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The Danger of Hoax: The Effect of Inaccurate Information on Semantic Memory

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Abstract

This study focuses on the vulnerability of general knowledge held in semantic memory. Previous studies have shown that exposure to inaccurate information can negatively affect prior knowledge. This study explores the effect of exposure to inaccurate information on semantic memory, presented in nonfiction articles. The procedure consisted of a pretest (general knowledge quiz), a manipulation stage one week later with articles containing inaccurate information for the experimental group and neutral information for the control group, and a posttest (another general knowledge quiz) given immediately after the manipulation stage. The participants were 55 Universitas Indonesia undergraduate students, divided into control and experimental groups by randomized matching based on the pretest results. An independent sample t-test showed a significant difference between the experimental group ($M = -1.538$, $SD = 1.794$) and the control group ($M = 0.517$, $SD = 1.639$), ($t(53) = -4.441$, $p < 0.01$, *two-tailed*), with the experimental group showing a decline in general knowledge quiz scores. These findings demonstrate that exposure to inaccurate information affects semantic memory by interfering with the retrieval process of that memory.

Bahaya *Hoax*: Efek Pemberian Informasi Tidak Akurat terhadap Ingatan Semantik

Abstrak

Studi ini membahas mengenai kerentanan pengetahuan umum yang tersimpan dalam memori semantik. Studi sebelumnya menunjukkan bahwa paparan informasi yang tidak akurat dapat mempengaruhi pengetahuan yang dimiliki sebelumnya secara negatif. Studi ini mengeksplorasi pengaruh paparan informasi yang tidak akurat terhadap memori semantik, yang disajikan dalam bentuk artikel nonfiksi. Penelitian terdiri dari *pretest* (kuis pengetahuan umum), satu minggu kemudian diberikan manipulasi menggunakan artikel yang berisi informasi yang tidak akurat untuk kelompok eksperimen dan informasi netral untuk kelompok kontrol, dan *posttest* (kuis pengetahuan umum lainnya) yang diberikan segera setelah tahap manipulasi. Partisipan terdiri dari 55 mahasiswa S1 Universitas Indonesia, yang dibagi secara acak ke dalam kelompok kontrol dan kelompok eksperimen berdasarkan hasil *pretest*. Analisis *independent sample t-test* menunjukkan ada perbedaan skor yang signifikan antara kelompok eksperimen ($M = -1.538$, $SD = 1.794$) dan kelompok kontrol ($M = 0.517$, $SD = 1.639$), ($t(53) = -4.441$, $p < 0.01$, dua arah), kelompok eksperimen menunjukkan penurunan skor kuis pengetahuan umum. Temuan ini menunjukkan bahwa paparan informasi yang tidak akurat mempengaruhi memori semantik dengan mengganggu proses *retrieval*.

Keywords: fake news, inaccurate information, misinformation, semantic memory

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1. Introduction

Advancements in technology make the exchange of information increasingly easier. However, circulated information comprises not only important information, but also "information" that lacks urgency and meaning, for instance, gossip, rumors, and hoaxes (Situngkir, 2011). Hoax news, also called "fake news," can be considered journalistic deception, that is, the distribution of messages containing false or incomplete information (Elliot & Culver, 1992; Lee, 2004). In the technological communication context, a hoax can be defined as any electronic message containing false information intended to deceive the reader. False information can be presented as text, image, audio, or any other type of

multimedia content (Vuković, Pripužić, & Belani, 2009). In Indonesia, circulated hoaxes are common. For example, news that Indonesia's ex-president B.J. Habibie had passed away circulated through *WhatsApp* on March 30, 2017. Later, the news was found to be fake (Haryandi, 2017).

Previous studies have demonstrated that human memory is vulnerable to interference that can cause its alteration or even loss (Tulving, 1986). Indeed, many studies have focused on episodic memory's vulnerability (Loftus, 2004; Tversky & Marsh, 2000). Then, what about semantic memory or memory of general knowledge related to what often appears in hoaxes?

Tulving (1972) pictured semantic memory as a mental encyclopedia in which one stores organized knowledge about words and other verbal symbols (cited in Mitchell, 1989). In addition, Ashcraft and Radvansky (2010) defined semantic memory as one's general knowledge or knowledge about the world, including common knowledge like information provided in schools and general everyday knowledge (King, 2012).

Several factors affect semantic memory, such as age (West, Crook, & Barron, 1992; Nyberg, Bäckman, Erngrund, Olofsson, & Nilsson, 1996), education (West et al., 1992), and gender (Nyberg et al., 1996). According to West et al. (1992), age is the most significant factor affecting memory performance. This is supported by Nyberg et al.'s (1996) finding that age is associated with fluid intelligence that can affect memory. West et al. (1992) also found that education affects memory performance. In relation to gender, Nyberg et al. (1996) stated that compared with men, women performed better on episodic and semantic memory tests.

Although Tulving (1986) mentioned that episodic memory is more vulnerable to interference, subsequent studies have shown that semantic memory is not fully safe from interference. One type of interference is inaccurate information, or misinformation; this is false information spread intentionally or unintentionally, and the reader does not consciously realize the errors presented (Antoniadis, Litou, & Kalogeraki, 2015). Inaccuracy can be produced by intentionally manipulating information or by an unintentional error that makes a text unreliable (Rapp & Braasch, 2014).

Empirical studies have consistently shown that reading inaccurate information can influence general knowledge. A participant who read fictional stories containing inaccurate information tended to produce incorrect answers in general knowledge tests conducted afterward and even misrepresented the source of misinformation (Marsh, Meade, & Roediger III, 2003; Fazio et al., 2013). Warning participants about the existence of misinformation in stories did not diminish this effect (Marsh & Fazio, 2006).

Fazio et al. (2013) researched the effect of inaccurate information in fictional stories on people's ability to answer correctly on a general knowledge quiz. The participants first took a general knowledge quiz as a pretest of their base knowledge. Then, they took another quiz after they had read fictional stories containing inaccurate information. The results showed that reading fictional stories containing inaccurate information made the participants recall incorrect information that contradicted their prior knowledge during the later measurement. Inaccurate information affects knowledge by creating an "illusion of knowledge," that is, an error in which a person mistakes inaccurate information that s/he just read as information s/he knew previously.

For the current study, we asked the following research question: "Does exposure to inaccurate information affect semantic memory?" Thus, this study's purpose is to shed light on the effects of exposure to inaccurate information on semantic memory by analyzing the difference or change in scores between the pretest and posttest for experimental and control groups. We proposed the following hypothesis: "There is a difference of mean in declining test scores between an experimental group given articles containing inaccurate information and a control group given articles containing neutral information."

Given the previous studies, the relation of semantic memory and exposure to inaccurate information motivated our team to conduct research based on Fazio et al.'s (2013) work concerning interference in semantic memory. Fazio's study used a general knowledge quiz as the measurement tool of semantic memory to examine the effect of exposure to inaccurate information presented as fictional stories. The current study modifies the previous one by changing fictional stories to nonfictional articles to increase the relevancy of circulated hoaxes with the current issue. The present study was conducted with the hope of providing insights into semantic memory's stability; since inaccurate information might interfere with existing memory, one needs to be careful when presented with new information, namely, to check its validity before committing the new information to semantic memory.

2. Methods

Participants. The participants were Universitas Indonesia undergraduate students, whose ages were limited to 18–23 to ensure constancy, from the graduating classes of 2013, 2014, 2015, and 2016. To recruit them, we used two types of non-probability sampling: snowball and accidental. This study's first stage included 64 participants (M = 19.89, SD = 1.311), randomly divided into two groups of 32 (i.e., a control group and experimental group) by a matching technique based on

their pretest results. Nine participants failed to fall into categories for the study's second and third stages, leaving 55 participants with complete data (26 in the experimental group and 29 in the control group).

The 55 participants consisted of 76.5% female and 23.6% male participants with an age range of 18–22 (M = 19.89, SD = 1.21). They came from 11 faculties at Universitas Indonesia, with the highest percentage (50.9%) from the Faculty of Psychology and the lowest from the Faculties of Computer Science, Economy and Business, and Nursing Sciences, with 1.8% each.

Research Design. This is an experimental study that used strict controls, manipulation, and randomization (Gravetter & Forzano, 2012). Based on paradigm and control techniques, the study used the between-subjects matched two-group design (Gravetter & Forzano, 2012). The treatments given to the participants were articles containing inaccurate information for the experimental group and neutral articles for the control group. The control techniques consisted of randomized matching based on pretest scores for dividing the participants into the two groups, as well as ensuring constancy for age range, education, time of experiment, and same location for the pretest and posttest.

Instruments and Measurement. The measurement tools were two general knowledge quizzes, the first administered as a pretest before the manipulation and the second as a posttest after the manipulation. The two quizzes were similar. Quiz questions were based on the norm of general knowledge from Nelson and Narens (1980) and a compilation of general knowledge from researchers and textbooks used by Indonesian students—to match the Indonesian college students' general knowledge. Meanwhile, the instruments for manipulation were three nonfictional articles containing neutral information for the control group and three nonfictional articles with the same themes but with inaccurate information added for the experimental group.

The quizzes used to measure semantic memory consisted of 30 general knowledge questions each, with questions in two categories. The first category contained 20 critical questions that appeared on both the pretest and posttest (e.g., "In what city is the Colosseum located?"). Information related to the critical questions was included in the treatment articles (e.g., "As we know, Italy has one of the seven wonders of the world, that is, the Colosseum"). The second category contained filler questions not included in scoring and not mentioned in the treatment articles (e.g., "Which country uses the Rupee as its currency?"). Different filler questions were used for the pretest and posttest.

To test the 20 critical questions, we had previously conducted a pre-research survey with 30 undergraduate psychology students in 2013, 2014, 2015, and 2016 to ensure questions were considered common or general knowledge by undergraduate college students. The preliminary survey participants completed an online quiz of 40 multiple-choice general knowledge questions (link: bit.ly/SurveyPraPenelitian).

Referring to a similar study by Fazio et al. (2013), we used multiple-choice questions, with codes of "correct answer," "answer from misinformation," "false answer," and "I don't know." The order of codes was randomized for every question. For example, a question used on both the pretest and posttest was, "What is the capital city of Australia?" with answer choices of "Canberra" (correct answer), "Sydney" (answer from misinformation presented in manipulation article), "Melbourne" (false answer), and "I don't know." Each correct answer for the 20 critical questions was scored as 1. Participants who chose the answer from misinformation, i.e., the false answer, or "I don't know," received a score of 0. The quiz scores were then summed for a total score with a maximum of 20 points and a minimum of 0.

The manipulations were nonfictional articles with three themes. The control group received three nonfictional articles containing 20 pieces of neutral information (e.g., "As we know, Italy has one of the seven wonders of the world, that is, the Colosseum"). Meanwhile, the experimental group received three similar nonfictional articles manipulated to contain 15 pieces of inaccurate information (e.g., "As we know, Italy has one of the seven wonders of the world, that is, the Colosseum located in the city of Milan") and five pieces of neutral information (e.g., "The first national flag of Indonesia was sewn by Soekarno's wife").

The three articles were presented on three sheets of paper, respectively, and then assembled into a package of articles. Three packages of articles were used, each in a partially different order for counterbalancing, to control any sequencing effect that might occur (Gravetter & Forzano, 2012).

Procedures. The study was conducted in three stages–pretest, manipulation, and posttest (see Figure 1). For the pretest stage, the participants gathered in a classroom and answered quiz questions online (link: bit.ly/TahapSatu) for 5 minutes. They gave their informed consent to participate through the pretest link. After the pretest, the participants were asked to indicate their preference for a posttest schedule during the next week.

The second stage was manipulation, conducted a week after the pretest. Before this stage, the participants had already been divided, via the randomized matching technique, into a control group and an experimental group. The control group received articles with neutral information, while the experimental group received

articles with inaccurate information. The participants had 5 minutes to read each article once. After that, they played the online game 2048 for a 5-minute break to prevent retrieval practice. According to Barber et al. (2008, in Fazio et al., 2013), retrieval practice can strengthen the activation of misinformation, so errors are possible after a time delay.

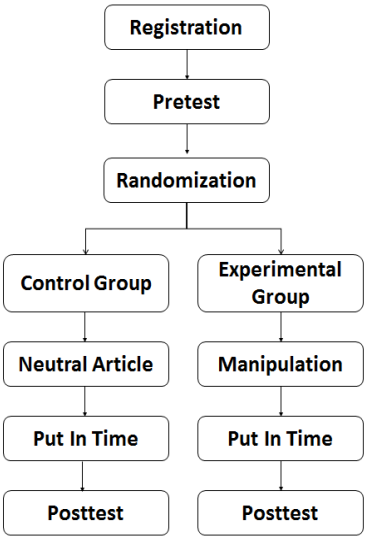

Figure 1. Research Procedures Flowchart

The last stage was conducted immediately after the 5-minute break. The participants opened a link to the posttest questions, which they were to complete in 5 minutes. At the end of the posttest form, a manipulation check was included: "Do you think the articles that you read earlier contained inaccurate information?" The participants who answered "yes" in the experimental group were considered successfully manipulated. Finally, we debriefed all the participants.

3. Results

An independent sample t-test was used to compare the mean scores between the experimental and control groups. The change scores were also measured for the experimental group and control group. The change score indicates the difference in value between a variable measured at a specific time and the value of the same variable measured previously (Lewis-Breck, Bryman, & Futing Liao, 2004). In this study, the change score was obtained by finding the difference between participants' pretest and posttest scores.

The results in Table 1 reveal that the mean change score for the experimental group had a negative value, indicating a decline from the pretest to posttest scores. Meanwhile, the mean change score for the control group had a positive value, indicating no decline from the pretest to posttest scores.

After obtaining the change score means for each group, we performed statistical analysis to determine whether the difference between the pretest and posttest scores for the experimental and control groups differed significantly. Based on the results of an independent samples t-test, there was a significant change score difference between the experimental group ($M = -1.538$, $SD = 1.794$) and the control group ($M = 0.517$, $SD = 1.639$) ($t(53) = -4.441$, $p < 0.01$, *two-tailed*), with an effect size of $r^2 = 0.271$. Based on Gravetter and Wallnau (2013), this result reflects a large effect size, demonstrating that 27% of the variance in participants' semantic memory can be explained by exposure to inaccurate information.

4. Discussion

The analysis results showed a significant difference between participants who read articles containing misinformation and those who read articles containing neutral information. The experimental group had a decline in scores, which indicates that the misinformation in the nonfictional articles affected their semantic memory. This decline happened even after the participants were warned that the articles might contain inaccurate information and participants already possessed prior knowledge of that information. This finding corresponds to our reference study by Fazio et al. (2013) and some other previous studies (Mullet, Umanath, & Marsh, 2014; Marsh, Meade, & Roediger III, 2003), which showed that reading misinformation could result in wrong factual knowledge that contradicted prior knowledge.

Table 1. Mean and Standard Deviation for Pretest, Posttest, and Change Scores for the Experimental and Control Groups

Research Group				Change Score	
	N	*Pretest Mean*	*Posttest Mean*	*Mean*	*SD*
Experimental group	26	15.077	13.539	−1.538	1.794
Control group	29	15.276	15.793	0.517	1.639
Total	55				

Fazio et al. (2013) explained the effect of misinformation on knowledge with the term "illusion of knowledge," an error in which a person feels that s/he has previously known the misinformation in an article even before reading the article (Marsh, Meade, & Roediger III, 2003). Illusion of knowledge is also supported by "knowledge neglect," an error in which participants actually have the required correct knowledge in their memory but fail to retrieve it (Marsh, Meade, & Roediger III, 2003).

However, the effect of misinformation should not be seen as an alteration of correct memory into false memory. As explained by Fazio et al. (2013), knowledge from misinformation coexists with prior correct knowledge in a person's memory. The difference is that memory from misinformation is easier to access because it has only recently been in the memory, unlike prior correct knowledge that has been in the memory for a relatively long time (Fazio et al., 2013). This mechanism is supported by the recency effect that suggests newer information, or information that has just been encoded, is most likely still saved in the working memory, making it easier to retrieve than old memories (King, 2012).

The effect of exposure to misinformation did not diminish even when the participants were warned beforehand about the possibility of inaccurate information appearing in the articles. This finding corresponds with those of previous studies (e.g., Eslick, Fazio, & Marsh, 2011), which showed that warnings made participants more cautious in reading, which in turn made it easier to encode misinformation into the memory. This could even increase the likelihood of participants answering questions about general knowledge with false information they just read.

Although this study replicates previous research by Fazio et al. (2013), one difference is that the articles used here for manipulation were nonfictional. In several prior studies, the effect of inaccurate information was revealed by manipulation with fictional stories. This study shows the same effect in nonfiction.

One of this study's strong points is its relevancy to current everyday lives because it relates to hoaxes, usually in the form of "fake news" that is falsely perceived as reliable. Another strong point is the sample of late adolescents and young adults who used technology frequently; the study could raise their awareness about the effects of inaccurate information easily distributed through communication technology. The research findings are quite urgent for late adolescents and young adults because previous studies have shown that they are more vulnerable to the effects of misinformation in comparison to children, late adults, and adults experiencing early Alzheimer's and dementia. This is because young people can better encode inaccurate information into memory and are thus more vulnerable to knowledge neglect (Fazio & Marsh, 2008; Marsh, Balota, & Roediger, 2005). Lastly, this study shows a large effect size, indicating that failure in retrieving semantic memory can be explained partly by exposure to inaccurate information.

This research has some limitations. One is participant attrition; some participants dropped out, particularly between the pretest and the manipulation stage. This led to a minor disproportion between the control and experimental groups, resulting in less data than expected. To prevent this situation in future research, several measures could be taken, for instance, discussing early in the registration phase the most appropriate time for the posttest. In anticipation of attrition, researchers could also recruit a larger number of participants than necessary.

Another limitation is the disproportion between male and female participants, that is, 13 males and 42 females, especially because a previous study indicated that gender influences memory performance (Nyberg et al., 1996). For future researchers, we suggest controlling gender to minimize external factors, or adding gender difference as a variable. Lastly, this study was conducted in the hope of providing insights into the effect of inaccurate information on cognition, so that future studies can further advance the field.

5. Conclusion

Based on the research question, this study showed that exposure to inaccurate information can affect semantic memory by generating an illusion of knowledge and knowledge neglect. One study implication is that the retrieval of semantic memory may be disrupted by inaccurate external information despite the possession of prior correct knowledge. Another implication pertains to the impact of inaccurate information in people's everyday lives.

Students and the general public are often confronted with hoaxes containing inaccurate information in their everyday lives. Therefore, determining what matters, what information supports or refutes a statement, and how to respond to contradictory sources becomes important for daily routine (Rapp, 2016).

This study found that reading misinformation could interrupt prior knowledge, which could remind us that sometimes, knowledge neglect is unavoidable when we fail to use information we have obtained and instead use inaccurate information that we have just attained. This finding could be used to raise social awareness about thinking critically and to raise alertness to hoaxes being spread. Increasing alertness to hoaxes would be useful because, as suggested by this study, misinformation

appearing in hoaxes could affect memory even when we know that the information might be inaccurate.

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