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IMPACT OF REMEMBERING VS. KNOWING ON STRENGTH OF BELIEF IN NEUROMYTHS

A Capstone Project Presented in Partial Fulfillment

of the Requirements for the Degree Bachelor of Psychology

with Honors College Graduate Distinction at

Western Kentucky University

By

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November 2019

*****

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2019

I dedicate this thesis to my family for their continued support towards this thesis and my college education.

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ABSTRACT

As technology advances, misinformation can be spread easier than ever before. Many things the general public believe to be true are either completely false or contradict research findings. However, many people are not willing to give up their belief in false information, even if there is evidence to refute it. Neuromyths are a particular type of widespread misinformation involving incorrect beliefs about brain function (e.g., people can be either left-or right brained). Understanding the origins of neuromyths is important, because it may relate to the strength of individuals' belief in these myths. Therefore, it is important to determine whether remembering (i.e., have a specific recollection of when and where something was learned) vs. knowing (i.e., knowing the information but having no recollection of where or from what source it was learned) impacts how firm people are in their beliefs. Participants were presented with a list consisting of facts about the brain and neuromyths, asked how strongly they believed each statement, and whether they remembered, knew, or guessed that the statement was true. If they remembered, they were asked the specific source of the information (e.g., read it in a book, told by a teacher, etc.). For 2 of the 8 neuromyths, there was a significant relationship between strength of belief and having a distinct recollection of the source of the information. However, overall, knowing was associated with stronger beliefs than remembering the source of the information. These findings may be useful for interventions designed to combat neuromyths, as determining neuromyths' origins could help educators identify more effective ways to replace neuromyths with correct knowledge about brain function.

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Prevalence of misinformation

Advances in technology are making it easier to spread misinformation, which in turn makes misinformation accessible to more people. While it is simultaneously becoming easier to access true information, many people trust inaccurate sources of information and refuse to change their beliefs in misinformation, even when they are presented with information that refutes it (Ecker, Lewandowsky, & Tang, 2010). A prime example is the false statement made by both Dick Cheney and Donald Rumsfield regarding Saddam Hussein having weapons of mass destruction (WMDs). Little research had been done on this claim prior to the story being spread, but it was soon discovered that there was no evidence to support it. Once it became known that Cheney and Rumsfield had fabricated this statement, 35% of those polled still believed that Hussein had WMDs (Kull, Ramsay, & Lewis, 2003). Oftentimes, people accept information as it is presented to them without doing further research because they received it from a seemingly reliable source (e.g., news, educators, and scholarly articles). However, the reliability of the source does not always impact the strength of individuals' belief in the information (Henkel & Mattson, 2011). Therefore, it is important to explore other factors that cause people to hold onto beliefs in false information.

With the increase of access to "fake news" (i.e., "fabricated information that mimics news media content in form but not in organizational process or intent"; Lazer, Baum, Benkler, Greenhill, Menczer, & Schudson, 2018, p. 1094), it is becoming increasingly important to stop the spread of misinformation. A survey conducted by the Pew Research Center in 2016 found that 23% of adults in the United States have shared some form of misinformation (Barthel, Mitchell, & Holcomb, 2016). Some people claimed to have spread the misinformation knowingly, but many Americans have found themselves sharing news to later find out that it was fake. This problem is caused by individuals believing what is presented to them without researching it before sharing it with others.

There is also the issue of many people only taking in news that is convenient to them (primarily through the internet and cable television; Jarvis, Stround, & Gilliland, 2009). Additionally, believing information to be true, but not recalling where it originated, may contribute to the spread of false information: individuals can unintentionally create false memories where they claim to “remember” learning something that they never actually learned (Roediger & McDermott, 1995). Roediger and McDermott measured the amount of false recall and recognition in a list learning paradigm. Participants were presented with 12 words, then asked to look at another list of words to determine whether each word on the new list was on the original list. “Non-words” (words which were not on the original list) were recalled with high confidence 40% of the time when participants were tested immediately after being presented with the original word list. When the word list was longer and more time passed between presentation and testing, “non-words” were recalled 55% of the time. Thus, even when tested immediately after learning, people can confidently create false memories of learning information and as more time passes, they are more likely to create these false memories. Roediger and McDermott’s (1995) results show how easily false memories for learning can be created, which may lead to people unknowingly spreading misinformation, and being confident of its accuracy.

Neuromyths

In the field of psychology, the spread of false information can be found in the form of neuromyths. Neuromyths are widely believed misconceptions about the brain and how it functions (Pasquinelli, 2012). Some common neuromyths are "we only use 10% of our brains" and "individuals learn better when they receive information in their preferred learning style" (Dekker, Howard-Jones, & Jolles, 2012). In her research on neuromyths, Pasquinelli (2012) found that, like most widely believed misinformation, neuromyths are often rooted in scientific fact. Neuromyths can be a result of the distortion of true information, such as the unnecessary simplification of scientific fact, or simply misunderstanding the results of experiments. Additionally, due to new discoveries and advancements in the fields of neuroscience and psychology, neuromyths are often the result of continuing to believe scientific theories that have been widely believed for a long period of time, but have since been determined to be false. In an investigation of the accuracy of introductory psychology course textbooks, Ferguson and colleagues (2018) found a large number of incorrect facts (e.g., listening to classical music increases children's reasoning ability, the Kitty Genovese story, and the impact media violence has on aggression and violence). They also found a large amount of bias in many of the textbooks (e.g., citation bias and ideological biases). In a content analysis of education and educational psychology textbooks, Wininger et al. (2019) found that 80% of these textbooks included content on learning styles.

Consequences of belief in neuromyths

Although the present study specifically focused on neuromyths, it is important to understand the impact false information as a whole can have. Refusing to believe new information that disputes one’s existing false beliefs can be harmful in many regards. If educators were to believe in false information, especially when the contradictory accurate information is presented to them, they might continue to pass on misinformation to students. On a broader scale, the belief in the false information that vaccines cause Autism Spectrum Disorder has had a large impact on society. Although there is no scientific evidence that vaccines are harmful, and despite the fact that the evidence that led to this myth was fabricated, it is now a widespread belief that impacts the decisions of many about whether to vaccinate their children (Godlee & Marcovitch, 2011). This false information has led not only to an increase in vaccine-preventable diseases, but also large amounts of money being invested in further research and campaigns to correct the misinformation (Lewandowsky et al., 2012). Nevertheless, years after the publication of the original false information, this misinformation is still being spread.

Belief in neuromyths can lead to the spread of inaccurate information, which is detrimental in and of itself. However, it can also lead people to behaviors that can be harmful, or at the very least, not ideal. One example of this is the belief in the neuromyth “individuals learn better in their preferred learning style.” Those who believe this myth believe that they learn best using one specific sense (e.g., visually). Consequently, they may believe that to learn best, they need to be provided instruction visually, and that they will not perform as well if they are not provided instruction in this way (Riener & Willingham, 2010). Experiencing difficulty in learning situations may then be attributed to not being taught in one’s preferred learning style, as opposed to attributing difficulty to something within the learner’s control. Such maladaptive attributions can decrease motivation, and eventually, result in learned helplessness (the belief that one will fail no matter what; Peterson, 2010).

Rejection of correct information

Even when accurate information is presented that contradicts existing beliefs in false information, many people continue believe the misinformation. Ecker (2017) found that even when a correction to false information is presented, and the correction is understood, believed, and remembered, many people are still influenced by the false information.

One reason people reject correction of misinformation is because of inconvenience. When information does not fit into beliefs and attitudes that they have already formed, it is not motivating for them to try and find new information that refutes what they already believe, especially when the misinformation aligns with their existing worldviews. Correcting this misinformation could require reevaluation of beliefs, which many are hesitant to do (Kahnerman, 2011). Oftentimes, people refuse to reevaluate their beliefs because of their connection to their self-concept. Being told to reevaluate beliefs, to many people, feels like reevaluating who they are (Harris et al., 2009).

Additionally, correction of misinformation can also lead to stronger beliefs in the false information. This is called the “worldview backfire effect” (Ecker, et al., 2011). This is when people attempt to correct false information by repeating that the information is false. However, when the misinformation is stated repeatedly, people may remember something about it, but not have an explicit memory of the myth being corrected (e.g., “I know he said something about vaccines and autism”). Therefore, some attempts to correct myths may unintentionally reinforce belief in false information (Ecker, et al., 2011).

Finally, the way correction of misinformation is presented can impact how well the correction works. For example, if a neuromyth was presented as “the belief that individuals can be left-brained or right-brained is false,” this allows people to read the myth statement, process it, and potentially begin to believe it before processing the part of the statement that indicates it is incorrect (Ecker, et al., 2011).Therefore, in order for this type of correction to be successful, the recipient may have to backtrack (i.e., reread) after being exposed to the myth, in order to learn that it is incorrect.

Belief Formation and Impacts

Due to the prevalence of misinformation and the difficulty of correcting beliefs in misinformation, it is important to find a way to combat people’s tendency to hold onto beliefs, even when presented with alternative information. Beliefs can be formed in response to the human brain’s readiness to identify patterns in the world (e.g., assumptions based on what one has observed), as well as our tendency to believe that everything takes place intentionally (Grayling, 2011). In other words, beliefs come from people’s desires to understand what is going on in the world around them. However, people are presented with an overwhelming amount of information, and don’t have the capability to process of all of it. Because it is easier to process information that fits into an existing schema, people may be more willing to attend to information that fits into what they already believe, and more likely to reject the information that contradicts what they believe (Ecker, 2017).

Beliefs are important because they can impact decisions that affect not only the person making the decision, but others as well. This can be seen in the resurgence of measles due to those who falsely believe that vaccines cause autism (McCoy, 2019).

Therefore, it is important to determine why people cling to beliefs in misinformation when alternative correct information is available. How strongly people hold on to their existing beliefs could be related to whether or not they remembering learning the information, as opposed to just believing it is true, but not being sure why they believe it to be true. Although the specific source of information (whether reliable or unreliable) does not impact how strongly people believe the information, remembering learning it could lead to stronger beliefs (Henkel & Mattson, 2011). In other words, recalling any source, as opposed to no source, may cause people to be more confident in their beliefs due to having a specific memory associated with the information.

The Remember/Know Paradigm

Different cognitive processes are involved in remembering information versus simply knowing the information to be true. This created what is known today as the remember/know paradigm (Tulving, 1985). Henson et al. (1999) found that different regions of the brain exhibited enhanced responses for remember, compared to know, responses. Specifically, remember responses were associated with elevated responses in the anterior left prefrontal, left parietal, and posterior cingulate regions in comparison to know responses. One the other hand, know responses were associated with elevated responses in the right lateral and medial prefrontal cortex. This supports the idea that remembering is based on recollection-based decisions, while knowing is based on familiarity-based decisions (Wais, Mickes, & Wixted, 2008). Thus, if individuals have the ability to recall learning the information, and they believe the information to be true, this may lead to stronger beliefs in that information.

In the present study, “remembering” was defined as being consciously aware of the learning episode. This would be the ability to recall some aspect of the experience, such as in what class the information was learned, or who taught the information. ”Knowing” consists of believing the statement to be true, without being able to recall a specific source of the information. In the present study, I hypothesized that stronger beliefs would be associated with having a specific memory of learning the believed information.

Hypotheses

Although the relationship between belief in false information and age has been examined, there is no existing research on the impact of other factors, such as education, on strength of belief in false information (Chen, 2002). Due to the importance of finding ways to reduce the amount of inaccurate information that people continue to believe, I also tested the impact of other variables on strength of beliefs in neuromyths. Knowledge about the brain can act as a “safeguard against belief in neuromyths” (Papadatou-Pastou, Haliou, & Vlachos, 2017, p. 1), so I expected students who had more education, as well as those who had taken more psychology or neuroscience classes, to be less likely to believe neuromyths, compared to those with less education or psychology/neuroscience background. That is, those with more education, and especially more psychology or neuroscience exposure, should have more knowledge about the brain, which should prevent them from believing false information about the brain. If participants had additional education, especially in the field of psychology, I expected them to have been taught that the neuromyths were incorrect.

METHODS

Participants

The present study included a total of 198 participants (59.6% of participants identified as male, 39.9% as female, and one participant identified as other), ages 20-68 years old (*M* = 35.1; *SD* = 9.8). One participant was removed due to failing attention checks. The participants were recruited using Amazon's Mechanical Turk and received a $3.50 participation incentive for completing the study.

Procedure

The participants completed a survey online using Qualtrics survey software. The survey took approximately 35 minutes to complete. Two attention check questions were included to ensure fidelity of the data (e.g., "Choose 'strongly agree' for this question."). Participants who completed the survey and answered attention check questions correctly were awarded the participation incentive.

Measures

The online survey consisted of 18 statements, 8 of which were neuromyths and 10 that were true statements about the brain (see Appendix A for statements included in the survey and Appendix B for evidence of each neuromyth's inaccuracy). The term neuromyth was not used in the survey. Participants were asked to indicate how strongly they believed each statement to be true on a scale ranging from 1 (firm disbelief) to 5 (firm belief). For statements they believed to be true (i.e., items participants rated as a 4 or 5 on the 5-point belief scale), they were asked follow-up questions about whether they remembered, knew, or guessed that that statement was true. If they reported remembering the statement, additional questions were asked about the source of the information (e.g., if they read it or it was told to them, who told them or where they read it). Participants were then prompted to provide as much additional information regarding their memory of learning the information as they could. Additionally, participants were asked to provide their age, gender, ethnicity, highest education level, college major/minor, GPA, ACT/SAT scores, and number of psychology and neuroscience courses taken.

Statistical analyses

The data were analyzed using IBM SPSS Statistics 25. Values of $p < 0.05$ were considered statistically significant (Edwards, 2005). An independent samples *t*-test was used to test the hypothesis that having a specific memory of learning the information (remembering) would be associated with stronger belief than "knowing" the information to be true. A *t*-test was chosen because, for each scale item, two groups were compared: those who "remembered" and those who "knew" the information. Correlations between years of education and strength of belief in neuromyths, and between number of psychology and neuroscience courses taken and strength of belief in neuromyths, were used to test the hypothesis that more education, and specifically, having taken more psychology and neuroscience courses, would be associated with weaker beliefs in neuromyths.

RESULTS

Similarly to previous studies of neuromyths (Dekker et al., 2012), over half of participants believed almost every myth, and three myths were believed by over 80% of participants (see Table 1). Among participants who believed each neuromyth, the percent who remembered, knew, or guessed each neuromyth to be true can be found in Table 1. Remembering the source of information was associated with stronger beliefs in two of the eight neuromyths. Participants who remembered the source of these myths were more likely to have stronger beliefs in the myth than participants who “knew” that the myth was true, without remembering a specific source. These neuromyths were: individuals learn better when they receive information in their preferred learning style, $M = 4.61$, $SD = .495$, $t(116) = 2.665$, $p < .001$, and people can be either left-brained or right-brained, $M = 4.20$, $SD = .410$, $t(68) = 1.30$, $p = .003$. However, despite these significant relationships, overall, knowing was associated with stronger beliefs in neuromyths, $r = .489$, $p < .001$, than remembering, $r = .161$, $p < .001$.

Table 1

Percent of remember, know, and guess responses for each neuromyth among participants who believed each myth.

Neuromyth	Believed	Remember	Know	Guess
Exercises that rehearse coordination of motor-perception skills can improve literacy skills.	57	9	34	57
Individuals learn better when they receive information in their preferred learning style.	80.8	20	54	26
Enriched environments enhance the brain's capacity for learning.	82.9	5	36	59
Children are less attentive after consuming sugar.	60.6	11	41	48
Watching educational children's shows increases children's intelligence.	65.2	5	39	56
People have the ability to multitask.	84.8	4	61	35
People can be either left-brained or right brained.	53.0	19	48	33
Listening to classical music increases children's reasoning ability.	49.5	17	25	58

No significant relationships were found between number of psychology/ neuroscience courses taken and belief in any of the neuromyths, all *p*s > .05 (see Table 2). More years of education did not impact the likelihood of having strong beliefs in 7 of the 8 neuromyths, all *p*s > .05. However, more years of education was associated with being less likely to believe the myth "people have the ability to multitask," $r = -.217$, $p < .001$. Overall, the hypothesis that more education would be associated with weaker belief in neuromyths was not supported.

Table 2

Correlations between strength of neuromyth beliefs and education variables.

	1	2	3	4	5	6	7	8	9	10	11
1.Exercises that rehearse coordination of motor-perception skills can improve literacy skills	1										
2. Individuals learn better when they receive information in their preferred learning style.	.144*	1									
3. Enriched environments enhance the brain's capacity for learning.	.293**	.459**	1								
4. Children are less attentive after consuming sugar.	.098	.207**	.167*	1							
5. Watching educational children's shows increases children's intelligence.	.093	.317**	.292**	.150*	1						
6. People have the ability to multitask.	.037	.305**	.273**	.085	.297**	1					
7. People can be either left-brained or right-brained.	.101	.210**	.095	.253**	.122	.109	1				
8. Listening to classical music increases children's reasoning ability.	.203**	.271**	.313**	.231**	.295**	.077	.320**	1			
9. Education Level	.026	-.104	.029	.033	-.066	-.217**	.034	.104	1		
10. Psychology/ Neuroscience Courses	.125	-.027	.029	-.077	-.078	-.123	.105	.080	.377	1	
11. Neuromyth Confidence	.432**	.644**	.618**	.520**	.573**	.471**	.538**	.626**	-.030	.011	1

* indicates p < .05, ** indicates p < .01

DISCUSSION

In this study, I investigated the relationship between the source of information and the strength in belief of that information. For two of the eight neuromyths, there was a significant positive relationship between remembering the source and having a strong belief in the information. However, overall, participants reported stronger beliefs in information that they "knew" (i.e., did not report a specific memory of learning) than information that they remembered learning. One possible explanation for this finding is the "feeling of knowing" phenomenon. The feeling of knowing is the sense that the individual knows a specific piece of information and will be able to accurately identify that information at a later point in time (Widner & Smith, 1996). This phenomenon shows that participants may have felt that they knew the information simply because they recognized it. Furthermore, semantics could play a role in why participants had stronger beliefs in the information they claimed to know. Due to the fact that the word "know" has a strong connotation with the information being correct, regardless of the definitions of remember vs. know provided to participants during the study, it is possible that participants chose "know" for information they had stronger beliefs in due to the fact that the word itself implies certainty, or a strong belief.

Additionally, I examined the impact of education level and number of psychology and neuroscience courses taken on strength of belief in neuromyths. Surprisingly, there was no evidence of a relationship between number of psychology and neuroscience courses taken and strength of belief in neuromyths. Additionally, only one myth, "people have the ability to multitask," was less likely to be believed by participants with more years of education.

One explanation for the absence of a relationship between years of education and belief in neuromyths (i.e., the failure to find a significant negative correlation between these variables) is that many neuromyths are still being taught in educational settings (Dekker, et. al, 2012). In a survey of 242 primary and secondary school teachers who were interested in the relationship between neuroscience and learning, participants believed an average of 49% of the neuromyths presented (Dekker, et. al, 2012). Additional findings indicated that the teachers who were interested in the application of neuroscience were more susceptible to believing the neuromyths because they had a hard time discerning between myths and true statements about the brain. Given that 80% of teacher education textbooks reviewed in a recent study contained neuromyths (Wininger et al., 2019), it may not be surprising that belief in them is so widespread among educators. Both the educational materials and teachers who are instructing the courses may believe and perpetuate neuromyths, which could result in increased and repeated exposure to these neuromyths as education increases.

Limitations

The main limitation of this study is in regards to lack of variation in the results. Due to the construction of the survey, participants were only asked remember/know questions if they indicated that they believed the statement to be true, i.e., if participants indicated they did not believe a myth, it would have been confusing to ask them "do you remember/know/guess this information that you don't believe?" This resulted in limited variance in the remember/know judgement data. In order to better determine whether remembering is associated with stronger beliefs than knowing, it is necessary to collect remember/know judgement data from all participants. In future studies, surveys such as the one used in the present study should be adjusted so that the remember/know judgements can be made by all participants, including those who do not believe the myth statements.

Also, the more diverse Mechanical Turk sample is in some ways a strength, in other ways, surveying this population makes interpretation of their remember/know judgments difficult. Because there was a wide age range in the sample, it was difficult to determine how long ago participants took the classes that may have protected them from (or exposed them to) neuromyths. This may be one reason I did not find a relationship between education level and belief in neuromyths. Finally, the self-report nature of the data is a limitation for some variables; future researchers may wish to investigate other methods for determining the source of information associated with particular beliefs.

CONCLUSION

Although none of the three hypotheses were supported, the results indicate new information about the relationship between remember/know judgments and strength of beliefs in neuromyths. Future research should examine other potential reasons why people hold so strongly to their beliefs, both in neuromyths and other false information. Neuromyths remain prevalent, and may be spread both informally and in educational settings. Although I did not find a significant relationship between remembering the source of the information and confidence of belief in neuromyths, determining what causes people to hold so strongly to this information is an important first step in stopping the spread of it. Beliefs in false information can impact decision making, including willingness to accept to accurate information that contradicts false beliefs. Neuromyths in particular can be detrimental to learning (Riener & Willingham, 2010), so it is important to find ways to reduce widespread acceptance of them among teachers and students.

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APPENDIX A: SURVEY OF NEUROMYTHS AND TRUE STATEMENTS PRESENTED TO PARTICIPANTS

1. Boys have bigger brains than girls.
2. *Exercises that rehearse coordination of motor-perception skills can improve literacy skills.*
3. *Individuals learn better when they receive information in their preferred learning style.*
4. Academic achievement can be affected by skipping breakfast.
5. The human brain can process information at a speed of over 200 miles per hour.
6. The brain is over 2/3 water.
7. *Enriched environments enhance the brain's capacity for learning.*
8. Drinking alcohol does not kill brain cells.
9. *Children are less attentive after consuming sugar.*
10. The brain functions asymmetrically.
11. Adults who participate in mind-challenging activities are less likely to develop dementia.
12. Head injuries can starve neurons of oxygen.
13. The human brain uses a pruning process to remove unnecessary structures.
14. Severing the fivers between the two hemispheres of the brain is a treatment for severe epilepsy.
15. *Watching educational children's shows increases children's intelligence.*
16. *People have the ability to multitask.*
17. *People can be either left-brained or right brained.*
18. *Listening to classical music increases children's reasoning ability.*

Neuromyths are presented in *italic.*

APPENDIX B: NEUROMYTHS PRESENTED IN THE SURVEY AND CORRESPONDING EVIDENCE REFUTING EACH MYTH

Neuromyth	Correct Information	Source of Correct Information
Exercises that rehearse coordination of motor-perception skills can improve literacy skills.	Exercises that promote motor-perception skills have no relationship with literacy.	Hyatt, 2007
Individuals learn better when they receive information in their preferred learning style.	Students who learn in a preferred "style" do not perform better than those who learn in a nonpreferred style.	Riener & Willingham, 2010
Enriched environments enhance the brain's capacity for learning.	Even children who are not exposed to an enriched environment can achieve high performance later in life.	Papatzikis, 2017
Children are less attentive after consuming sugar.	Sugary snacks can temporarily increase children's attention.	Busch et al., 2002
Watching educational children's shows increases children's intelligence.	Watching television has adverse effects on intelligence in children under 3 years old.	Zimmerman & Christakis, 2005
People have the ability to multitask.	People cannot attend to two attention-demanding tasks at the same time.	Loukopoulos et al., 2016
People can be either left-brained or right brained.	Asymmetrical brain function does not mean that people are left vs. right brained.	Corballis, 2014
Listening to classical music increases children's reasoning ability.	There is no effect of classical music on reasoning or other cognitive abilities.	Bangerter & Heath, 2004