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On Memorability of Maximally Counterintuitive Ideas

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Abstract

Previous work has suggested that concepts that are only slightly counterintuitive are more memorable than concepts that are intuitive or overly counterintuitive (Boyer, 1994; Boyer & Ramble, 2001), though the causes for this memory advantage have been debated (Barrett, 2008; Upal, 2010). This paper describes three experiments conducted to better understand the cognitive processes that underlie memory for counterintuitive concepts. They suggest that additional time spent processing counterintuitive concepts may be the primary driver of the minimally counterintuitive effect rather than domain violation.

Résumé

Selon certaines études, les concepts légèrement contre-intuitifs seraient plus faciles à retenir que les concepts intuitifs ou excessivement contre-intuitifs (Boyer 1994; Boyer et Ramble, 2001), quoique les causes de ce phénomène aient été remises en question (Barrett 2008; Upal 2010). Le présent document fait état de trois expériences menées dans le but de mieux comprendre les processus cognitifs qui expliqueraient pourquoi les concepts contre-intuitifs seraient plus faciles à retenir. Ces expériences donnent à penser que le temps de réflexion additionnel que demandent les concepts contre-intuitifs pourrait être le principal facteur à l'origine de l'effet des concepts minimalement contre-intuitifs, plutôt que la violation du sens commun.

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Executive summary

On Memorability of Maximally Counterintuitive Ideas:

; DRDC Toronto TM 2013-117; Defence R&D Canada – Toronto; November 2013.

Introduction and background: The Canadian Armed Forces (CAF) need to be able to communicate effectively with various population groups in their area of operations to inform and reassure the sympathetic, to deter the adversarial, and to win over the undecided. Influence researchers regard memory as a key measure of effectiveness of a message since messages that are harder to remember are less likely to lead to the desired behaviour and attitude change. Cognitive scientists interested in studying memory for various types of ideas have argued that ideas that are *minimally counterintuitive* (e.g., a tree that barks) are more memorable than *intuitive* (e.g., a tree that is green) and *maximally counterintuitive* ideas (e.g., a tree that barks, glows, and is invisible). While numerous studies have investigated recall for intuitive and minimally counterintuitive ideas, little work has been done to investigate memory for maximally counterintuitive ideas. The purpose of the three experiments described in this report is to fill this gap.

Results: The experiments reported here offer new insights into memory for maximally counterintuitive concepts. They suggest that additional time spent processing counterintuitive concepts may be the primary driver of the minimally counterintuitive effect rather than domain violation.

Significance: CAF Influence Activities practitioners can use the lessons of the research reported here to design more effective messages that are likely to be better remembered by their target audience members.

Future plans: To make precise predictions about memory for various types of concepts, we need to better understand how they are represented in the minds of target audience members. Follow-up studies are planned to elicit people's expectations about features for various common categories such as "person." This knowledge, in combination with the context-based model of memory for counterintuitive ideas, will allow us to more precisely predict recall for such concepts.

Sommaire

On Memorability of Maximally Counterintuitive Ideas:

; DRDC Toronto TM 2013-117 ; R & D pour la défense Canada – Toronto; novembre 2013.

Introduction et contexte : Les Forces armées canadiennes (FAC) doivent être en mesure de communiquer efficacement avec divers groupes de la population dans leur zone d'opérations pour informer et rassurer les sympathisants, dissuader les adversaires et convaincre les indécis. Pour les chercheurs qui étudient le phénomène de l'influence, la mémorabilité est une mesure clé de l'efficacité d'un message étant donné que les messages plus difficiles à retenir sont moins susceptibles de produire le comportement ou le changement d'attitude désiré. Des spécialistes de la cognition qui se sont penchés sur la mémorabilité en lien avec différents types d'idées ont fait valoir que les idées qui sont *minimalement contre-intuitives* (p. ex. un arbre qui aboie) sont plus faciles à retenir que les idées *intuitives* (p. ex. un arbre qui est vert) et les idées *excessivement contre-intuitives* (p. ex. un arbre qui aboie, brille et est invisible). Bien qu'un grand nombre d'études aient exploré le rappel en lien avec les idées intuitives et minimalement contre-intuitives, peu de travaux ont été entrepris sur la mémorabilité des idées excessivement contre-intuitives. Les trois expériences décrites dans le présent rapport cherchent à combler cette lacune.

Résultats : Les expériences dont nous faisons état jettent un nouvel éclairage sur la mémorabilité des concepts excessivement contre-intuitifs. Elles donnent à penser que le temps de réflexion additionnel que demandent les concepts contre-intuitifs pourrait être le principal facteur de l'effet des concepts minimalement contre-intuitifs, plutôt que la violation du sens commun.

Portée : Les praticiens des activités d'influence des FAC peuvent se servir des enseignements tirés de la recherche en question pour concevoir des messages plus efficaces, qui sont susceptibles d'être mieux retenus par les membres de l'auditoire cible.

Recherches futures : Si l'on veut prédire avec exactitude la mémorabilité de différents types de concepts, nous devons mieux comprendre leur représentation dans l'esprit des membres de l'auditoire cible. On prévoit mener des études de suivi pour vérifier les attentes des gens face aux caractéristiques de diverses catégories communes, par exemple la « personne ». Ces connaissances, conjuguées au modèle de mémoire fondé sur le contexte pour les idées contre-intuitives, nous permettront de prédire avec plus d'exactitude la capacité de rappel pour ces concepts.

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1   Introduction

Cognitive processes clearly underlie our thoughts and beliefs about the world. However, only recently have scientists begun to explore how such processes actually perpetuate ideas and beliefs in a way that renders them "cultural" or "religious" (Boyer & Ramble, 2001). Boyer (1994) proposed perhaps the most popular theory regarding how some ideas become cultural and therefore survive over time and space (Sperber, 1996). He claimed that concepts that are *minimally counterintuitive* (MCI) (i.e., violate one or two features of an ontological category, such as a person who can fly) are more likely to be remembered than concepts that are entirely intuitive or concepts that overly or *maximally counterintuitive* (MXCI) (i.e., a violation of three or more ontological categories; see Barrett (2008) for more on quantifying maximally counterintuitive concepts). Because minimally counterintuitive ideas are more likely to be remembered, they are also more likely to be communicated to others who are also likely to remember and retell the story. In other words, the memorability of such concepts promotes their survival and subsequent cultural expression.

While initial studies provided support for Boyer's "minimally counterintuitiveness" hypothesis (Barrett & Nyhof, 2001; Boyer, 1994; Gonce, Upal, Slone, & Tweney, 2006; Upal, 2005; Upal, Gonce, Tweney, & Slone, 2007), subsequent work has addressed both how and why the MCI effect exists (Harmon-Vukic & Slone, 2009; Upal, 2010). Upal (2005, 2010) argued that understanding the role of context in memory performance is critical to understanding the MCI effect. Specifically, he proposed the context-based perspective of the MCI effect. Within this view, the extent to which a concept is counterintuitive depends upon the concept itself *and* the context within which it is embedded. People generate expectations (Schank & Abelson, 1977) about features of a concept based on the context in which it occurs. Concepts that violate these expectations (e.g., counterintuitive concepts) trigger extra processing because they provide intelligent agents with learning opportunities to improve the predictive ability of their world model (Schank, 1999). This extra processing involves searching the long-term memory to find knowledge that can justify the expectation-violation. Upal (2005, 2010) argued that, given the learner's motivation to process and the amount of time available for cognitive processing, a concept is remembered well if the reader can successfully justify an expectation-violation. MCI concepts are remembered better than MXCI concepts because a small number of expectation-violations are more likely to be justified than a large number of expectation-violations.

The context-based view has been supported by a number of studies (Harmon-Vukic & Slone, 2009; Harmon-Vukic, Upal, & Sheehan, 2011; Harmon-Vukic, Upal, & Sheehan, 2012; Upal et al., 2007). All of these studies suggest that either semantic or episodic context is important in determining the memory advantage of minimally counterintuitive ideas.

However, few studies address memory performance for maximally counterintuitive concepts. Recall that according to Boyer's (1994) original hypothesis, MXCI concepts are more difficult to remember as compared to MCI concepts. However, as many have pointed out, this is problematic when we consider the god concept, for example. God concepts are often maximally counterintuitive because they possess several counterintuitive properties (e.g., immortal, all-seeing, omnipresent, omnipotent, etc.). Therefore, the MCI hypothesis fails to account for a significant aspect of religious belief.

Although no research to date specifically studied memory for MXCI concepts, Harmon-Vukic et al. (2012) suggested that poor recall of MXCI ideas may be due to the inability of readers or listeners to attach so many counterintuitive ideas to a broader context. In other words, if a story includes three counterintuitive ideas (making it MXCI), it may be too difficult to integrate these ideas into a coherent whole. Although the recipient of the information may try to make sense of the material, the challenge proves too great, and the receiver eventually gives up. The lack of integration of story concepts results in a poorer memory trace and therefore has a negative impact on subsequent retrieval.

The purpose of the present set of experiments is to further investigate the role of context in memory for maximally counterintuitive stories. Specifically, if Harmon-Vukic et al. (2012) are correct, then providing a context that encourages participants to spend additional cognitive effort to process and make sense of multiple expectation violations should improve recall for maximally counterintuitive ideas. This can be done, for instance, by directly instructing participants to spend extra cognitive effort to process concepts or by increasing their motivation to process various concepts by providing them with additional rewards.

What is the importance of this research for the Canadian Armed Forces (CAF)? The CAF need to be able to communicate effectively with various population groups in their area of operations to inform and reassure the sympathetic, to deter the adversarial, and to win over the undecided. Influence researchers regard memory as a key measure of effectiveness of a message since messages that are harder to remember are less likely to lead to the desired behaviour and attitude change. CAF Influence Activities practitioners can use the lessons of the research reported here to design more effective messages that are likely to be better remembered by their target audience members.

2　Experiment 1

The purpose of Experiment 1 was to investigate the influence of instructions on memory performance with respect to concepts that were intuitive, minimally counterintuitive, or maximally counterintuitive. Specifically, participants were explicitly instructed to make sense of any strange or unusual material. Although such instructions do not constitute a specific context, they encourage participants to create a context as they read. If such instructions facilitate integration, we should see the greatest effect in the maximally counterintuitive condition; that is, memory performance in the maximally counterintuitive condition should be enhanced compared to the intuitive condition. In addition, recall should also be higher in the minimally counterintuitive condition as compared to the intuitive condition.

2.1　Participants

Forty-five Providence College undergraduate students participated. Participants were compensated $5.00 for their time.

2.2　Materials

The materials included a set of 12 vignettes that were part of a broader story (see Annex A for two sample stories). The overall theme of the story involved a woman visiting another planet. Each vignette discussed her observations and experiences on that planet. The participants read an introductory paragraph, which explained the general situation (i.e., the woman visiting another planet), and then read the 12 vignettes. The vignettes were presented in one of three conditions: intuitive, minimally counterintuitive, or maximally counterintuitive. The minimally counterintuitive stories contained one domain violation while the maximally counterintuitive stories contained three domain violations, consistent with Barrett's (2008) coding scheme. Three material sets were created so that all 12 vignettes could be read in each of the three conditions. Therefore, each material set contained four intuitive concepts, four minimally counterintuitive concepts, and four maximally counterintuitive concepts. The order of the concepts was counterbalanced within each set so that some subjects saw Concept 1 first while others saw one of Concepts 2 through 12 first. Participants read a concluding paragraph after reading all 12 vignettes.

2.3　Procedures

Participants read all material on a computer screen, one sentence at a time. They were told to read at a comfortable pace. They were instructed to press the space bar after reading each sentence to continue to the next sentence. Once they pressed the space bar, they could not return to the previous sentence. Therefore, they were not able to reread any text. After reading the series of stories, the participants were presented with a packet of paper. Each sheet of paper had the main character of a vignette and that character's location (e.g., the old woman in the house). The participants were instructed to write down as much as they could remember about that vignette.

2.4   Results and Discussion

The subject responses were coded for recall by assigning a value of 1 if the gist of the concept was recalled by the subject. A score of 0 was assigned otherwise. Partial points were coded in the MXCI condition if the participant remembered part of the counterintuitive idea. In both the MCI and MXCI conditions, participants could earn points only if the counterintuitive aspect of the concept was remembered. For instance, regarding the concept of a woman floating in the air, participants must clearly remember floating in air, not in water.

The proportion of recall was measured by dividing the number of concepts recalled by subjects in a given condition by the total number of concepts of that type in the entire set (which was 12). The proportion of recall for each statement is presented in Table 1:

Table 1: Recall Rates for Experiment 1.

	MXCI	MCI	INT
Proportion Recall	.63	.53	.49

Note: MXCI = Maximally counterintuitive; MCI = Minimally counterintuitive; INT = Intuitive.

There was a significant main effect of level of intuitiveness, $F(2,84) = 13.48$, $MSE = .048$, $p < .05$. Recall was significantly higher in the MXCI condition compared to the INT condition, $F(1,42) = 19.33$, $MSE = .048$, $p < .05$, and was also higher in the MXCI condition compared to the MCI condition, $F(1,42) = 19.09$, $MSE = .025$, $p < .05$. However, the difference between the MCI and INT conditions was insignificant, $p > .05$. This result was puzzling. It is unclear why this occurred, although it could be that the stories were written in such a way as to be very coherent. This may have made the MCI concepts as easy to process as the INT concepts, and therefore the MCI ideas didn't enjoy a memory advantage.

However, consistent with our hypothesis, it appears as though the instructions to make the stories coherent actually enhanced memory for MXCI stories; recall performance was higher in the MXCI condition compared to the MCI condition. This effect has not been documented in previous work. However, upon further review of the materials, we observed a different possible interpretation of this result: roughly half (seven) of the vignettes contained counterintuitive statements that violated intuition in a similar way. For instance, the woman guard could turn people to stone, control minds, and was omnipresent. In other words, she had three "superhuman" powers. However, in other vignettes, the violations occurred across categories. For instance, the cat Jill met could predict the future, could disappear into thin air, and could speak. The cat, in this case, had both divine and human powers. Although "divine" has not typically been considered a domain, certain acts—such as becoming invisible, turning others to stone, or disappearing into thin air—represent properties that no natural object, artifact, or living thing can possess. Therefore, such properties can be considered "other worldly" or "divine."

In order to explore whether the similarity of domain violations affected recall, we re-analyzed the data from the MXCI condition comparing recall performance for stories with similar versus different domain violations. An independent groups t-test showed that recall was significantly higher for stories containing similar domain violations, $t(10) = 3.87$, $p < .05$ (see Table 2 for averages for MXCI materials containing similar and different domain violations).

Table 2: Recall Rates for MXCI Stories with Same and Different Domain Violations in Experiment 1.

	Same	Different
Proportion Recall	.72	.52

One possible explanation for this result is that encountering two or more domain violations could prompt an inferential process in which participants attempt to categorize the subject of the story. If all domain violations are similar, they offer a sort of context within which participants can interpret the subject's traits, actions, and abilities. However, when the violations come from different domains, the subject does not fit into a single category (i.e., a cat that has special unearthly powers *and* human powers does not neatly fit into a known category). In such cases, a context is unavailable and integration of the information is too difficult, rendering a poorer memory trace.

3 Experiment 2

The purpose of Experiment 2 was to investigate whether the instructions drove the effect in the MXCI condition or if the similarity of domain violations accounted for the effect. The set-up was the same as Experiment 1, with the exception that participants were no longer instructed to try to make sense of strange concepts in the story. Thus, participants read the series of 12 vignettes presented in the INT, MCI, and MXCI conditions. They were then asked to recall everything they could about each vignette.

3.1 Participants

Participants were 45 Providence College undergraduate students who were compensated $5.00 for their time.

3.2 Materials

The materials were the same as in Experiment 1.

3.3 Procedures

The procedures were the same as in Experiment 1, with the exception that participants received no instruction to make sense of strange or unusual material.

3.4 Results and Discussion

Average recall rates are presented in Table 3. There was a main effect of intuitiveness, $F(2,84) = 10.59$, MSE $= .065$, $p < .05$. Recall rates were significantly higher in the MXCI condition as compared to the MCI condition, $F(1,42) = 8.24$, MSE $= .037$, $p < .05$, and were also higher as compared to the INT condition, $F(1,42) = 29.22$, MSE $= .03$, $p < .05$. Finally, recall was not significantly higher in the MCI condition as compared to the INT condition, although there was a trend towards significance, $F(1,42) = 6.16$, MSE $= .024$, $p = .07$.

Table 3: Proportion of Recall in Experiment 2.

	MXCI	MCI	INT
Proportion Recall	.62	.54	.48

Note: MXCI = Maximally counterintuitive; MCI = Minimally counterintuitive; INT = Intuitive.

The pattern of results mimics those of Experiment 1. Eliminating the instructions had no apparent influence on the overall pattern. Thus, neither Experiment 1 nor 2 support the idea that instructions can encourage participants to create a context.

As with Experiment 1, we compared the recall data from the "same-domain violation" vignettes to that from the "different-domain violation" vignettes in the MXCI condition. Memory performance was significantly higher for the same-domain violation passages than for the different-domain violation passages, $t(10) = 2.26$, $p < .05$ (see Table 4 for mean proportion of recall for same and different domain violations).

Table 4: Recall Rates for MXCI Stories with Same and Different Domain Violations in Experiment 2.

	Same	Different
Proportion Recall	.66	.51

However, consistent with Experiment 1, it appears that participants are more likely to remember the story when violations of the same category occur. In other words, such cases present a sort of context through inferential processing. That context facilitates participants' understanding and integration of the counterintuitive information.

4   Experiment 3

The purpose of Experiment 3 was to further investigate the possibility that domain-violations can serve as context. If such violations truly serve as a context, it likely happens after the reading of the first counterintuitive statement in the story. This hypothesis is supported by both Experiments 1 and 2 in that memory performance in the MCI condition was significantly worse than in the MXCI condition. Thus, it is likely that when participants encounter either the second or the third counterintuitive idea, they infer something about the subject that allows them to integrate the entire story, including the counterintuitive ideas. For instance, if we encounter a story about a man who can fly, become invisible, and walk through walls, we might infer that this is no ordinary man but, rather, a "super" man. In other words, we may infer that he is a superhero. The context of "superhero" would allow us to make sense of the counterintuitive information quite easily. This would result in a more coherent memory trace of the story and would therefore facilitate retrieval.

In order to investigate the possibility that participants infer a context, we conducted a study in which we asked participants to read statements that contained either a single counterintuitive idea (e.g., a man who can fly) or a statement with two counterintuitive ideas (e.g., a man who can fly and walk through walls). After reading each statement, participants indicated the extent to which they agreed that a human could possess the properties referred to, on a scale from -3 (strongly disagree) to +3 (strongly agree).

If participants make inferences as we previously discussed, agreement ratings should be higher for statements containing two counterintuitive ideas from the same domain as compared to statements containing only one counterintuitive concept.

4.1   Participants

Participants included 153 individuals who completed the study online through Mechanical Turk, for a small remuneration. Three participants failed the attention check question (the question asked participants "please do not click here") and thus were excluded from all subsequent analysis.

4.2   Materials

The materials included a set of statements involving a human being who possessed a superhuman (i.e., counterintuitive) property. The properties included in this study were the the abilities to (a) see through walls, (b) become invisible, (c) fly, (d) walk through walls, (e) leap over skyscrapers, and (f) hear whispers from miles away. Participants rated each statement in terms of how strongly they agreed that a person could possess the given ability, on a scale of -3 (strongly disagree) to +3 (strongly agree).

Six of the statements included a human with a single counterintuitive ability (e.g., a human who can fly). Fifteen of the items contained any two of the previously mentioned abilities from the superhero domain (e.g., a man who can fly and see through walls).

4.3 Procedures

Participants completed the survey online through Mechanical Turk. They were asked to read and then rate each statement according to how strongly they agreed or disagreed with the entity's ability to possess such a property.

4.4 Results and Discussion

Participant means from items with single and double counterintuitive statements were computed. An independent groups t-test demonstrated that participants rated single counterintuitive statements as less likely compared to statements containing two counterintuitive ideas, $t(288) = 24.14$, $p < .05$ (see Table 5 for means).

Table 5: Mean Ratings for Experiment 3.

	One CI Idea	Two CI Ideas
Rating	-2.88	.31

Note: CI = Counterintuitive.

These results show that, although a single counterintuitive idea is deemed highly implausible, when more than one counterintuitive idea is presented—in this case, from the "superhuman" category—the overall idea seems more likely. Thus, the results support the argument that, when counterintuitive ideas stem from similar domain violations, that domain or category then serves as a general context to interpret all information presented.

5   General Discussion

The results of the experiments reported here indicate that context may have a significant impact on memorability of maximally counterintuitive concepts. Although Experiment 1 demonstrated a significant memory advantage of MXCI statements, it was unclear whether the results were due to the explicit instructions given to participants, or to the extent to which the domain violations in the MXCI stories came from a similar or different category. In Experiment 2, the instructions were omitted, but the pattern of results remained the same. In addition, once again we found that memory for MXCI stories containing similar domain violations was significantly better than MXCI stories with different domain violations.

In combination, these two experiments indicate that when MXCI stories contain violations from a similar domain, that domain then becomes a context. For instance, when participants read about a woman who can float in the air, spit fire, and see through walls, they categorize her as "something like a superhero." The context of "superhero" facilitates their memory of that woman. However, the same is not the case if different domains are violated. Consider the goat that can breathe underwater, write, and project a force field. This goat has human, fish, and "superhuman" properties. It is hard to imagine a context in which these disparate elements make sense. Therefore, integration is difficult, resulting in a poor memory representation of that story.

This hypothesis is further supported in Experiment 3. Participants rated statements containing two counterintuitive ideas as more likely than those with just one counterintuitive concept. Based on the results from the first two experiments, it appears as though these results are confined to situations in which the counterintuitions violate the same domain. However, further research is necessary to explore the role of the type of violation on memory for MXCI concepts.

In conclusion, these results are consistent with the context-based view of the minimally counterintuitiveness effect. Previous work has shown poor memory performance for MXCI stories (Harmon-Vukic et al., 2012). Consistent with Upal (2009) and Harmon-Vukic et al. (2012), the results of these three experiments suggest that memorability depends upon the extent to which a given concept can be integrated with available context. Previously, this hypothesis has only been supported for minimally counterintuitive stories. This study shows that the same is true for maximally counterintuitive stories. In addition, the results from this study hint that context is not limited to story events or general-world knowledge; it is also possible that an inference may serve as context.

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Annex A   Sample Stories from Experiments 1 and 2

Introduction
The night was cold, and Jill was looking for shelter when she found a cave.
Maximally Counterintuitive
Jill entered the cave and found a woman floating in space. She hung motionless ten feet off the ground. Cautiously, Jill approached her. When the woman finally saw Jill, she spit fire. She aimed the flames right in Jill's direction. For a moment, Jill stood dumbstruck before she began trying to escape. The woman, unfortunately, could also see through walls. She could see Jill when she tried to hide behind a boulder.
Minimally Counterintuitive
Jill entered the cave and found a woman floating in space. She hung motionless ten feet off the ground. Cautiously, Jill approached her. As she moved closer, the woman awoke and began throwing stones. She frightened Jill with her violent attack. For a moment, Jill stood dumbstruck before she began trying to escape. The woman screamed at Jill. She was so loud that Jill wanted desperately to hide from the sound.
Intuitive
Jill entered the cave and found a woman sleeping on the floor. She lay motionless in the corner. Cautiously, Jill approached her. As she moved closer, the woman awoke and began throwing stones. She frightened Jill with her violent attack. For a moment, Jill stood dumbstruck before she began trying to escape. The woman screamed at Jill. She was so loud that Jill wanted desperately to hide from the sound.
Conclusion
Terrified, Jill ran from the cave. She wanted to get as far away from the woman's wrath as she could, so she ran down the first path she found.

Introduction
The watchman walked with Jill through the city, leading her slowly to the king.
Maximally Counterintuitive
Along the way, she saw a goat breathing underwater. She saw bubbles float up from his nose. Jill thought the scene was funny. When the goat saw Jill, he projected a force field. He used the force field to protect himself from strangers. Jill stopped in her tracks to watch him. The watchman told Jill the goat was an excellent scribe. The goat recorded historical events in beautiful writing.
Minimally Counterintuitive
Along the way, Jill saw a goat being pulled on a leash. The stubborn goat was refusing to move. Jill thought the scene was funny. The goat bit a farmer that tried to push him from behind. The goat was getting violent. Jill stopped in her tracks to watch him. The watchman told Jill the goat was an excellent scribe. The goat recorded historical events in beautiful writing.
Intuitive
Along the way, Jill saw a goat being pulled on a leash. The stubborn goat was refusing to move. Jill thought the scene was funny. The goat bit a farmer that tried to push him from behind. The goat was getting violent. Jill stopped in her tracks to watch him. The goat followed the farmer when he was bribed with food. He would always do anything for food.
Conclusion
The watchman didn't let Jill watch for long before he began urging her onward. Jill had a hard time moving quickly because she wanted to observe everything for her research.

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List of symbols/abbreviations/acronyms/initialisms

CAF	Canadian Armed Forces
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
INT	Intuitive
MCI	Minimally counterintuitive
MXCI	Maximally counterintuitive
R&D	Research & Development

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4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used) Mary Harmon-Vukic, M. Afzal Upal, Caitlin Trainor

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Previous work has suggested that concepts that are only slightly counterintuitive are more memorable than concepts that are intuitive or overly counterintuitive (Boyer, 1994; Boyer & Ramble, 2001), though the causes for this memory advantage have been debated (Barrett, 2008; Upal, 2010). This paper describes three experiments conducted to better understand the cognitive processes that underlie memory for counterintuitive concepts. They suggest that additional time spent processing counterintuitive concepts may be the primary driver of the minimally counterintuitive effect rather than domain violation.

Selon certaines études, les concepts légèrement contre-intuitifs seraient plus faciles à retenir que les concepts intuitifs ou excessivement contre-intuitifs (Boyer 1994; Boyer et Ramble, 2001), quoique les causes de ce phénomène aient été remises en question (Barrett 2008; Upal 2010). Le présent document fait état de trois expériences menées dans le but de mieux comprendre les processus cognitifs qui expliqueraient pourquoi les concepts contre-intuitifs seraient plus faciles à retenir. Ces expériences donnent à penser que le temps de réflexion additionnel que demandent les concepts contre-intuitifs pourrait être le principal facteur à l'origine de l'effet des concepts minimalement contre-intuitifs, plutôt que la violation du sens commun.

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