Do you believe in magic?

The Role of Forces in Our Perception of the Occult

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a thesis submitted to the Faculty of Emory College of Arts and Sciences
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Causal illusions can aid our mental wellbeing, but can also be maladaptive. In the present study, we first test if participants perceive causal illusions. We predicted that causal illusions are formed using the same cognitive mechanisms that infer causation, namely through the dynamics model of causation. One version of the dynamics model is the dual process model of causation, which suggests that causation is inferred through separate but simultaneous experiential and rational processes of thinking. This paper examines whether causation is affected by reliance on such processes, predicting that high reliance on experiential and low reliance on rational thinking will yield higher causal ratings. Furthermore, this paper looks at if engaging in paranoid tendencies predisposes one to perceive more causal illusions. This was tested by providing participants with questionnaires measuring paranoid tendencies, thinking styles, as well as animations depicting causal illusions. Lastly, this paper looks at the effect of timing on the inference of causal illusions, predicting that causation would still be inferred at comparable levels in both the temporal delay and non-delay conditions. Results for the causal ratings were as predicted. No connection was found between paranoia and causal ratings. Results regarding experiential and rational thinking styles were different than expected but still suggest that the dual process approach plays a role in the inference of causation. Temporal delay did not greatly affect ratings in illusory causal conditions.

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Abstract

Causal illusions can aid our mental wellbeing, but can also be maladaptive. In the present study, we first test if participants perceive causal illusions. We predicted that causal illusions are formed using the same cognitive mechanisms that infer causation, namely through the dynamics model of causation. One version of the dynamics model is the dual process model of causation, which suggests that causation is inferred through separate but simultaneous experiential and rational processes of thinking. This paper examines whether causation is affected by reliance on such processes, predicting that high reliance on experiential and low reliance on rational thinking will yield higher causal ratings. Furthermore, this paper looks at if engaging in paranoid tendencies predisposes one to perceive more causal illusions. This was tested by providing participants with questionnaires measuring paranoid tendencies, thinking styles, as well as animations depicting causal illusions. Lastly, this paper looks at the effect of timing on the inference of causal illusions, predicting that causation would still be inferred at comparable levels in both the temporal delay and non-delay conditions. Results for the causal ratings were as predicted. No connection was found between paranoia and causal ratings. Results regarding experiential and rational thinking styles were different than expected but still suggest that the dual process approach plays a role in the inference of causation. Temporal delay did not greatly affect ratings in illusory causal conditions.

The Role of Forces in Our Perception of the Occult

Humans idealize the world. We try to make the complex simple in order to better understand how the world works. One way we do this is by perceiving and adhering to causal relationships. For example, when we turn the keys in our car's ignition, we expect the car to turn on or off because our action caused it to happen. If the car does not turn on, we know something is wrong because that outcome contradicts the causal relationship we have established between turning the keys and the engine starting. In this paper, we explore different views on how causal relationships are formed by looking at how causation is inferred in situations where a causal illusion occurs. A causal illusion is a situation in which object *A* appears to cause object *B* despite there being no possible known mechanism to validate such a causal relationship. For example, if a black cat rushes across your path and moments later your phone is dropped; did the black cat cause that bad luck? Causal illusions are at the core of such superstitions, where the impressions of causation are strong but there is no real mechanism to justify the impression. This paper explores how these false impressions occur, and how they may relate to personality measures and thinking styles.

Background

In order to understand how causal illusions are formed, we must first look at how typical causal relationships are inferred. The conversationalist explanation of causation dictates that when an inquirer questions someone about the cause of an event (a crashing plane) the answer one gives would omit many relevant causes (i.e. gravity). The omission stems from the assumption that the inquirer is asking about a specific aspect of the event that he or she is unaware of, and the assumptions that the answerer makes about what the inquirer already knows (Cheng and Novick, 1991; Mackie, 1965). In other words, the conversationalist model argues that we understand causation by weighing known and usual causes versus unknown or unusual causes. This requires us to have a stored database of causal relations. The conversationalist explanation is useful in emphasizing the importance of causality in our everyday lives because it shows how certain causal relationships are assumed to be so obvious they no longer deserve mentioning. It is less useful, however, at showing how causal relationships are formed or through which mechanisms we know to discern the unknown from the known.

Currently, there are two main approaches to causation that try to answer what the conversationalist model leaves out. These two main approaches are instantiated in two prominent models of causation: the probabilistic contrast model and the dynamics model of causation. The two models offer explanations for the processes we use to understand causation and need to be looked at in a historical context in order to be fully understood. In the early 18th century, Hume (1737, 1975) believed that causation was inferred based on certain properties or circumstances related to the events that implied causation. Hume's definition of causation stems from the Enlightenment's mechanistic view of the world, which holds that everything operates like machines and therefore eschews the magical or unseen (Wolff and Shepard, 2013). He interpreted causation as one event that frequently occurs before a second event, so that once event *A* occurs, event *B* is likely to occur as well. It is important to note that Hume's theory focuses on the outcome (the observable property or event) rather than the mechanism behind it.

Cheng and Novick (1991) proposed that causation is inferred through co-variation and therefore align themselves with Humean beliefs. Cheng and Novick's proposed model, the probabilistic contrast model, like Hume's, emphasizes the outcome of the event. The model is based on the probability that an effect will occur when the cause is present, as well as the probability that the effect will occur when the cause is not present. Their model is dependent on the cause being present so that it can be associated with the outcome, and also dependent on people experiencing an event more than once, as co-variation needs multiple occurrences in order to be inferred. The probabilistic contrast model therefore becomes shaky in situations where the cause is not observable or an event where causation is inferred based on only one occurrence (single instance identification of causation) (Ahn & Kalish, 2002; Wolff, 2007).

Lien and Cheng (2000) argued that the probabilistic contrast model still holds in single instance identifications of causation if the model is amended to include the power theory. The power theory states that previous knowledge of a causal mechanism is necessary for causation to be inferred. The combined theory of the probabilistic contrast model and the power theory results in the coherence theory, which states that although a particular instance of causation has never been encountered before, knowledge from similar categories relating to that event extend to that instance and allow causation to be inferred. However, this theory would imply that if no similar knowledge of an occurrence was available then causation could not be inferred, which is unlikely. Fair (1979) argues and offers examples that people do in fact make causation ratings even with events outside of their knowledge, and based on only one instance.

Before the Enlightenment, action at a distance was less of a problem, as can be seen through both Ancient Greek philosophy and medieval views of causation. Aristotle claimed that causation is created through an interaction of forces between an agent and a patient, an idea that is a precursor to the dynamics theory (Wolff & Shepard, 2013). An example of such a causal interaction is when a child (the agent) throws a ball (the patient). The energy from his throw is transferred to the ball, which allows the ball to travel far. To explain action at a distance, Aristotle resorted to breaking down the process into steps that allowed the agent to travel across distances (such as the sun moving the winds which in turn moved the waves) (Wolff & Shepard, 2013). Hume rejected such a view because forces could not be seen or sensed, and were therefore considered to be occult. In this paper we argue that Humean descriptions of causality do not offer a complete explanation for causation. We argue that it is actually the medieval view of causation that is closer to our psychological understanding of causation.

Forces and Causation

Medieval thinkers had no problem with action at a distance or supernatural forces acting upon the world. Many medieval thinkers believed that stars or other supernatural forces acted upon the everyday world and explained unexplainable events (Jammer, 1957). Although in today's world cries of witchcraft or supernatural forces are often replaced with more scientific explanations of causes, there are still events in which we perceive forces and are willing to attribute a supernatural cause. For example, let us return to the black cat mentioned earlier. As a society, we subscribe to certain superstitions (Rapoport, 1989; Matute, Yarritu, &Vadillo, 2011) and are therefore willing to entertain the idea that the black cat can in fact cause bad luck. In the end, we may not attribute the black cat as the cause of our bad luck, but the idea, at least on an intuitive level, does not seem too ludicrous.

A more modern example illustrating how people may understand forces in a similar fashion to the medieval scholars can be found in an elevator prank that illustrates our readiness to perceive and attribute forces as causes. The prank, posted on YouTube (http://www.youtube.com/watch?v=y7-1A_j3fSM), includes one friend standing inside the elevator, and raising his arm just as the doors begin to close. Meanwhile, his accomplice stands outside where none of the elevator occupants can see him, and presses the elevator button from the outside so that the doors will open in sync with the hand movements of the man inside the elevator. The comments of occupants in the elevator (varying from "The force is with you" to "Stop doing that!") suggest that they attribute the doors opening to the man raising his arm, and some even attribute it to "the force." Of course, we do not get to see how many attempts it took the two pranksters to elicit the reactions they wanted or if every occupant fell for their prank. Nonetheless, what is compelling about the video is that even while seeing the accomplice press the elevator button, it is tempting for us as viewers to see the man in the elevator as the cause of the opening door and not his accomplice pressing the button. This occurs despite our knowledge that it is highly unlikely that this man has the power or ability to open the elevator doors by raising his arm.

Figure 1. Elevator prank using "The Force"

The ideas of forces and causation have been around since ancient times and are still being talked about today, as is illustrated by Talmy's (1988) force dynamics model. Talmy's model refers to forces to explain interactions between entities. Talmy takes a cognitive linguistics approach to studying force dynamics, which is based on the idea that the language we use provides information as to how we organize meaning. Talmy argues that force dynamics consists of three dimensions: the tendency for an object (the agonist) to be either in action or rest, the strength of the force exerted by an antagonist on the agonist compared with the strength of the agonist, and the force created from the interaction.

Talmy argues that our tendency to understand causation through forces is embedded into the English language in varying domains (physical events, psychological, intra-psychological, and socio-psychological). By including psychological and socio-psychological as domains, Talmy is referring not only to physical forces, but to social ones as well. In other words, Talmy is referring to notions like “social pressures”. One example he gives is of a girl who has got to go to the park vs. a girl who gets to go to the park (Talmy, 1988). The former example implies that her tendency is not to go to the park, but someone else does want the action to occur and the force of their will to follow through with the action overcomes the force of her will to not complete the action. Therefore the word “got” in this sense, carries a resisting force in its implications. Further analyses and examples are beyond the scope of this paper, but Talmy does offer an extensive analysis of how force dynamics are embedded in the English language.

Many of Talmy’s (1988) intuitions are captured in the dynamics model (Wolff, 2007). The dynamics model differs from Talmy’s (1998) theory of force dynamics in offering a way to identify different modes of causation such as ENABLE (the door would not be able to open without a hinge, but a hinge did not cause the door to be open) and PREVENT (the pole prevented the tent from blowing in the wind, or the pole caused the tent to not be blown away by the wind).

Wolff (2007) showed how the notions of CAUSE, ENABLE, and PREVENT may be realized in terms of forces in a series of experiments testing different animated scenarios where the force configurations were manipulated in order to reach different outcomes. For example, one of the scenarios showed a boat floating in a pool. The boat showed its tendency at the beginning of the animation (either moving away from or toward a cone in the pool) and then fans began flowing with a force either weaker or stronger than the force of the moving boat, and either with or against the direction of the boat. Participants were then shown the animations and asked whether the fans enabled (tendency toward the cone, and the winds aiding the boat to reach the cones), prevented (tendency for the boat toward the cone, but the winds caused the boat to miss) or caused (tendency away from cone, but the winds caused the boat to go to the cone) the boat to reach its destination. Participants' responses were as predicted, indicating that they had taken into account the interaction between the two forces and could differentiate between the different conditions of CAUSE, ENABLE, and PREVENT.

Wolff's dynamic model shows that we perceive causation by considering how multiple forces interact with one another. Such an argument gains support by looking at Bigelow, Ellis and Pargetter's (1988) argument for an account of forces as causal relations. The authors argue that we perceive causation not in terms of an entity (a cause), a mediating force, and another entity (the effect), but rather as the interaction between these three things, an interaction for which forces are central. They make the point that we have the ability to feel forces. This can be seen in our physical interactions with everyday objects. The same object that we touch can feel different depending on how we make impact. For example, a ball may feel soft if you simply touch it or bounce it, but it feels hard if it is thrown at you. This change in how we understand what an object feels like depends on the force exerted by the object, which in this case is minimal at rest and strong when thrown. This occurs despite no change occurring in the object itself. The only differing aspect in such instances is the force of impact of the object. The authors then make the argument that we can perceive this difference because we can detect the differing strengths of the forces at play.

Recent research raises the possibility that causation may be grounded in the sense of touch. As proposed in White's (1999) theory of causal realism, there are cases where humans can infer causality directly. For example, if a glass is dropped on a wooden floor, it does not hit the floor and then break, it breaks simultaneously with the impact of hitting the wooden floor. This same outcome would not occur had the glass fallen on a soft mattress, where the force of the impact would be absorbed rather than returned. We can directly observe these forces because we have previously experienced them and therefore can detect them in other objects. His view provides support for the argument presented by Bigelow, Ellis, and Pargetter, echoing the idea that we understand causation through forces because we regularly experience or feel them.

The dynamics model and the causal realism view suggest that we can experience causality based on different modalities, not just visually. White (1999) offers examples of causality being inferred through other modalities, such as olfactory (the nice smell we detect is caused by a rose), taste (eating a lemon caused a sour taste), auditory (the chirp we heard is caused by a bird) and tactically (pushing a mug across a table allows us to know that we caused the mug to move). Many of these modalities are not studied often in the field, but there is research that looks at the connection between our haptic senses and inferences of causality.

Perception of Forces

Several studies have shown that we can in fact sense forces. Panerese and Edin (2010) placed an apparatus on participants' index fingers and had the apparatus exert a force on the participants' fingers. Participants were accurate at discriminating forces from different directions, even with forces whose directions differed by only 7.1°. Similarly, another study tested human subjects' ability to reproduce forces with a joystick. The ability to reproduce forces differed based on the hand's motor ability to reproduce a force coming from that direction, suggesting that humans understand forces by calculating the effort needed to reproduce them (Toffin, McIntyre, Droulez, Kemeny, & A. Berthoz, 2003).

A third study provided evidence that we make assumptions about forces when acting on objects, such as when we over-lift an empty suitcase we believed was full. In this study, participants were given a robotic arm that exerted a force that hindered them from following a given path with their hand. After participants were given a few trials and adjusted to the force so that it no longer hindered their hand's movement, the force was removed. The result was that participants' hands moved off the given path in the opposite direction of the force exerted (Reinsmeyer, Emmken, & Crammer, 2004). Further studies reveal this to be an automatic and implicit reaction, providing further evidence that we calculate the forces needed to complete an action (Reinsmeyer, et al., 2004; Wolff & Shepard, 2013).

In another study, Wolf and Shepard (2013) showed that participants were faster to detect forces in causal situations than in non-causal situations. This was done by showing participants a set of animations in which a circle came onto the screen and hit another circle, causing the second circle to move (causal), or a non-causal control video where one circle simply moved across the screen at the same speed. These animations were shown to participants in two experiments, one where it was just circles moving across the screen, and the second where these circles were rendered hyper-realistically to show two marbles making contact. Participants were randomly assigned to three conditions, a visual condition where participants were asked to press the button after a dot flashed on the screen at the end of the animations, an auditory condition where participants were told to watch the animations and press a button after they heard a sound through headphones, and a haptic condition where participants were told to press the button after they felt a controller exert a small force. The researchers measured participants' reaction times in pressing the button, and found no significant differences for the visual and auditory conditions. They did, however, find that participants were faster to press the button in response to a force after watching a causal animation than a non-causal animation (Wolff & Shepard, 2013). Such a study provides further evidence that people can detect forces and use these forces to understand causation.

The same study further tested whether their results held up in more abstract situations where the underlying forces were not as evident as two marbles making contact. Two separate experiments showed increasingly abstract situations in which the use of forces was not direct, including a social causation example. One study depicted a wooden mannequin getting up and flipping on a light switch. In the causal condition, the light was on and flipping the switch turned the light off. In the non-causal condition, the light remained on despite the person flipping the switch. In the experiment on social causation, one mannequin directed another mannequin to change its running direction. In the non-causal condition, the mannequin travelled the same path but without another mannequin directing him. As in the previous experiments, the faster reaction time occurred only in the causal animations of the force condition, and not the visual or auditory conditions. This suggests that even in very abstract settings like the social causation example, people perceive forces (Wolff & Shepard, 2013).

Causal Illusions

Until this point, we have discussed the evidence in favor of causation being a common part of our everyday lives, and our own aptitude at discerning causal relationships. However, sometimes people infer causation when no cause is present and there is no mechanism through which the causal relationship could occur. Often in such cases, researchers have tried to write causal illusions off as uncommon. Ahn and Kalish (2002) discuss the Power PC theory, which is a modification of the probabilistic contrast model where co-varying events are viewed as non-causal if they are known to occur independently of the effect. Cheng (1997) uses the Power PC's theory's take on causal illusions to argue that causal illusions are possible only if a possible mechanism can be inferred, regardless of if the mechanism exists or not. Ahn and Khalish offer the example that no one would believe that wearing socks causes Alzheimer's disease, because there is no possible mechanism. However, one could counter that there are exceptions to this. For example, some people will believe that wearing a specific set of "lucky" socks can help their preferred team win a game despite there being equally no possible existing mechanism for such a belief (see Rudski & Edwards, 2007 for a study on the use of superstitious behavior and rituals).

White (1999) strongly advocates for causal illusions being exceptions and not the norm. The first criterion he mentions for causal realism to be accepted is that a causal relationship will not be inferred where it does not exist. He acknowledges causal illusions only to show the error in them and to explain how illusions of causation should not detract from the causal realism view. His second criterion deals with accuracy of the cause, once again reinforcing the idea that the cause needs to be realistically possible for it to be inferred. He acknowledges that causal illusions exist, and can exist in every modality, but tries to discredit them as not detracting from his theory.

Interestingly, there is strong evidence to suggest that causal illusions are actually quite common. Matute, Yarittu, and Vadillo (2011) report that a large percentage of Americans and Europeans believe in pseudoscientific techniques and that a smaller but still alarming percentage of American and European people actually partake in pseudoscientific treatments. They argue that superstitions, defined as irrational beliefs relating to fictitious causal attributions, are at the core of pseudoscientific beliefs such as quackery (a specific pseudoscience relating to medical practice).

Further evidence that causal illusions are common comes from research examining the relationship between superstitious behavior and uncertainty (Malinowski, 1954). Rudski and Edwards (2007) asked participants to indicate under which conditions they would engage in ritualistic behavior like dressing up, refraining from jinxing, or knocking on wood before a big event like an exam, performance, or game. As the stakes of the event went up, the researchers found that the likelihood of engaging in superstitious behavior increased. In a related finding, Gallagher and Lewis (2004) found that 70% of students partake in rituals or superstitions related to test taking.

Further research suggests that superstitious behavior also increases when results of an event are favorable, even when a person does not have control over the outcome. For example, Rudski, Lischner, and Albert (1999) found that when playing a video game in which points were randomly assigned, participants who were “winning” created more superstitious rules for the game to explain how they were scoring points than those participants who were arbitrarily losing. Many of the participants in the winning condition also had more confidence in the rules they made and their ability to win again.

Another, more intrinsic manner in which causal illusions are part of our everyday lives is through our illusion of control. Langer (1975) introduced the concept of illusion of control, which is when an individual predicts that he or she has more control than is realistically possible. If one believes he is controlling something, then he also believes he is causing something to occur. Therefore, if one has the illusion that he is controlling an object or circumstance, he is also subscribing to the illusion that he is causing the object or circumstance to play out in his desired manner. Langer found that participants believed they had more control over chance events that they had invested more time participating in, or were given a choice in. For example, participants given a choice in lottery tickets betting on Superbowl teams valued their tickets as more expensive than those randomly assigned to one. For chance events, choice, knowledge, familiarity, or other similar factors have no bearing on the chance outcome. Yet people perceived these factors as influencing the outcome, showing that people do partake in causal illusions.

Additionally, one's illusion of control was also found to be correlated with one's mental wellbeing. Matute (1994) found that the illusion of control provides a protective layer against learned helplessness in aversive situations in which one has a limited amount of control. Taylor and Armor (1996) provide a study indicating that people who subscribe to positive illusions may be better adjusted individuals. Such positive illusions include causal illusions. For example, the study discussed previous work with women suffering from breast cancer, who believed they had more control over the progression of their cancer than they actually had according to their medical records. These illusions also extended to patients with HIV/AIDS, heart disease or other cancers, who perceived they had more control regarding the future development of their illness, another factor which is largely unpredictable in nature.

Though causal illusions can sometimes positively affect our wellbeing, too many or too few causal illusions can negatively influence our wellbeing. Several studies have found that depressed patients often have either a realistic or lower sense of control than their psychologically healthy counterparts. Alloy and Abramson (1979) found that when giving participants different problems to solve, and varying the degree of reinforcement (onset of a green light), non-depressed participants overestimated their control of the light when results were favorable, and underestimated their level of control when results were unfavorable. Conversely, depressed participants were quite realistic in their estimates of control. Another more recent study found that lacking a sense of control was a strong predictor of anxiety and depression in both mothers and fathers during the first year after having a child and that increasing new parents' sense of control decreased their levels of anxiety and depression (Keeton, Perry-Jenkins, & Sayer, 2010).

Too much control can also be pathological and can lead to anxiety. A recent study gave university students questionnaires measuring depression and obsessive compulsive symptoms. Following the completion of the questionnaires, participants were asked to participate in a task similar to the one Alloy and Abramson (1979) used, which consisted of participants completing problem solving tasks and the researchers varying the frequency of a desired outcome (a green light) to create an illusion of control. Participants were encouraged to try to control the light based on keyboard movements. Participants scoring high on obsessive compulsive symptoms perceived that they had more control over the green light, even though they realistically did not, and displayed more ritualized behavior (pressing the keyboard buttons) as well. These findings were replicated in a similar experiment as part of the same study, which compared participants with Obsessive Compulsive Disorder (OCD) to a control group without OCD (Reuven-Magril, Dar, & Liberman, 2008).

Similarly, causal illusions play a central role in paranoia. Paranoia can be pathological, but it also exists in a non-pathological form. Non-clinical paranoia is often casually thrown around during conversations, like when a friend tells you "don't be so paranoid" or if one believes a group of people may be talking about him even though he has no evidence to prove this. Both clinical and non-clinical paranoia are characterized by thoughts focusing on the self (self-referent thoughts) and self-consciousness (Fenigstein & Vanable, 1992). Duval and Wicklund (1973) found that self-referent thoughts may lead to a higher level of perceived control in an individual. They asked participants to focus on a hypothetical scenario that had a negative outcome. Half of the participants were given a mechanical task, and the other half were not. It was predicted that those focusing on a task while being asked to also focus on the hypothetical scenarios would attribute the cause for the negative outcome as external, because their attention was focused externally on the task. Additionally, it was predicted that because the participants not completing a task had nothing else to focus on, they would attribute the cause of the negative event to themselves, as more of their focus was drawn inwardly. The results were as predicted, and were replicated in another experiment (same paper) where positive scenarios were also tested.

Causal illusions are likely more common than the causation literature suggests, but there has been little work on how theories of typical causation might be extended to explain illusory causation. Humean views of causation, which call for co-variation, would most likely accept causal illusions in which the cause and effect were temporally close. The force dynamics theory would most likely predict that causal illusions would be inferred when an agent acts in a manner consistent with the imparting of forces. If the forces seem as if they could lead to an outcome, causation may be inferred even if the forces are not physically present or possible.

Predictions of the force dynamics and covariational views

To test whether people can detect causal illusions, we created animations that varied in three dimensions: contact, direction, and movement. One of the animations was legitimately causal, three were examples of causal illusions, and two were control situations (clearly not causal). In Experiment 1, participants were asked to provide ratings of the degree they could say the agent (in this case a wooden mannequin) caused the event (for most of the animations, a ripple in a water-filled tray). If we view causation through covariation, then any animation that depicts an action (cause) and a result (effect) may be viewed as causal due to the correlation. This would include animations depicting the causal illusions. The resulting ratings should be high on all causal and illusory causal animations and low for the non-causal controls. If we infer causation based on the dynamics model, then people should be especially sensitive to whether the direction of the cause matches the direction of the effect. Matching directions should be important because forces have direction. The dynamics model predicts, then, that participants should provide higher ratings of causation when the direction of the force generated by the agent matches the direct of the effect, and that this effect should occur for both actual and illusory causation.

A promising version of the force dynamics theory is the dual process theory, which connects our ratings of causation to two processes of thinking. Wolff and Shepard (2013) proposed the dual-process theory of causation, which suggests that we have two main processes of thinking about causation: an intuitive process and a rational one. The intuitive process is an automatic process that detects the forces we see. The rational process is relatively slower and tries to understand if the witnessed forces were plausible and causal. These two processes work simultaneously to interpret what we see. If the dual process of causation holds, then we can predict that those higher on intuitive thinking will rely more on their initial, intuitive judgments of causation and will provide higher ratings of causation if they witness or detect a force. Participants high on the second, rational, process would analyze the situation more fully and would provide lower ratings of causation for illusory animations, as they would not find a plausible mechanism for the effect to take place. In order to test the dual process theory of causation, we provided participants with the Rational-Experiential Inventory (Epstein, Pacini, & Norris, 1998) in order to measure participants' reliance on either the first process (the experiential scale) or the second process (rational scale).

Although there are studies linking self-referent thoughts and paranoia, there are no studies that we are aware of that test the link between tendency to subscribe to causal illusions and paranoia. This paper will test whether people believe causal illusions, as well as if the tendency to subscribe to illusions of control is heightened when one has high paranoid tendencies. In this paper, we focused on studying the effects of non-clinical paranoia on causal ratings, predicting that if the effect is strong then it should show up in the non-clinical population as well. To test non-clinical paranoia, we used Fenigstein and Vanable's (1992) Paranoia and Self Consciousness scale. In Experiment 1 and 2 we gave participants the Paranoia and Self-Consciousness questionnaire to measure their paranoia tendencies. We predicted that participants with high scores on the Paranoia and Self-Consciousness scale would provide higher ratings for animations depicting causal illusions than those with low scores. We also predicted that participants' ratings of causation would be higher for actual causation than for causal illusions. In sum, for the first experiment we tested whether participants can detect causal illusions and then tested whether their causal ratings relate to their thinking styles or paranoid tendencies.

Experiment 2 differed from Experiment 1 in that it further tests the force dynamics theory by asking participants to give ratings based on force instead of degree of causation. If we interpret causation through forces, ratings for the animations in Experiment 2 should replicate the ratings found in Experiment 1. Experiment 3 looked at whether timing informs our understanding of causal illusions, especially if there is a temporal delay between cause and effect. Would direction of forces determine whether causation is inferred, even if the effect is delayed? In Experiment 3, participants were given the same animations as they were given in Experiments 1 and 2, but were additionally given an altered version of those animations that involve the same situation but delay the effect. We predicted that a delay should be less causal in normal causal situations because we are used to seeing the effect immediately after the cause. However, if the forces are matched up in a causal illusion, participants may rate the animations as equally causal with or without a delay. This is because if participants view causation in terms of forces, they are likely to infer illusory causation with or without a delay based on the witnessed interaction of forces. This being the case, ratings of causation for illusory causal conditions where the direction of forces match may be higher than typical causal conditions.

Experiment 1

Methods

Experiment l looks at the connection between causal illusions, thinking styles, and paranoia. In this experiment, participants are given causal and non-causal animations and asked to rate the degree of causation. We predicted that participants scoring high on paranoia ratings would provide higher ratings of causation in response to the causal illusion conditions than would participants scoring high on the experiential engagement (EE) and low on the rational engagement (RE) subscales of the REI.

Participants

Participants were 81 paid participants who responded to a posting on Amazon's mechanicalTurk website. The average age of participants taking this study was 33.2, with the youngest being 19 and the oldest 58 years old. 39.2% of participants were female (n=31), 58.4 % were male (n=49) and 1 participant did not answer the question.

Procedures

An online survey was created on Qualtrics incorporating the Rational Experiential Inventory-40 (REI), Paranoia and Self- Consciousness Scale, and causal animations. The survey included two questions at the end of the animations to insure that participants viewed the animations. Participants saw each survey separately and only one animation per page. Each question was mandatory, and all participants saw all three components of the survey. The survey was distributed on Amazon's mechanicalTurk website.

Materials

Causal Animations

Participants were shown nine animations in total and asked to provide ratings of causation based on the hand of the wooden mannequin in the animations. The animations were made using computer animation software AutoDesk 3ds Max and RealFlow. Ratings were provided on a scale of 0-9 with 0 corresponding to "to no extent" and 9 "to

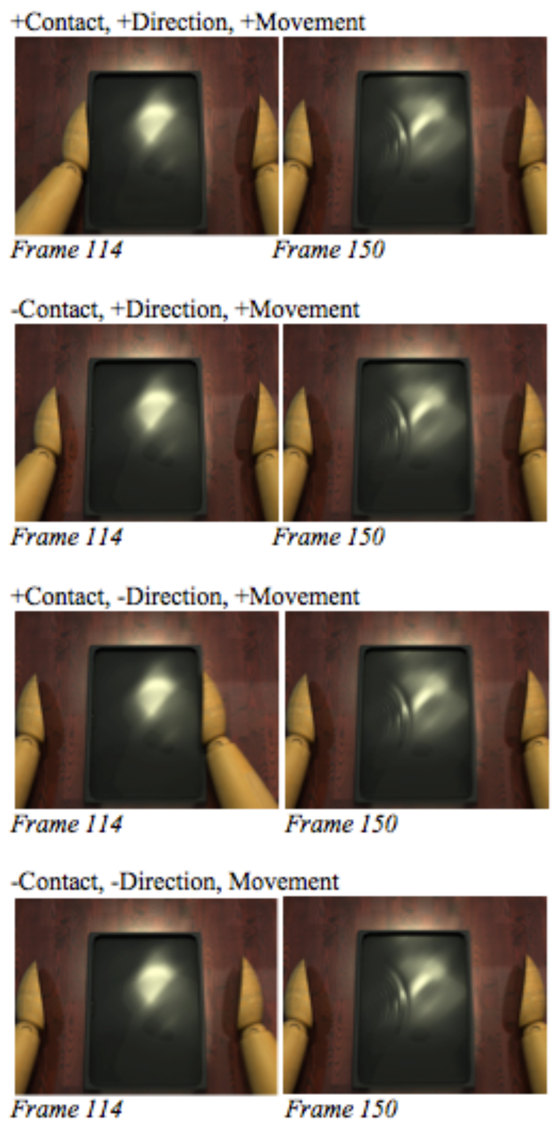

Figure 2. Causal and illusory causal conditions

the fullest extent." Each animation was shown on a separate page to prevent participants from changing previous answers based on viewing a certain animation. The order in which the animations were presented was random.

The first six animations were a series of tray and water animations. Of these animations, one was legitimately causal. The rest differed on three dimensions: direction, contact or movement, to create a variety of causal illusions and a control (-direction, -contact, -movement). In the causal condition, the hand hit the side of the tray (+movement, +contact) and the ripples appeared from the side of contact (+direction). In the illusory causal conditions, the hand either came half way (-contact), hit the tray of water from the opposite side that the ripple emanated from (-direction), or came half way, also from the opposite side that the ripple emanated from (-contact, -direction). The non-causal control animations consisted of no hand movement (-movement) with one animation for ripples emanating from the left, and one for ripples emanating from the right. Participants were randomly assigned to the set of animations with the ripples appearing from the right side of the tray or the same series of animations, but with the ripples coming from the left side of the tray. This was to ensure there was no bias associated with either the left or right side. Each set of animations (ripples coming from right or ripples coming from left) had one control video in which the ripple came from the opposite side as the other animations in the series. The last three animations were of a mannequin with his hands facing each other and either turning face up, face down, or not moving as rain begins to fall, and returning to the starting position as the rain stops.

At the end of the survey, participants were asked two comprehensive questions to make sure they were answering honestly and as if the scenarios were real scenarios.

Participants were asked both “under what circumstances did you find you could say the hand caused the water to move?” and “under what circumstances did you find you could NOT say the hand caused the water to move?”

The use of animations is particularly useful for our purposes as it allows for a great deal of control in each scenario. For each scenario, the ripple begins at the same frame number. The hand reaches its final point at the same frame and hits or stops at the equivalent point of the tray for each scenario (the right hand hits the right side at the same point regardless of if the ripple occurs on the right or left side). Each animation is also created with the same number of frames so they are all comparable to each other. This is also true for the rain animations. The rain begins and stops at the same time, and the hands all begin in the same place. There are an equal number of frames in each animation.

Measures

Rational-Experiential Inventory (REI)-40

Participants’ tendency to engage in system 1 (experiential) or system 2 (rational) thinking styles was measured by the Rational-Experiential Inventory (Epstein, Pacini, & Norris, 1998). The REI contains 40 items. It is a modification of previous versions of the REI and is composed from a modified version of the Need for Cognition (NFC) (Cacioppo & Petty, 1982) that measures engagement in cognitive activities, as well as the level of enjoyment one has during such activities. The scale also contains items from the Faith in Intuition (FI) scale, which was constructed for the purposes of this measure as a counterpart to the NFC.

The REI is split into 20 questions that measure one's rational ability and rational engagement and 20 questions that measure one's experiential ability and experiential engagement. Rational Ability (RA) refers to one's self report of a high level of logical and analytical thinking while Rational Engagement (RE) refers to how frequently one relies on and enjoys these abilities. An example of an RA item is "I am much better at figuring things out logically than most people" while an example of a RE item is "I enjoy solving problems that require hard thinking." The scale contains items that measure the negative of these subscales (e.g. "I am not a very analytical thinker" and "Thinking is not my idea of an enjoyable activity" on the RA and RE scales, respectively) to insure that the scale is measuring what it intends to measure.

The second set of questions measure Experiential Ability (EA), and Experiential Engagement (EE). Experiential Ability refers to the strength of one's intuitions and feelings during decision making, while Experiential Engagement refers to one's reliance on those intuitions and feelings. An example of an item on EA is "Using my gut feelings usually works well for me in figuring out problems in my life" while an example for EE is "I tend to use my heart as a guide for my actions." These also contain negative items like "My snap judgments are probably not as good as most people's" (EA negative) and "I generally don't depend on my feelings to help me make decisions" (EE negative). Participants rated all forty items on a Likert scale of 1-5,1 correlating with "definitely not true of myself" and 5 with "definitely true of myself."

The Rationality and Experientiality scales on the REI had high reliability ratings of $\alpha = 0.90$ and $\alpha = 0.87$ respectively. The two scales are independent of each other. Pacini and Epstein also showed that the subscales demonstrated discriminant validity

(1999). They demonstrated construct validity by comparing scores on REI with a variety of other measures, including the Big Five Personality measures and the ratio-bias paradigm, which creates a conflict between the two systems of thinking and has high construct and external validity outside of the lab setting. Their findings supported the reliability and validity of the REI-40.

Paranoia and Self-Consciousness Scale

The Paranoia and Self-Consciousness Scale measures a person's non clinical paranoia (Fenigstein & Vanable, 1992). It measures the level of awareness one has of their publically visible features and the degree to which they believe external events are directed at them (self-as-target bias). For example, some items on the questionnaire include "I have often felt that strangers were looking at me critically" or "I often wonder what hidden reason another person may have for doing something nice for you." It is a 20-item scale in which participants are asked to rate the degree to which each statement is true for them on a scale of 1-5, 1 being not at all applicable to me and 5 being extremely applicable to me (Fenigstein & Vanable, 1992). The items are derived from the Minnesota Multiphasic Personality Inventory. The survey was created for use in a college population.

Alphas for the survey testing internal consistency of the items ranged from 0.81-0.87, indicating strong internal consistency. The authors investigated the relationships between paranoia and associated measures (trust, anger, and control beliefs) in order to establish the construct validity of the measure. Such analyses provided evidence for convergent and discriminant validity.

Results

Ratings of Causation

We predicted that ratings of causation would follow the force dynamics model and differ across causal, non-causal, and illusory causal conditions. Ratings did not differ across the ripple right and ripple left conditions and therefore the ratings were combined for all subsequent analyses. Ratings of causation were highest when contact, direction, and movement matched and lowest for the non-causal control condition. As shown in Table 1, in the illusory conditions, ratings were highest when direction matched but no contact was made (-

Table 1 Causation Ratings for Experiment 1 (0-9 Scale) with (SDs)

Condition	Mean Ratings
+Contact, +Direction, +Movement	7.54 (1.89)
-Contact, +Direction, +Movement	4.91 (2.84)
+Contact, -Direction, +Movement	3.33 (2.75)
-Contact, -Direction, +Movement	2.00 (2.31)
-Contact, -Direction, -Movement	0.46 (1.15)

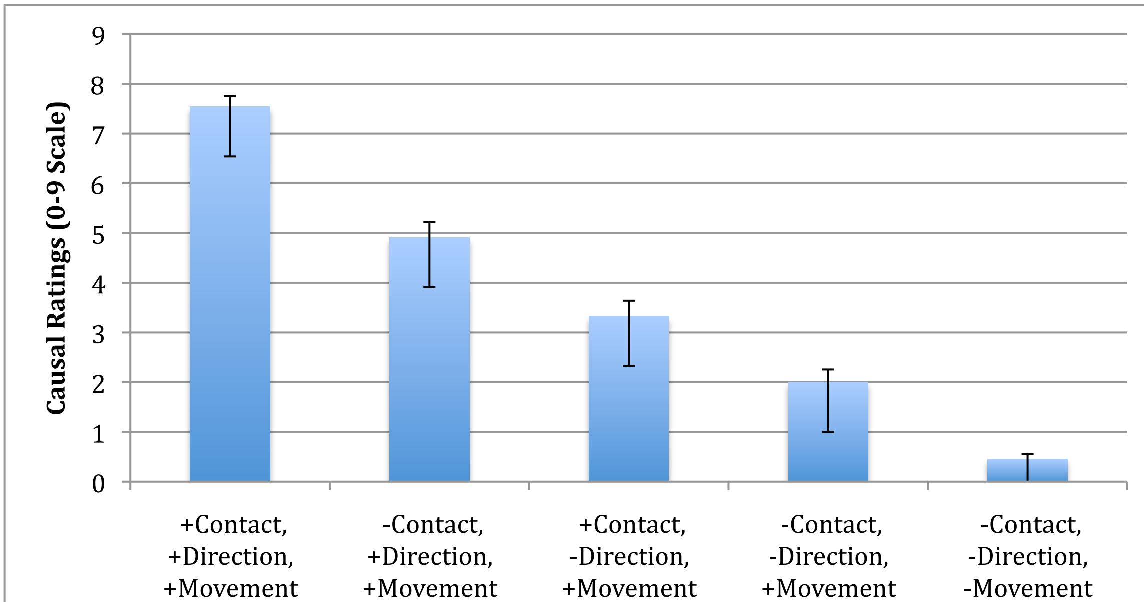

Figure 3 Ratings of Causation for Experiment 1

contact, +direction, +movement) and lowest when direction did not match and no contact was made (-contact, -direction, +movement). As predicted, causal ratings were higher when there was physical contact (*M*= 5.4) than when there was no contact (*M* = 3.45), $F(1,80) = 71.72$, $p < .001$, $\eta^2 = .473$. Also as predicted, causal ratings were higher when the direction of the cause and the effect were the same (*M* = 6.2) than when they differed (*M* = 2.65), $F(1,80) = 170.48$, $p < .001$, $\eta^2 = .681$. Of particular interest, the effect of direction was greater when the cause made contact with the effect than when it did not, as supported by a significant interaction between direction and contact, $F(1,80) = 11.80$, $p = .001$, $\eta^2 = .129$.

Additionally, we asked participants to report the conditions under which they could say the hand caused the water to move and the conditions under which they could not. This was to ensure that participants were viewing the animations as real scenarios. A majority of participants reported that they could say the hand caused the water to move when it made contact with the tray. Some participants mentioned direction of the hand and contact as necessary factors. One participant wrote:

> "It was a definite yes when the hand touched the side of the pan and the ripples then originated from the same side of the pan as the hand which touched. It was a medium yes when the hand on the same side as the ripples moved toward the pan but did not touch the pan. It was a lower yes when it was the hand opposite the ripple origin that touched the pan."

One participant made a comment consistent with the co-variation view, saying that whenever the water moved he could attribute causation to the hand because no other cause was present. Participants mostly reported that they could not infer causation when the hands did not move. Some specified direction or contact as factors that influenced their decision. One participant reported "I could not say that the hand caused the water based on real world experience." Overall, the comments trended in a manner that suggested participants were viewing the animations seriously and realistically.

Paranoia and Self-Consciousness

We predicted that participants scoring high on non-clinical paranoia and self-consciousness would provide higher ratings of causation in the illusory causal conditions. The average participant score on the Paranoia and Self Consciousness scale was 2.35 (*SD*=0.92). We did not find any significant correlations between participants' score on the Paranoia and Self-Consciousness scale and their ratings of causation. Additionally, we ran a regression test to see whether scores on the REI and scores on the Paranoia and Self-Consciousness scales influenced one another in relation to participants' causal ratings. Results were inconclusive.

REI and Ratings of Causation

We predicted that participants scoring high on experiential thinking styles would provide higher ratings of causation for illusory causal conditions and that participants scoring low on rational thinking styles would provide higher ratings of causation as well. To begin testing this hypothesis, we recoded the negative items to match the positive ones. The mean score on the Rationality scale was 3.74 (*SD*=0.76) while the mean score on the Experiential scale was 3.25 (*SD=0.81).* We found no significant correlations between rational and experiential thinking styles and ratings of causation.

We then looked for interaction effects between the subscales and ratings of causation. We predicted that participants who liked to engage or rely on experiential thinking and did not like to engage or rely on rational thinking would provide higher ratings of causation in the illusory causal conditions. In other words, those high on EE scores and low on RE scores should have the highest ratings of causation. To run the interaction analysis we mean-centered the results from the REI. We found an interaction effect between RE and EE in which high ratings on EE interacted with high ratings on RE to produce higher causation ratings for the –contact, -direction, +movement condition (b = 0.245, $t(81) = 2.12$, $p < .05$). This was in the opposite direction as we predicted.

Discussion

The pattern of ratings given for the causal, illusory causal, and non-causal animations supported our initial hypothesis that people recognize causal illusions and that they do so in a manner consistent with the dynamics model. This was particularly strengthened by comparing the ratings on -contact, +direction, +movement, and -contact, -direction, +movement, where ratings were higher when the direction of the forces were consistent. Additionally, the effect size for directionality was large, $\eta^2 = .681$. Such a finding suggests that perhaps the direction of forces is more important than contact in our interpretation of causation, which to our knowledge has not been shown before.

The interaction effect found between REI scores on RE and EE with ratings of causation in the –contact, -direction, +movement condition partially supported our initial hypothesis. The significant interaction suggests that systems 1 and 2 play a role in our interpretation of causation, but that this role is not the same as what we originally predicted. Instead of high system 1, low system 2 we found that someone who scores high on both of these systems will provide higher ratings of causation on animations.

This at first seems counter-intuitive. However, system 1 is an automatic and experiential process. If system 1 is high, it might not be searching for what intuitively looks compelling, but rather what experientially seems compelling. In other words, system 1 likely searches for situations in which a similar event had occurred. We have enough experience around water to know that no contact or mismatched hand-ripple directions should not cause the ripples to move. This is where system 2 kicks in. In our predictions, we looked at the rational system's role as one that determines whether a situation was causal or not. Our results suggest that perhaps the rational system does not just discern correct from incorrect situations, but will also justify incorrect situations if they seem compelling. The animations clearly show that these regularly impossible situations have just occurred. System 1 is suggesting that this event is implausible, system 2 questions if it is. System 2 might begin to rationalize possible mechanisms for the event to occur and try to reconcile the conflict between what we saw and what we know, thereby resulting in higher ratings of causation by the individual.

We found no significant correlation between Paranoia and Self-Consciousness scores and causation ratings, which is contrary to our initial hypothesis. We predicted that because self-referent thoughts are related to a higher sense of control in an individual, people scoring high on the paranoia scale would provide higher ratings for illusory causal animations. However, finding no significant correlation is interesting in and of itself. If people with paranoid tendencies tend to subscribe to self-related causal illusions, is there a difference between agent causation and patient causation? In other words, we suggest that perhaps there are two types of causal illusions, those relating to the person or thing causing the effect and those relating to the effect itself. If this holds, then it is likely that paranoid individuals or individuals with paranoid tendencies would be more sensitive to agent causation (where it is they themselves who caused the action) than patient causation (where the causal interaction is passively witnessed). It is therefore not surprising that there was no correlation between paranoid tendencies and ratings of patient causation seen in the animations given, as the animations gave no indication that the participant was the agent.

Experiment 2

Experiment 2 was identical to Experiment 1 in all but one respect. In this experiment, participants were given causal and non-causal animations and asked to rate the degree of *force exerted* instead of *causation*. This allowed us to study whether the way people perceive causation and the way people perceive forces are comparable. We predicted that the pattern of causal ratings would replicate the results found in Experiment 1, which would suggest that people think about causation and forces in a similar manner.

Methods

Participants

Participants were 78 paid participants who responded to a posting on Amazon's mechanicalTurk website. The average age of participants taking this study was 33.22, with the youngest being 19 and the oldest 81 years old (standard deviation: 11.36). 34.3% of participants were female (n=27), 64.4% were male (n=51) and 1 queer gender participant.

Procedure

The procedure for Experiment 2 was the same as in Experiment 1. This time, however, for the tray and water animations, participants were asked “To what degree did it seem like the hand exerted a force against the water” instead of to rate to what degree the hand caused the water to move. Participants provided ratings from 0-9 with 0 corresponding to "to no extent" and 9 "to the fullest extent."

Results

Ratings of Force

The results based on participants ratings of force largely mirrored those based on participants' ratings of causation. As expected, causal ratings were higher when there was physical contact (*M*= 6.4) than when there was no contact (*M* = 4.10), $F(1,77) = 77.00$, $p < .001$, $\eta^2 = .575$. Also as predicted, causal ratings were higher when the direction of the cause and the effect were the same (*M* =

Table 2 Force ratings for Experiment 2 (0-9 Scale) with (SDs)

Condition	Mean Ratings
+Contact, +Direction, +Movement	7.13 (1.90)
-Contact, +Direction, +Movement	4.46 (2.82)
+Contact, -Direction, +Movement	3.65 (2.56)
-Contact, -Direction, +Movement	1.65 (1.94)
-Contact, -Direction, -Movement	0.66 (1.60)

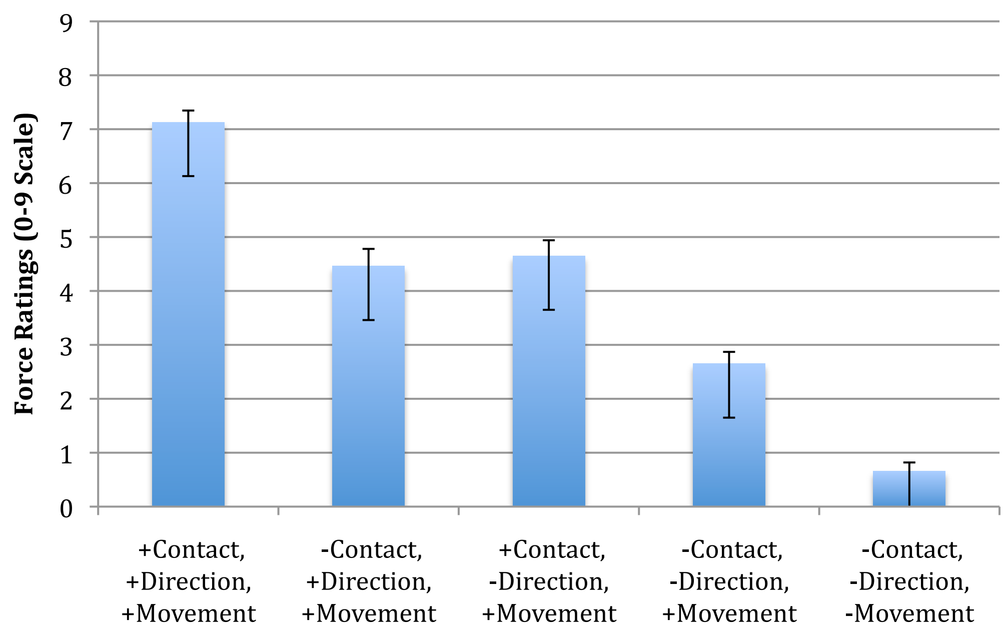

Figure 4 Force Ratings for Experiment 2

6.79) than when they differed (*M*= 3.65),$F(1,77) = 158.67$, $p < .001$, $\eta^2 = .673$. Unlike in Experiment 1, the interaction of direction and contact was only marginally significant, $F(1,77) = 3.298$, $p = .073$, $\eta^2 = .041$, but the differences were in the same direction as in Experiment 1, with the effect of direction being greater when the cause made contact with the effect than not.

The comments given in Experiment 2 followed a similar pattern to those given in Experiment 1. Contact and direction were both mentioned frequently as factors that influenced participants' ratings. In Experiment 2 but not Experiment 1, multiple references to the mechanism behind the causation were mentioned such as ". . . a slight breeze to move the water. . .," ". . .something magnetic. . .," and even ". . .a bit of magic or a jedi trick. . . ." Lack of movement was the biggest factor that contributed to participants' saying they could not say the hand exerted a force, but lack of contact was also mentioned frequently.

Paranoia and Self-Consciousness, REI, and Ratings of Causation

We predicted that results for the personality questionnaires would replicate the results found in Experiment 1. The average score on the Rationality scale was 3.52 (*SD*=0.75) while the average score on the Experiential scale was 3.09 (*SD*=0.71). The average score on paranoia ratings was 2.23 (*SD*=0.72). We found no significant correlations between rational and experiential thinking styles, paranoia, and ratings of causation. We found no significant interaction effect between RE and EE scores and causal ratings.

Discussion

The overall pattern of force ratings mirrored those based on causation ratings in Experiment 1. The direction of the difference between the average ratings for –contact, +direction, +movement and -contact, -direction, +movement, was consistent with the direction of ratings found in Experiment 1, and the effect size for directionality was once again greater than the effect size for contact. The replication of these findings provides further support that the direction of forces matters more than contact does in causal illusions. One of the reasons why the statistical difference of the interaction effect did not replicate may be related to how we understand forces versus causation. Much of the literature suggests that our understanding of forces is implicit (Toffin, et al 2003; Reinsmeyer, et al., 2004; Wolff & Shepard, 2013). In this experiment, we asked participants to think about forces explicitly. That mechanisms for causation were mentioned in the comments of Experiment 2 but not Experiment 1 suggests that thinking about forces explicitly may bias participants to think about the mechanisms behind the event (like contact) and therefore may result in higher ratings of causation for the contact condition.

The interaction effect between RE and EE did not replicate across these two experiments. This may be due to chance and needs to be further studied in order to be confirmed. One possible way to test this is by providing participants with the REI then asking them to provide their initial reactions about the animations and seeing if participants high on experiential thinking (specifically the EE subscale) provide ratings of causation consistent with their previous experience with the subject at hand. To test system 2, we would ask participants if they could ultimately conclude causation, and see if participants scoring high on RE would provide higher ratings of causation. We believe the findings regarding paranoia and self-consciousness (no association) were replicated for similar reasons as those suggested in Experiment 1. Further testing exploring the difference between patient and agent causation is therefore needed before making any conclusions regarding the relationship between paranoid tendencies and causal illusions.

Experiment 3

We were curious to see to what degree the matching or mismatching of the forces' direction determined causality. In the previous two experiments we tested the direction of the forces against contact (a mechanism for the forces). In the current experiment we tested whether the importance of directionality in people's impressions of causation would interact with temporal contiguity. We predicted that ratings of causation would be higher when the effect occurred immediately after contact with the cause than when the effect occurred after a short delay. Of key interest was how the effect of directionality might interact with temporal contiguity. In particular, we predicted that ratings of causation in the delay condition would be highest when direction matched, even if no contact was made.

Methods

Participants

Participants were 24 Emory undergraduates seeking course credit for participation in our study. The average age of participants taking this study was 19.5, with the youngest being 18 and the oldest 23 years old. 70.8% of participants were female (n=17), 29.2% were male (n=7).

Procedure

For this experiment, the same tray and water animations used in Experiment 1 were recreated with a 30 frame temporal delay between when the hand moved and when the ripples appeared. There was no change in the control animations. Participants were shown the animations from Experiment 1 first in the same format (one animation per page) and were asked to provide ratings of causation on a scale from 0-9. After watching the animations from Experiment 1, participants were shown the delayed animations in the same format. Participants were asked the same comprehensive questions at the end of the study.

Results

We predicted that ratings of causation in the delay condition would be highest when direction matched, even if no contact was made. As found before in the literature, ratings of causation were higher for non-delayed causation ($M = 4.97$) than delayed causation ($M = 3.49$), $F(1,23) = 22.53$, $p < .001$, $\eta^2 = .495$. As found in the previous experiments, ratings of causation were higher when the cause made contact with the

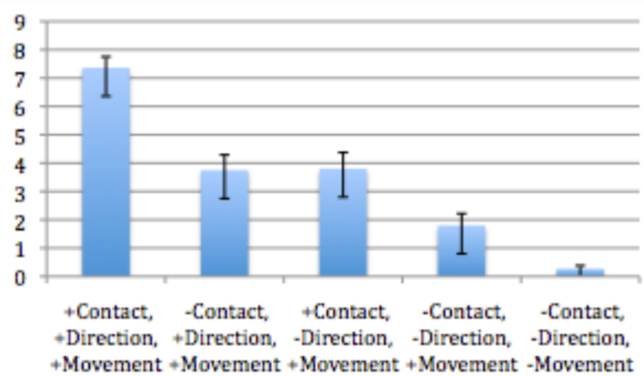

Figure 5.1 Ratings of Causation, Non-Delay Condition, for Experiment 3

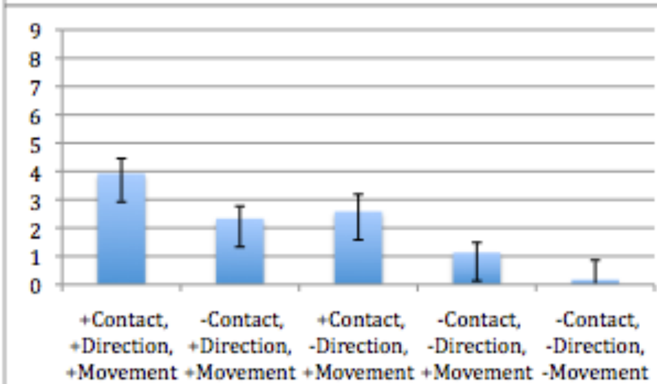

Figure 5.2 Ratings of Causation, Delay Condition, for Experiment 3

effect (*M* = 5.43) than when it did not make contact with the effect (*M* = 3.03), $F(1,23) = 22.53$, $p < .001$, $\eta^2 = .495$. Also as found in previous experiments, ratings of causation were higher when the direction of the causation matched the direction of the effect (*M* = 5.34) than when the directions differed (*M* = 3.11), $F(1,23) = 36.64$, $p < .001$, $\eta^2 = .614$.

Changes in contact had a larger effect on ratings of causation when the causation was immediate rather than delayed, as supported by a delay by contact interaction, $F(1,23) = 12.71$, $p = .002$, $\eta^2 = .356$. This finding is consistent with the hypothesis that contact matters more for non-delayed causation than delayed causation. Similarly, changes in direction also had a larger effect on ratings of causation when the causation was immediate than delayed, as supported by a delay by direction interaction, $F(1,23) = 23.49$, $p < .001$, $\eta^2 = .505$. Thus, just as was predicted, the effect of direction matters more for immediate causation than delayed causation. Although the effect sizes suggest that delays may have a larger impact on the effect of direction than the effect of contact, the three way interaction between delay, contact, and direction was not significant, $F(1,23) = .396$, $p = .535$.

Table 3.1 Causation Ratings for Experiment 3 Non Dealy (0-9 Scale) with (SDs)

Condition	Mean Ratings
+Contact, +Direction, +Movement	7.38 (1.93)
-Contact, +Direction, +Movement	3.83 (2.82)
+Contact, -Direction, +Movement	3.75 (2.64)
-Contact, -Direction, +Movement	1.92 (1.50)
-Contact, -Direction, -Movement	0.23 (0.74)

Table 3.2 Causation Ratings for Experiment 3 Delay (0-9 Scale) with (SDs)

Condition	Mean Ratings
+Condition, +Direction, +Movement	3.91 (2.62)
-Contact, +Direction, +Movement	2.33 (2.14)
+Contact, -Direction, +Movement	2.58 (2.98)
-Contact, -Direction, +Movement	1.13 (1.72)
-Contact, -Direction, -Movement	0.17 (0.48)

We found that in the delay condition, ratings of causation were low across all conditions. The ratings did not differ based on left to right conditions and were therefore combined for all subsequent ratings. Ratings were highest when contact, direction, and movement matched and lowest for the non-causal control condition. In the illusory conditions, ratings were highest for the illusory causal condition where contact was made but direction did not match. Ratings for this condition (+contact, -direction, +movement) were not significantly different than the causal condition. Ratings for the ripple right causal condition were higher than the ripple left conditions in the non-delay condition $t(22)=2.39$, $p<.05$.

Discussion

These findings partially supported our initial hypothesis. Ratings of causation for the delayed causal condition were lower than in the non-delay conditions, but still higher than the illusory causal conditions. The average ratings for the delay illusory causal conditions are not much lower than the ratings provided for equivalent animations in Experiments 1 and 2, suggesting that the mechanisms through which causal illusions are justified do carry over when there is a delay, and causation is still (although partially or weakly) inferred. This is consistent with previous literature (White, 2011), which suggests that ratings of causation are still inferred, even when a delay is present between a cause and effect, but these ratings decrease as the temporal gap is increased. Overall, our findings suggest that causal illusions will still be inferred even if not accurately timed, and that actual causal impressions will be weaker with a temporal delay.

General Discussion

In sum, this paper bridges the literature gap among cognitive, social, and clinical fields of psychology in regards to causation and causal illusions. The cognitive psychology literature greatly explored the mechanisms through which we view and understand causation, but often neglects to discuss or study how we view and subscribe to causal illusions. By contrast, the social and clinical fields of psychology explored the ubiquitous nature of causal illusions in the minds of individuals with or without mental disorders, but frequently exclude the mechanism through which these illusions are inferred. This paper has outlined two main views of causation and how causal illusions can fit into these processes of normal causation. Furthermore, this paper has attempted to link causal illusions to certain thinking styles and personality measures, to further bridge the gap between the differing fields.

This paper has shown that people perceive causal illusions. This can be seen through the consistent pattern of causal ratings given on illusory causal animations, which were reliably and significantly above the ratings of non-causal controls. What is striking about the data is that ratings of causation were high in the absence of contact, provided the direction of the cause and the effect matched. Additionally, participants were provided the opportunity to describe situations under which they could conclude that the hand caused the water to move. Many participants referred to having strong feelings of causation in the causal condition, and weaker yet present feelings of causation for the illusory control conditions. Such descriptions occurred most often when direction matched or contact was made, but even when neither of these factors was present, the hands movement still elicited some causal feelings demonstrated by the statistical difference of the –contact, -direction, +movement condition from the non-causal controls.

The direction of the ratings in the illusory causal conditions further suggests that direction may be a stronger predictor than contact for causal illusions, providing strong support for the dynamics model of causation over the co-variation view. This is important because it implies that when inferring causation, the *direction of the forces is more important* than having a mechanism through which the effect could occur. Furthermore, we found that these ratings of causation in the illusory causal conditions still held up with a temporal gap between the cause and effect, but due to the low power of the experiment it is difficult to determine whether contact or direction is the stronger predictor of causation in such cases. Further testing is needed to determine whether forces are stronger predictors than contact when inferring causation. Such evidence would provide strong support for the dynamics model as it would imply that we interpret causation through the interaction of forces.

The second way we were hoping to support the dynamics model was through the dual process system of causation, which our data partially supported. We predicted that system 1, the intuitive and immediate system, would activate first to create a strong causal impression in participants who rely on intuitive, experiential thinking, and yield to strong causal judgments. These judgments would be either confirmed or disconfirmed based on system 2, the more rational system. We therefore believed that if participants did not rely on their rational thinking system, they would justify what they saw as true without questioning the mechanism through which it could or could not occur, and thereby provide high ratings of causation. Instead, in Experiment 1 we found that participants scoring high on both rational and experiential systems provided higher ratings of causation. This leads us to question whether the dual-process system works in the way that we had previously thought. These findings suggest that system 1 works based on heuristics of situations we have previously encountered, and system 2 does not simply confirm or disconfirm system 1's views, but rather analyzes and reconciles between what was witnessed and the knowledge gained from past experiences. However, these findings were not replicated in Experiment 2 and need to be further explored to determine the role these processes play in determining causation.

Furthermore, we found no connection between one's paranoid tendencies and their ratings of causation. However, this may suggest that there are two types of causal illusions that we perceive: patient causation and agent causation. The animations presented in this experiment depict clear examples of patient causation. However, the types of illusions studied in most of the literature on causal illusions in clinical settings have been of agent causation. It would be interesting to test whether paranoid tendencies relate to agent causation rather than patient causation. This type of study would have implications for the type of causal illusions present in psychological disorders and can provide insight into the mechanisms through which causal illusions influence our well being.

Some of the limitations of this study include time, methodology, and the limited breadth of the experiments. More participants are needed for Experiment 3 in order to increase power and determine whether contact or direction is the stronger determinant of causation. The surveys provided to participants require participants to think about hypothetical situations or think about their own tendencies, which leaves room for bias in their responses. Furthermore, the Paranoia and Self-Consciousness scale was designed to test paranoid tendencies in college students. We gave the survey out to a varied range of participants, most of them out of the university setting. Ideally, we would have been able to further test whether people perceive forces faster when witnessing causal illusions in order to cement the connection between causation, illusory causation, and forces by providing evidence that we implicitly account for forces when viewing causation as well.

Overall, the present study provides evidence that we can view causal illusions and that there may be two types of causal illusions: agent causal illusions and patient causal illusions. Studying the difference between and agent and patient illusions could have implications for the mental health field, as causal illusions have been shown to be related to an array of psychological disorders as well as to normative thinking. Additionally, this paper provides evidence to support the notion that directionality matters more than contact when inferring causation, a finding that has not yet been shown. This paper suggests that the dual process model of causation may in fact hold, but in a different manner than initially predicted. This contributes to the literature available on the processes through which we interpret causation as well as to the literature regarding the dynamics theory as a whole. Lastly, this paper brings together varying approaches to the study of causation from clinical, social, and cognitive fields of psychology, allowing for a more comprehensive view on our current understanding of causation as well as causal illusions.

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