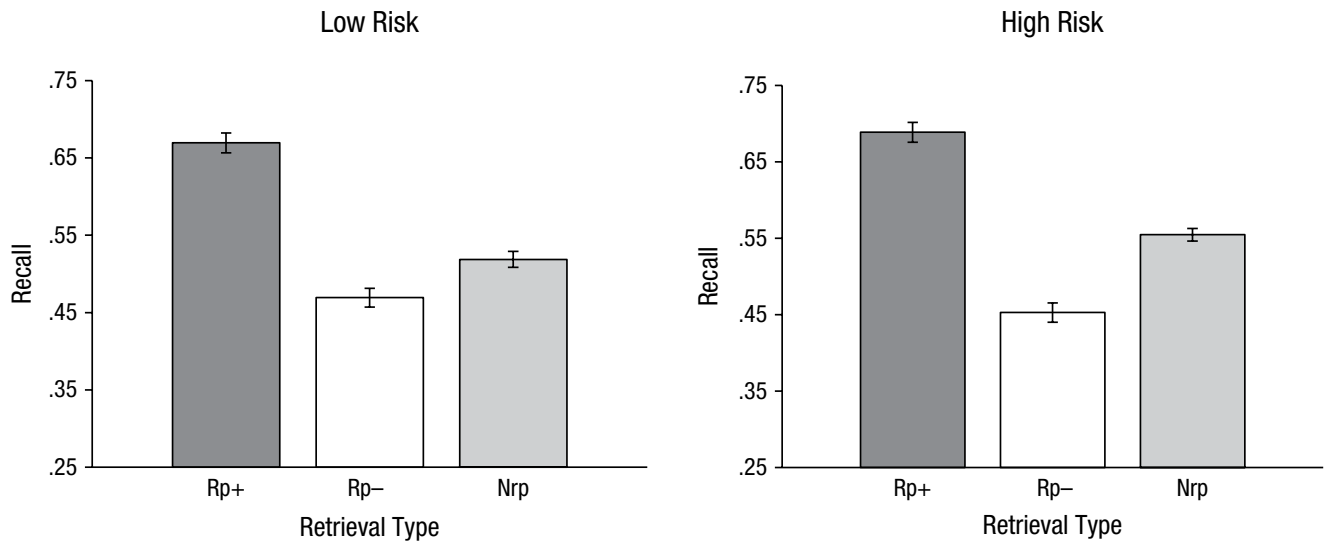


Fig. 1. Mean proportion of correctly recalled items as a function of retrieval type, separately for the low-risk condition (left panel) and the high-risk condition (right panel). Rp+ items are those that were mentioned by the speaker in the audio clip, Rp- items are those that were not mentioned but were related to the Rp+ items, and Nrp items are those that were not mentioned and were unrelated to the Rp+ items. Error bars represent $\pm 1 SE$, adjusted for within-subjects comparisons.

Discussion

By revealing the influence of risk perception on forgetting, rather than on remembering, our study is the first to show the deleterious consequences that exposure to mass media’s selective rendering of facts might have on the public’s memories. Risk perception had no impact on the rehearsal effect, however. One possible explanation is that there was a ceiling effect in the degree to which rehearsal led to increased recall. Previous research also found dissociations between rehearsal effects and RIF

(Storm, Bjork, Bjork, & Nestojko, 2006), probably because they involve different mechanisms, as mentioned in the introduction.

At a theoretical level, this study further clarifies the conditions that trigger SSRIF. We found that increasing risk perception led to a larger SSRIF effect. This pattern cannot be explained by the fact that the context shifted from the study phase to the test phase in the high-risk condition but not in the low-risk condition (Jonker et al., 2013). According to context-shift theory, these condition differences should have resulted in better recall for Nrp

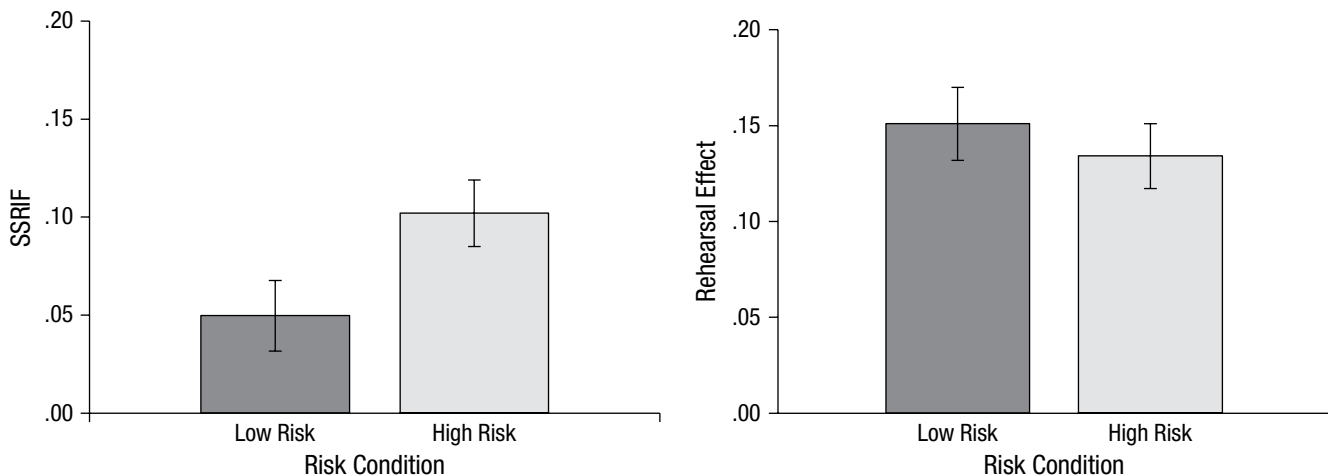


Fig. 2. Mean socially shared retrieval-induced forgetting (SSRIF; left panel) and rehearsal effect (right panel) in the two risk conditions. SSRIF was computed by subtracting the proportion of recall for nonmentioned items related to mentioned items (Rp- items) from the proportion of recall for nonmentioned, unrelated items (Nrp items). The rehearsal effect was computed by subtracting the proportion of recall for Nrp items from the proportion of recall for mentioned items (Rp+ items). Error bars represent $\pm 1 SE$.

items in the low-risk condition than in the high-risk condition, which we did not find. The pattern we obtained is consistent, however, with previous findings showing that anxiety increases attention to threat-relevant stimuli (MacLeod et al., 1986). Our findings showcase a paradoxical effect: Individuals who listen to health experts thoroughly because of increased risk perception are most susceptible to experiencing forgetting due to the selective nature of this exposure.

In our study, the listeners were exposed to the selective-practice phase only once. In real-world circumstances, however, individuals are typically exposed to similar renditions of the same facts repeatedly. Selective exposure has cumulative effects on forgetting, such that repeated retrieval practice leads to a proportional increase in SSRIF (Coman & Hirst, 2012). The repeated exposure to the selective practice characteristic of the 24-hr news cycle of cable television (Silvia, 2001) makes audiences particularly susceptible to SSRIF.

In today's media landscape, the competition among media sources triggers escalation in emphasizing the extreme nature of news events. This escalation leads mass media to overemphasize low-probability, high-consequence events, such as outbreaks of rare diseases (e.g., Ebola), and underemphasize more common but less dramatic risks (e.g., diabetes; Singer & Endreny, 1993). As the public continues to rely on mass-media sources for access to health information, the negative effects of this increased dependence need to be seriously considered. Although it is impractical to eliminate the possibility of SSRIF, there are specific measures that could be taken by media outlets to reduce these negative effects on the public's knowledge (Trumbo, 1999). Accurately depicting risks when covering disease-related information and ensuring that critical information is repeated in a complete, rather than selective, manner are strategies that could diminish the effect of retrieval on people's memories and result in a more informed and prepared public.

Author Contributions

A. Coman developed the study concept. Testing and data collection were performed by J. N. Berry. A. Coman performed the data analysis and interpretation. Both authors drafted the manuscript and approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Open Practices



All data and materials have been made publicly available via Open Science Framework and can be accessed at <https://osf.io/gjp53/>. The complete Open Practices Disclosure for this article can be found at <http://pss.sagepub.com/content/by/supplemental-data>. This article has received badges for Open Data and Open Materials. More information about the Open Practices badges can be found at <https://osf.io/tvyxz/wiki/1.%20View%20the%20Badges/> and <http://pss.sagepub.com/content/25/1/3.full>.

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