Investigating the Minimal Counterintuitiveness Effect

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Abstract

Scholars believe that minimally counterintuitive concepts are more memorable than intuitive ones (Barrett, 2008; Upal 2011). If an item has an unusual or counterintuitive property, such as a ball that rises rather than falls when dropped, the unusual property makes the item more memorable. However, experiments investigating this effect tend to have experimental confounds that make interpretation difficult. Our experiment aimed to solve these problems by using counterbalanced lists of nonwords, using the nonwords to control for prior associations and experiences.

Participants viewed a series of nonwords along with a noun-adjective pair (e.g. Frav – a roaring tiger) and were told that each nonword represented a name. Some nonwords were the names of an intuitive item (e.g. a roaring tiger) whereas others were counterintuitive (e.g. a writing tiger). Participants rated the likelihood that the described nonword was from Earth or from a parallel universe where things were different. Everyone was told to remember the nonwords and noun-adjective pairs for a later test. To improve overall recall, each item was presented and rated twice. After a distractor, participants were asked to recall as many of the nonwords as possible.

The results revealed that counterintuitive items were not better-recalled than intuitive items. In fact, in most tests, intuitive items were recalled significantly more often than intuitive items. Our results do not support the Minimal Counterintuitiveness Effect and suggest that when to-be-remembered words and their accompanying nouns are matched across conditions (counterintuitive and intuitive), that intuitive information is more memorable than counterintuitive information.

Introduction

According to the basic principles of evolutionary psychology, our mind has been shaped by natural selection to produce behaviors and mental systems that solve fitness-relevant problems (Cosmeides & Tooby, 1999). It is adaptive for humans to both learn and retain information effectively. This study deals with how we learn a specific type of information: counterintuitive information, defined here as "information contradicting some information provided by ontological categories (e.g.: "animal" is an ontological category) (Boyer, 2001)."

Counterintuitive information influences a variety of aspects of human behavior and cognition, from learning during infancy to the very foundations of religion and superstition (Barrett, 2008). Infants to pay more attention to actions that violate their expectations, such as an object moving through another object (Baillargeon, 1986). Phillips & Wellman (2005) found that infants look significantly longer at images of adults reaching for objects in indirect ways (e.g., reaching for an object while sticking the reaching arm's elbow up in the air) rather than the expected route of simply reaching directly for the object. Wellman & Gellman (1998) even considered encounters with counterintuitive information to be important for cognitive development, as they help to accelerate infants' learning of fitness-relevant information, such as the way animate creatures move and behave.

Furthermore, through religion and superstition, the counterintuitive has a strong presence in human social groups. Superstition is present in all societies, and it has a powerful hold on humanity. Almost every religion and superstition is based off at least one piece of

counterintuitive information (Barrett, 2000; Boyer, 2001; Barrett, 2008), be it living after death or encounters with heavenly beings. Atran & Norenzayan (2004) noted that the core beliefs of almost all religions only have a few counterintuitive traits, and that objects that are slightly or "minimally counterintuitive" are better-remembered than objects with a large number of counterintuitive traits. Some evolutionary psychologists claim that the tendency to be superstitious and religious is an adaptive behavior that improves the chances of a person passing on his or her genes by promoting large-scale and intergroup cooperation as well as higher fertility rates (Norenzayan & Shariff, 2011). In modern times, religiosity is associated with various traits desirable in a mate, such as fidelity and an increased willingness to have children (Gervais, Shariff, & Norenzayan, 2016; Norenzayan et. al., 2016).

The ability to remember counterintuitive information has already received some attention from both psychologists and anthropologists. Boyer and Ramble (2001) found in a variety of populations that counterintuitive information is more recallable than intuitive information. Gonce, Upal, Slone, & Tweney, (2006), used a method in which half of the participants received a word list containing both intuitive and counterintuitive items. The other participants received the same word list where each word also had a "context", a short intuitive or counterintuitive description about the word. Both intuitive and minimally counterintuitive words were recalled significantly better than maximally counterintuitive words (words which had many counterintuitive traits).

Of particular importance to the present experiment is Porubanova et. al. (2014). These researchers presented participants with forty-eight items consisting of a noun and an adjective. Nouns were grouped into four categories (human, animal, plant, and object), while adjectives were divided into intuitive, counterintuitive (called "ontologically counterintuitive") and culturally counterintuitive (information which violate cultural expectations but maintain physical expectations). After a two-minute distractor task, participants were asked to recall as many items as possible, both adjective and noun. Subjects were also contacted after a month and given a recognition task, including the forty-eight original concepts and forty-eight new concepts. The study found that, in immediate recall, intuitive items were significantly better-recalled than ontologically counterintuitive items; however, in the delayed recognition task, the opposite occurred. In both tests, culturally counterintuitive items were recalled significantly more often than either intuitive or ontologically counterintuitive items.

However, several of these experiments have had confounding factors. For example, animacy presents a confound in Porubanova et. al., 2014. The experiment divides items between having "agents" and "non-agents", but the majority of plants and objects are given counterintuitive and culturally-counterintuitive traits, effectively describing them as having animacy (e.g.: a hungry kettle). Given that animacy produces an effect on memory (VanArsdall, Nairne, Pandeirada, & Blunt, 2013), these descriptions could have caused inanimate nouns to be processed not only as counterintuitive, but as animate, leaving animacy as a confound. Furthermore, several foundational experiments, such as Boyer & Ramble, 2001, also took place in uncontrolled testing environments, such as a market square. Our study aims to examine memory for counterintuitive traits using larger sample sizes and a better-controlled testing environment. We adopted a similar method to the one used by Porubanova et. al. (2014) but corrected the errors in their method.

The current experiment also extended existing research on memory for counterintuitive information by using a nonword learning paradigm. Participants viewed four-letter nonwords paired with items composed of a noun and an adjective. Items were fully counterbalanced so that each nonword would be paired equally with an animate and inanimate item, as well as an intuitive and a counterintuitive item, in separate word lists given to separate groups of participants. Participants were asked to rate on a 1-5 scale how likely each item was to be from Earth, as opposed to a different dimension where things were different. After a short distraction task, participants were asked to recall as many nonwords as they could, then to match nonwords to their correct item descriptions. All experiment sessions were administered in a controlled environment.

Method

Participants

This experiment included one hundred and four viable participants recruited from Purdue University. Only native English-speaking participants were included in the analysis because the stimuli will include many English words (nouns and adjectives), and participants unfamiliar with these words may have experienced difficulty determining if a description is intuitive or counterintuitive. Participants were tested in groups of four per session. Each session lasted no more than twenty-five minutes and took place on individual computers used in the Purdue Psychology building.

Materials

The experiment, operated on the program Qualtrics, included a word list of twenty nouns, forty adjectives, and twenty pronounceable nonwords. The nouns include five inanimate objects, five plants, five animals, and five types of people (such as "butcher" and "runner"). Each noun was paired with an intuitive adjective and a counterintuitive adjective. All adjectives described physical properties of the noun. Half of the adjectives described intuitive properties, while the other half described counterintuitive traits, traits which could not be present in reality (transparency, floating, etc.). The stimuli are included in the appendix in Table 1 and Table 2. Each noun was also paired with a pronounceable nonword, a false word designed to appear as though it could be from the English language. All nonwords were drawn from ARC nonword database (Rastle, Harrington & Colheart, 2002), and all were four letters in length.

From the twenty nonwords and descriptions, the experimenters formed four lists, described as 1A, 1B, 2A, and 2B. All twenty nonwords were present across the word lists, and each contained 10 animate items and 10 inanimates, as well as 10 intuitive and 10 counterintuitive descriptions. However, descriptions, word order, and the pairing between nonword and description varied in a controlled fashion between the lists. Lists of the same number contained the same descriptions but varied in the pairing of nonwords and descriptions; a nonword paired with an animate item in 1A was paired with an inanimate item in 1B. This was meant to better examine animacy effects by controlling for the item (nonword) itself. Similarly, lists of the same letter contained the same pairings between nouns and nonwords but varied in intuitiveness: a nonword with an intuitive description in 1A had a counterintuitive description in 2A. This was meant to examine the effects of intuitiveness on recall. Finally, all four word lists also had four randomized orders; during the experiment, participants would be randomly

assigned to see two of the four randomized orders. The net result was that a given nonword appeared in each of the relevant experimental conditions across participants.

Procedure

On arrival, participants were randomly assigned to one of the four versions and seated at one of the four computers in the testing space. There they read and signed a consent form and were instructed to begin the experiment on the computer in front of them. After beginning the program, they received instructions for the experiment. Participant were given two practice test trials in which they saw a rating task identically formatted to that of the main task; however, the nonword names and their descriptions were merely dummy items and were not target items or included in any analyses. Once this was done, the participants were re-presented with the instructions and progressed to the target items.

Each nonword-description pair was presented on screen for 10 seconds. During this time, participants completed a rating task. In this task, participants studied the item and made a rating by clicking on the appropriate box on-screen. Ratings were on a 1-5 scale judging how likely items were to be from Earth, as opposed to a different dimension where some things differed. 5 corresponded to "very likely to be from Earth", while 1 corresponded to "very unlikely to be from Earth." After 10 seconds, the program automatically progressed to the next pair. After each participant rated each of the pairs once, they performed the rating task again, with the items arranged in a different randomized order. After the rating tasks, participants performed a two-minute even/odd distractor task. Single-digit numbers appeared on screen for two seconds apiece, and participants were asked to designate them as "even" or "odd" by clicking on the appropriate box on-screen. After the participants completed the distractor task, they were given the free recall test. Participants had 5 minutes to type all the nonwords from the word list that they could recall. The free recall task was followed by the matching recall task; participants had five minutes to drag and drop nonwords from one side of the screen to their appropriate descriptions on the other.

Results and Discussion

Rating

Items were rated on what percentage of answers given aligned with the intuitiveness category that the item was in. For example, if an item was deemed counterintuitive and 80% of replies, stated that it was unlikely or very unlikely to come from Earth, that object would receive a score of 80%. Most items received high scores above 80% (mean 83%, median 89%). Interestingly, most lower scores were given to items which were counterintuitive and inanimate (mean of all conditions 83%, mean of counterintuitive inanimate items 66%). An image of these averages can be seen in Figure 1.

Analysis found that intuitive items received significantly higher scores than counterintuitive items on both the subject ($F(1,103)=18.804$, $p<0.01$) and item level ($F(1,103)=18.552$, $p<0.01$). Similarly, animate items received significantly higher scores than inanimate items on both the subject ($F(1,103)=84.99$, $p<0.01$) and item ($F(1,103)=18.552$, $p<0.01$) levels. However, these differences may be because counterintuitive and inanimate objects received the majority of lower scores.

Free Recall

Data in the free recall test indicated that there were significant effects of animacy and intuitiveness. Data were scored with both strict and lenient methods; in strict, only a perfectly-spelled correct reply was accepted, whereas in lenient, nonwords with one letter misspelled were also accepted. Consistent with prior research, participants recalled animate items significantly better than they did inanimate items in both strict ($F(1,103)=14.63$; $p<0.001$) and lenient ($F(1,103)=18.318$; $p<0.000$) conditions. Participants also recalled intuitive items significantly better than counterintuitive items in both the strict ($F(1,103)=18.55$; $p<0.001$) and lenient ($F(1,103)=5.769$; $p<0.019$) conditions. No significant interactions were found in the strict ($F(1,103)=2.29$; $p>0.133$) or lenient ($F(1,103)=0.079$, $p<0.780$) methods. Category averages for strict and lenient free recall can be found in Figure 2 and Figure 3, respectively.

Matching

Results in the matching section were inconsistent with those found in both the rating and free recall sections. When analyzed on the subject level, no significant effects of animacy ($F(1,103)=0.012$, $p>0.9$) or intuitiveness ($F(1,103)=4.039$, $p>0.137$) were found. When analyzed on the item level, no significant differences were found in levels of animacy ($F(1,103)=0.868$, $p>0.4$) or in levels of intuitiveness ($F(1,103)=7.811$, $p>0.068$). Category averages can be found in Figure 4.

Discussion

None of the data gathered in this experiment support the Minimal Counterintuitiveness Effect. Test results disagree about whether intuitive information is remembered significantly more often than intuitive information. However, in no case is counterintuitive information recalled significantly more often than intuitive information. Even in tests in which no significant difference was found, intuitive information is on average more accurately recalled. This is directly contrary to the Minimal Counterintuitiveness Effect.

Several explanations are possible for this finding. The first explanation is that the Effect is simply incorrect, and that existing empirical support for the theory is due to random chance or experimental confounds. Second, the Minimal Counterintuitiveness Effect proposed for this effect could be partially correct but lacking a necessary detail. For example, in experiments which study the Minimal Counterintuitiveness Effect by using narratives, counterintuitive information is often presented amidst a larger group of intuitive information. For every counterintuitive detail explained, there might be three intuitive details. Perhaps in experiments such as ours, in which counterintuitive information is just as common as intuitive information, the counterintuitive information is so common that it is expected, and therefore loses part of its memorability. If this is the case, the theory about the Effect could be updated by adding that counterintuitive information must be in the numerical minority, or something in a similar spirit. Either explanation would help to explain why the Effect has received inconsistent empirical support. Alternatively, it is possible that our decision to use nonwords is somehow blocking the Minimal Counterintuitiveness Effect.

Overall, the data gathered do not support the Minimal Counterintuiveness effect. Tests stated that either no significant differences were found between recall and rating of intuitive and counterintuitive items, or that intuitive items were significantly better-recalled than counterintuitive items. Even in cases in which no significant differences were found, measures of central tendency usually supported intuitive items as being, on average, better-recalled and

more accurately rated. A follow-up experiment, titled Experiment 2, is currently under design and is intended to examine a type of concept not addressed by the Minimal Counterintuitiveness Effect: "culturally counterintuitive" concepts. As defined by Porubanova et. al. (2014), culturally counterintuitive concepts have a detail that makes them expectation-violating for individuals who come from a culture accustomed to a different detail but are not fundamentally impossible in the ontological way that minimally counterintuitive items are. For example, it is perfectly possible to have a plate in the shape of a right triangle, but for many people used to circular or square plates a plate of this shape may violate expectations in a way that is similar to the counterintuitive information described in Experiment 1.

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Appendix

Table 1. List of people and animal items.

"Animate" Noun	Counterintuitive Adjective	Intuitive Adjective
artist	An invisible	An inexperienced
butcher	A flying	A bearded
pilot	A transparent	An ugly
runner	A resurrected	A hideous
teacher	A ghostly	A healthy
horse	A barking	A galloping
koala	A swearing	A motherly
rabbit	An evaporating	A hopping
skunk	A copper	A stinky
tiger	A writing	A roaring

Table 2. List of plant and inanimate object items.

"Inanimate" Noun	Counterintuitive Adjective	Intuitive Adjective
grape	A radiant	A purple
grass	A shrinking	A growing
onion	A diamond	An infected
orchid	A liquid	A colorful
tree	A jumping	A thick
clock	A molten	A plastic
fence	A floating	A wooden
mirror	A gelatinous	A shattered
plate	An untouchable	A square
table	A glowing	A sturdy

Figure 1. Average proportion correct during rating task by item condition.

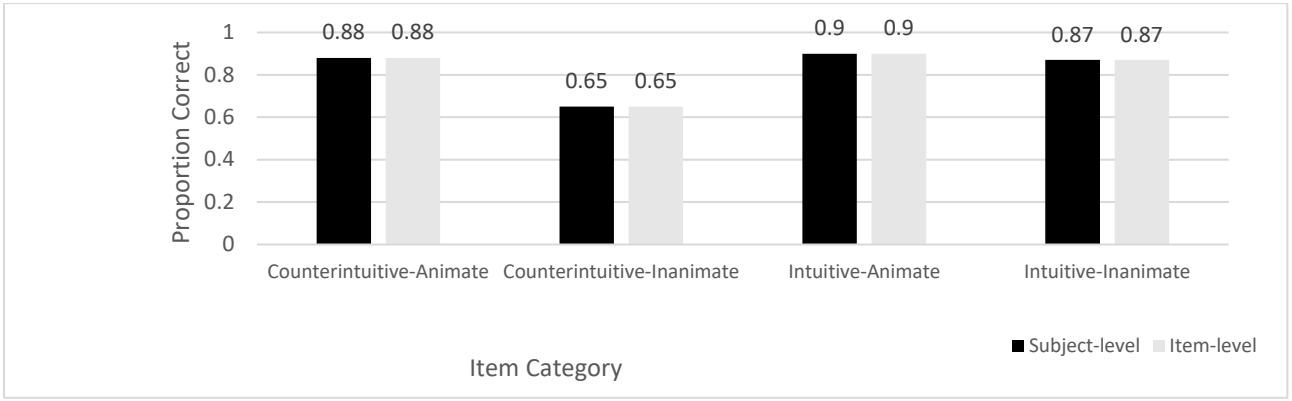

Figure 2. Average proportion correct during free recall task by item condition. Strict recall only.

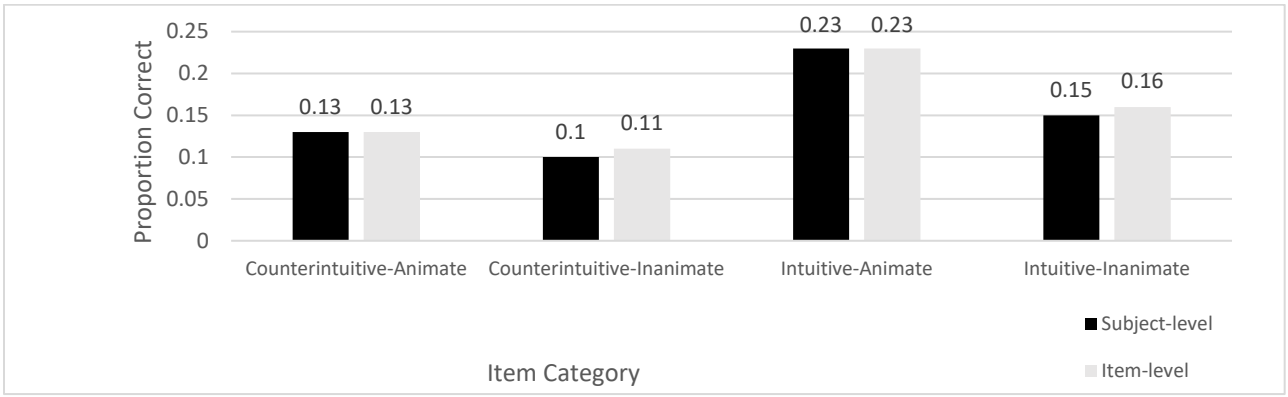

Figure 3. Average proportion correct during free recall task by item condition. Lenient recall only.

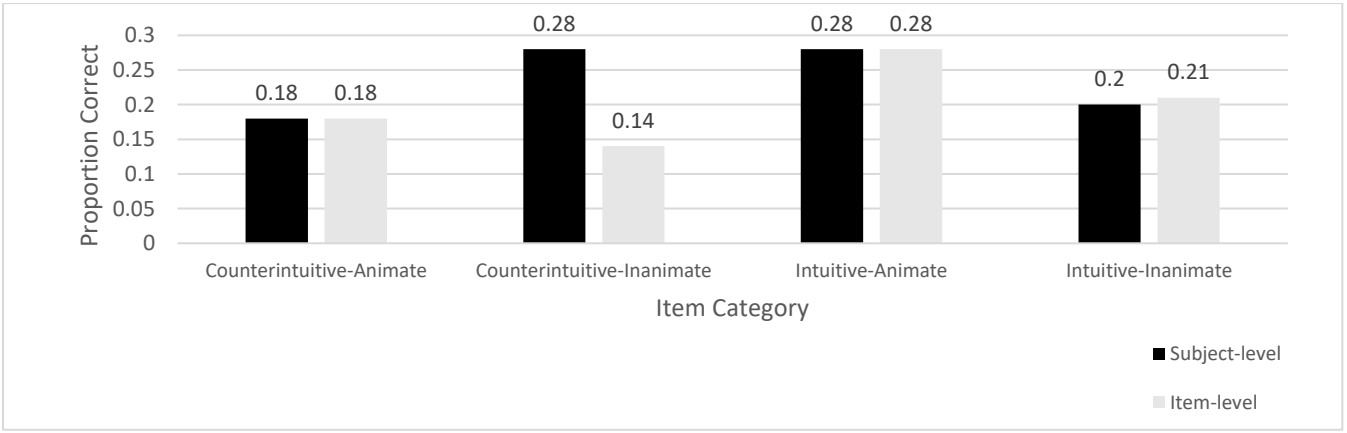

Figure 4. Average proportion correct during matching task by item condition. Lenient recall only.