Bachelor's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Psychology

10137

Navigating The Temporality Effect

A Comparative Replication Study of Coin Toss and Same/Different Card Scenarios In Counterfactual Thinking

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Supervisor: Subramanya Prasad Chandrashekar
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PREFACE

This undergraduate thesis marks the apex of an insightful empirical study within the realm of social psychology, with a specific emphasis on the temporality effect in counterfactual thinking. This expedition originated from a collaborative effort among six students in the PSY2900 course, united under the project "Counterfactual Thinking and Temporality Effect." Guided by our esteemed supervisor's research design, our goal was to recreate findings of previous studies conducted by Miller and Gunasegaram (1990) and Byrne et al. (2000). As the studies were conducted together, the phrasing of “our” studies does not imply that theoretical discussion and ideas are sheared by the fellow students, only by the author.

The backbone of this study was formed from a combination of preselected readings assigned by the supervisor and additional literature independently chosen by the author. Supplemental sources were procured through search engines such as "Google Scholar", "Oria", and "PsycInfo". Both the literature review and the ideation were carried out without external assistance. Given that this thesis is grounded in preexisting experiments without extension, it constitutes a direct replication of the aforementioned research. Therefore, meticulous attention was given to the precision of replication and the dependability of the findings. The choice of analytical methods was largely shaped by the original research, and our supervisor scrupulously designed the studies and collected the data to ensure their validity and consistency with the research objectives. The first study was promoted through word of mouth and social media, while the second study was distributed via the "Prolific" platform. The data acquisition was overseen by the supervisor, and all subsequent analyses were executed by the author.

I would like to convey my deepest appreciation to my academic advisor and fellow bachelor group members, whose insightful dialogues and perspectives greatly enriched my understanding of the theoretical and statistical intricacies of the subject matter. I am particularly indebted to my supervisor for their invaluable mentorship and for spearheading this project. Additionally, I wish to express my profound gratitude to my family and friends for their enduring support during this academically and personally enriching, yet challenging phase. A special thanks goes to my partner, whose unwavering support has been indispensable throughout this journey. With sincere appreciation for all those who have contributed to my academic progress and personal development, I proudly present this oeuvre as my own.

ABSTRACT

The critical role of counterfactual thinking in psychology is widely acknowledged. Theoretical frameworks and empirical evidence reviewed in this thesis highlight the complexity and importance of understanding the perception and experience of independent sequential events when thinking counterfactually. As research in this area continues to evolve and replicate, it is likely that our understanding of the temporality effect and its implications for counterfactual thinking will do accordingly. The temporality effect in counterfactual thinking refers to the tendency to generate more counterfactual thoughts for events that occurred more recently in time. It can arguably be considered as a fundamental aspect of human experience that shapes a wide range of psychological processes. In this bachelor thesis, we examine the temporality effect with an emphasis on direct replications of Byrne et al.'s (2000) first experiment involving a technical hitch, and Miller and Gunasegaram's (1990) coin toss scenario. By successfully replicating these findings, it is conclusive that temporality effect indeed is a replicable phenomenon. With integration of heuristic guided processes and the foundational tenets of temporality effect, this research provide a comprehensive understanding of the temporality effect, implications for blame assignment and guilt attribution, as well as a possible framework for future research.

Counterfactual thinking, the cognitive process whereby individuals mentally simulate alternative outcomes to events that have already occurred (Byrne, 2002; Byrne & McEleney, 2000), is a central aspect of human cognition. This psychological phenomenon allows individuals to reflect upon how events might have unfolded differently, which enables learning from past actions and offering valuable insights to causality. A critical factor in counterfactual reasoning is the temporal order effect or temporality effect; two terms that are prospectively used interchangeably. They refer to the influence of the chronological arrangement of events on individuals' perceptions of mutability, and the experience of emotions such as regret, guilt and blame (Miller & Gunasegaram, 1990; Byrne & McEleney, 2000; Gilovich & Medvec, 1994; Landman, 1987). Temporal order effect refers to the sequence in which events or actions occur, and it has been shown to influence how readily individuals can imagine alternative outcomes (Walsh & Byrne, 2004). Research by Miller and Gunasegaram (1990) established that individuals tend to perceive recent events as more mutable, leading to increased perceived blame in assignment for the individuals involved in these particular events. This finding has been supported and extended by subsequent studies, which have shown that temporal order effects can also impact guilt attribution (Byrne et al., 2000; Byrne & McEleney, 2000; Segura et al., 2002). The temporality effect in counterfactual thinking suggests that individuals tend to generate more counterfactual thoughts for events that occurred more recently in time (Byrne et al., 2000). This effect has significant implications for our understanding of the temporal pattern of regret or negative emotion to outcomes (Gilovich & Medvec, 1994; Landman, 1987), and the role of causality in counterfactual thinking (Spellman, 1997). Furthermore, the temporality effect is not limited to situations involving actions; it can also influence counterfactual thinking about failures to act (Byrne & McEleney, 2000). In these cases, individuals tend to focus on the earliest

omission in a sequence of events when considering alternative outcomes. As interesting as these “action/in-action” studies are, they are not excluded from thesis given the discrepancy of the research question and scientific resource constraints.

While the body of research on the temporality effect continues to expand, few studies have directly replicated key findings in this domain. Direct replications are essential for establishing the robustness and generalizability of psychological phenomena (LeBel et al., 2019). Therefore, in this bachelor thesis, the aim is to explore the temporality effect in counterfactual thinking by conducting direct replications of Byrne et al.'s (2000) first experiment and Miller and Gunasegaram’s (1990) coin toss scenario. By replicating these seminal studies, we seek to verify the existence of the temporality effect and contribute to a more robust understanding of this phenomenon. The thesis addresses the research question; "To what extent do the findings from direct replications of seminal studies on the temporality effect in align with previous results, and how do these replications advance our understanding of the effect within counterfactual thinking?“.

Further research is needed to replicate and extend previous findings, particularly in light of recent concerns regarding the replicability crisis of psychological research (Maxwell, Lau, & Howard, 2015). By building on the work of Miller and Gunasegaram (1990), Byrne et al. (2000), and other prominent studies, this research seeks to strengthen the empirical foundation of our understanding of temporal order effects in counterfactual thinking and its impact on human cognition and behavior. Moreover, the findings of this thesis hold potential implications for various applied domains. For instance, understanding the temporality effect in counterfactual thinking may inform interventions aimed at improving decision-making in diverse contexts, such as personal finance, healthcare, and public policy (Kahneman, D. 2011). Additionally, insights into the temporality effect may contribute to the development

of educational programs that foster critical thinking and the ability to reason effectively about alternative possibilities. By highlighting the pervasive influence of temporal order effect on human cognition, the present thesis invites future research to further investigate the underlying mechanisms and boundary conditions of the temporality effect in counterfactual thinking.

Furthermore, a more comprehensive examination of temporality effect in relation to other cognitive processes, heuristics processes, and memory can yield a more nuanced understanding of counterfactual reasoning (Spellman, 1997; Kahneman & Miller, 1986). For example, future research might explore how the availability heuristic, mental simulations, and working memory constraints interact with the temporality effect to shape counterfactual thinking (Kahneman & Tversky, 1973; Ebbinghaus, 1913; Baddeley & Hitch, 1993). Such investigations could lead to the identification of factors that may mitigate or amplify the temporality effect, ultimately offering a more complete picture of the cognitive processes underlying counterfactual reasoning.

In sum, this bachelor thesis contributes to the growing body of literature on the temporality effect in counterfactual thinking by meticulously replicating two pivotal studies. By emphasizing the importance of open science practices and the value of replication studies for enhancing the reliability and validity of scientific findings, the present work advances our understanding of the complex interplay between temporal order effect and counterfactual reasoning. Through the integration of insights from related areas of research, this thesis also highlights the interdisciplinary nature of the temporality effect, further enriching its academic significance. The aspiration behind this thesis is to inspire further exploration into the temporality effect and its implications for counterfactual thinking and decision-making,

while also emphasizing the essential role of replication studies in the pursuit of scientific progress.

LITERATURE REVIEW

DECIPHERING THE TEMPORALITY EFFECT

Counterfactual thinking, or the process of mentally simulating alternatives to past events is ubiquitous. One can claim it plays a critical role in human cognition, emotion, and decision-making (Byrne & McEleney, 2000). The temporality effect in counterfactual thinking refers to the phenomenon wherein individuals are more likely to modify events that occurred later in time, rather than earlier events, when generating counterfactual thoughts (Byrne et al., 2000; Walsh & Byrne, 2004). This effect can be observed in various domains, such as blame assignment (Miller & Gunesegaram, 1990) and thinking about actions and failures to act (Byrne & McEleney, 2000). Miller and Gunesegaram (1990) found that the perceived mutability of events and their temporal order influence blame assignment. Specifically, people tend to assign more blame to individuals involved in later events, as these events are perceived as more mutable and, therefore, more likely to be changed in counterfactual scenarios.

The term "temporality effect" is derived from the concept of temporality, which refers to the aspect of time or the sequential order of events (Harvey, 2001). In the context of counterfactual thinking (Roese, 1997), the temporality effect refers to the influence of the chronological arrangement of events on individuals' perceptions of mutability, causality, blame assignment, and the experience of emotions such as regret, guilt, and blame (Byrne, 2002; Miller & Gunasegaram, 1990). The coining of the term can be interpreted as a cause or consequence of the qualities directly concerned with temporal aspects, which means it deals

with the way events or information are organized, sequenced, or experienced over time (Roese & Olson, 1995).

Walsh and Byrne (2004) further explored the temporal order effect in counterfactual thinking by examining how individuals mentally simulate alternative outcomes to past events. They observed that people are more inclined to generate counterfactual thoughts for events that occurred later in a sequence of independent events, as opposed to earlier events. Segura, Fernandez-Berrocal, and Byrne (2002) investigated temporal and causal order effects in counterfactual thinking, highlighting the importance of considering the sequence and causal relationships among events when generating counterfactual thoughts. They found that the temporality effect is less pronounced when events are connected in casual chains, in other words dependent sequence of events. Other factors that try to diminish the effect is to apply the wording of events in the opposite way as they factually happen, or implementing a technical hitch scenario to outsource the recency effect from explanatory overpowering the temporality effect (Byrne et al.,2000). The different card variation in the technical hitch scenario (Byrne et.al.,2000) serves as a excluding mechanism for recency effect explanations. If the recency effect were to be accountable for the mutation of events, it would have worked similarly as the undoing of the event would have always been the last action, which are demonstrated is not the case (Byrne et al., 2000). This strongly implies that a need for presupposed first events is crucial to the presence of temporal order effect, as the first events is seen as more immutable because of its already set qualities.

Counterfactual thinking relies on the concept of mutability, or the belief that an event could have been different if certain actions or decisions had been taken (Kahneman & Miller, 1986). This sense of mutability is crucial for generating counterfactual alternatives and understanding their implications for decision-making, problem-solving, and learning. As

suggested by Walsh and Byrne (2004), the temporal order effect demonstrates that the order in which events occur can influence counterfactual thinking. Events that occurred earlier in a dependent sequence are often perceived as more causally relevant, leading to more counterfactual thoughts for these events compared to later events. This type of mental simulations, the cognitive process of imagining alternative scenarios, is the foundation of counterfactual thinking (Kahneman & Miller, 1986; Byrne & McEleney, 2000). The temporality effect can be partially explained by the ease with which individuals can mentally simulate alternative outcomes for recent events. The accessibility and vividness of recent events (Baddeley & Hitch, 1993) facilitate the generation of counterfactual alternatives, leading to a higher likelihood of engaging in counterfactual thinking for recent events (Smallmann & Summerville, 2018).

Causal models, or mental representations of the causal structure of events, one can argue is beneficial when understanding the interplay between temporal and causal order effects (Byrne & McEleney, 2000). Individuals construct causal models based on their experiences and knowledge, and these models shape their counterfactual thinking. The temporal order effect refers to the influence of the sequence in which events occur on the generation and evaluation of counterfactual alternatives (Murdock, 1962). Individuals construct causal models based on their experiences and knowledge, and these models shape their counterfactual thinking. When generating counterfactual alternatives, individuals rely on causal models to identify the most likely and impactful alternatives, which correspond to sequential events and their assumed causal structure (Segura et al., 2002). To enhance academic comprehension of counterfactual thinking, attention has been dedicated to understanding this interplay.

COGNITIVE PROCESSES – THE INTERPLAY BETWEEN TEMPORAL AND CAUSAL ORDER

Several cognitive mechanisms underlie the interplay between temporal and causal order effects in counterfactual thinking. One such mechanism is the availability heuristic (Kahneman, 2011), which influences the ease of generating counterfactual alternatives based on the accessibility of event information in memory. The availability heuristic (Kahneman & Tversky, 1973) suggests that individuals rely on the ease with which information can be recalled from memory when making judgments. In the context of counterfactual thinking, the availability heuristic implies that events that are more easily recalled, such as recent events or earlier events in a sequence, are more likely to be the focus of counterfactual thoughts. This aligns with the temporality effect, as recent events are more accessible in memory, making it easier to generate counterfactual alternatives for them. The simulation heuristic (Kahneman & Tversky, 1982) is another relevant concept in understanding the temporality effect in counterfactual thinking. According to this heuristic, people generate counterfactual alternatives based on the ease of mentally simulating these scenarios. Temporal factors can influence the ease of simulation, as more recent events may be easier to mentally manipulate and generate counterfactuals for compared to events that occurred in the distant past. This might lead to a temporality effect, where counterfactual thinking is more prevalent and detailed for recent events.

Another proposed mechanism is the crediting causality hypothesis (Spellman, 1997), which leads individuals to identify earlier events as more causally relevant and, therefore, more mutable in the generation of counterfactual alternatives. Several cognitive mechanisms might underlie the interplay between temporal and causal order effects, such as the availability heuristic and the simulation heuristic (Kahneman, 2011). Emphasis has been made on these two given their perceived suited explanatory power.

Causal models, or mental representations of the causal structure of events (Byrne & McEleney, 2000), play eminent role in understanding the interplay between temporal and causal order effects. Temporal order influences the ease with which individuals can generate counterfactual alternatives (Walsh & Byrne, 2004), while causal order affects the perceived impact of these alternatives on subsequent events (Segura et al., 2002). The two factors often interact, as individuals tend to perceive events that occurred earlier in a dependent sequence as having a more significant causal role. Consequently, they are more likely to generate counterfactual thoughts for earlier events, leading to a greater perceived impact on subsequent events (Spellman, 1997). it appears that Byrne et al. (2000) and Spellman (1997) have somewhat diverging viewpoints on the assignment of blame in the context of counterfactual thinking. According to the temporality effect proposed by Byrne et al. (2000), individuals are more likely to generate counterfactual thoughts for events that occurred more recently in time, leading to a higher assignment of responsibility to recent events. This perspective is also supported by the temporal order effect (Miller & Gunesegaram, 1990), which suggests that the order of events influences the generation of counterfactual thoughts and responsibility assignment, with a preference for recent events. In contrast, Spellman (1997) argues that people tend to assign greater blame or responsibility to the first event in a causal chain, which she refers to as the causal order effect. A causal chain refers to a sequence of events or actions in which one event causes the next, which in turn causes the subsequent event, and so on. These chains illustrate cause-and-effect relationships between different events. In a causal chain, the occurrence of a specific event directly influences the occurrence of the subsequent event. Understanding causal chains helps identify the root causes of problems and predict the potential outcomes of actions or decisions (Spellman, B. A., & Mandel, D. R. (1999). According to this view, earlier events are seen as more mutable

because of their perceived “causal” impact, and more likely to generate counterfactual thoughts, leading to a higher assignment of blame to those events. This would not be a subject of interest if Spellman had not proposed the “crediting causality” hypothesis for explaining both temporal and causal chains. A temporal chain refers to a series of events or actions arranged in chronological order. It simply indicates the sequence in which events occur over time, without necessarily implying any causal relationships between them. Temporal chains help in organizing information and understanding the progression of events, but they do not reveal the underlying cause-and-effect relationships that may exist (Reuter, Kirfel, van Riel, & Barlassina, 2014). Spellman´s working hypothesis does not align with the data, or in our case of investigation, as we are examining the relationship between two independent chance based events, i.e.. temporal chains. A settling remark for the attribution of causality within the chance based fifty-fifty scenarios, can easily be explained by “probabilistic causation” (Hitchcock, 2021). If one are to imagine individuals are not prone to biases and mental shortcuts overriding our facilitation of mental simulation, the answer should always be that the last event in a sequence of independent events is causally responsible for the outcome of the total event. This is because of the completion of sequence that accounts for one hundred percent of the final outcome. "Post hoc ergo propter hoc", the mistaken belief that because one event follows another, the first event must have caused the second (Munson, 2016), might be a point of contention. Regardless, it is known that the general individual is not fully deductible and reasonable at all times, which is postulated in previous literature and studies within both factual and counterfactual thinking (Kahneman, D. 2011). The proneness to biases is something we attend to unconsciously and indulge in as a part of life, it is much so how we operate. The following replication studies will further prove that discrepancies in understanding causality,

attributing emotion and mental simulating mutations of events indeed are present in our sample. This distinction of these replication experiments conducted are classified as temporal chains or independent sequence of events, further explanations regarding causal chains or dependent sequences seem reductant.

SIX TENETS OF TEMPORALITY

Walsh and Byrne (2004) propose that counterfactual thinking in the temporal order effect is underpinned by six fundamental principles, as demonstrated in their experiments: Individuals understand scenarios by considering the true possibilities (1). They do not consider the entire set of counterfactual possibilities (2). The counterfactual possibilities they keep in mind are guided by the winning conditions, or the possibilities in which the players would have won (3). Individuals mutate aspects of the facts to resemble the counterfactual possibilities of the winning conditions (4). The first element of the facts serves as an anchor, which is matched to the winning possibilities. If a match is found, the first element remains constant, and the second element is changed to match the winning possibility; if no match is found, the first element is changed (5). Individuals think about some elements of the true possibilities explicitly, such as those mentioned in the assertion, while leaving other elements implicit (6).

In their experiments, Walsh and Byrne (2004) manipulated the description of the winning conditions while keeping the facts constant to investigate how the mental representation of the conditions under which the players can win influences the temporal order effect. Their results demonstrated that the description of the ways in which an event could have turned out differently can have a significant effect on the counterfactual thoughts generated by people, akin to the effects of framing an option as a loss or a gain on people's preferences for risk-seeking and risk aversion (Baron, 2000). Walsh and Byrne's (2004)

account of the temporal order effect offers an alternative to the view that people calculate the probability of an outcome before and after each event, as proposed by Spellman (1997). They showed that when people are given an explicit alternative to the first event, they mutate it as often as the second event, even when the explicit alternative does not alter the probability calculations (Walsh & Byrne, 2004). Overall, their experiments revealed that the description of the winning conditions can influence the mutability of facts and that individuals can recruit counterfactual alternatives not only from actual past experiences but also from imagined hypothetical situations. These findings suggest that everyday counterfactual thoughts may be influenced by various imagined possibilities.

These diverging viewpoints may reflect the complexity of counterfactual thinking and blame attribution, as various factors such as temporal order, causal relationships, and perceived mutability can all influence the assignment of blame. It is possible that the influence of these factors varies depending on the specific context or scenario, leading to different patterns of blame attribution across different situations. Understanding the interplay between temporal and causal order effects in counterfactual thinking has important implications for the assignment of guilt and blame. As individuals perceive later events as more mutable and causally relevant in sequences of events that are not casually connected (Miller & Gunesegaram, 1990), they are more likely to assign blame to those events. Guilt can in these cases, be seen as the counteracting response to blame. The process of attributing emotions plays a pivotal role within the temporality effect, influencing both the observers and the actors involved. In our replication of Miller and Gunasegaram's 1990 study, and Byrne et al.'s 2000 study, we specifically explore this emotional aspect. Here, a third party (the observer) is prompted to simulate an emotional response on behalf of the fictitious actors presented in the scenarios. According to Kahneman and Miller (1986),

individuals are more likely to engage in counterfactual thinking when they experience negative emotions (ex. losing a potential prized event). Events that occurred more recently are often more emotionally salient (Gilovich & Medvec, 1994), leading to a higher likelihood of generating counterfactual thoughts for recent events. Moreover, the emotional intensity of an event can influence the frequency and persistence of counterfactual thinking (Landman, 1987), with more emotionally charged events prompting more frequent and enduring counterfactual thoughts. This can result in a biased blame or guilt assignment, as it may not accurately reflect the actual responsibility of each event in the sequence (Alicke, 2000). Awareness of these cognitive biases can help in making fairer and more objective judgments when assigning blame. The aforementioned research emphasizes the role of temporal order in counterfactual thinking and its various implications, such as blame assignment and the perceived mutability of events.

REAFFIRMING FINDINGS; THE REPLICATION IMPERATIVE

Replication underscores generalizability and validity in psychological research and reinforces theories via diverse methods (Nickerson, 1998). This thesis emphasizes direct replication to enhance understanding of subjects, relying on Byrne et al. (2000) and Miller and Gunasegaram (1990). Direct replication scrutinizes reported effects' robustness, identifies potential anomalies, and buttresses observed phenomena's evidence. Open Science Practices, encompassing open data, pre-registration, and more, foster transparency, credibility, and interdisciplinary collaboration (Allen & Mehler, 2019; Van´T Veer & Giner-Solla, 2016). Thesis replication not only amplifies academic rigor but also scrutinizes potential biases, false positives, and low statistical power, thereby ensuring the authenticity and robustness of effects.

METHODS

DATA ANALYSIS.

The original study by Miller and Gunasegaram (1990) (study 1) had certain limitations in its measurement and reporting of results. Specifically, the study did not provide sufficient information about the statistical tests used, which made it difficult to fully assess the reliability and validity of their findings. In order to address these limitations and align our replication study with the available information and results from the original study, we chose to conduct a z-test for our data analysis. In addition to the z-test, we also conducted descriptive statistics to summarize the data and explore any patterns or trends. This included calculating means, standard deviations, and frequencies for each of the dependent variables in both studies. In Study 2, the same hypotheses were tested as in Study 1, with two conditions: Same Card and Different Card. For each of the three hypotheses in both conditions, a one proportion binomial test was conducted. The variable k denoted the number of participants who chose the option being tested, while n represented the total number of participants in the condition. In order to assess the practical significance of the findings in both Study 1 and Study 2, effect sizes were calculated using Cohen's g, providing a standardized measure of the magnitude of differences between groups and facilitating the interpretation of real-world relevance. Both studies aimed to maintain rigorous, transparent, and replicable research through their analytical approach. Statistical analysis were conducted using RStudio and SPSS.

STUDY 1 (REPLICATION MILLER AND GUNASEGARAM, 1990)

SAMPLE AND PROCEDURES

Two hundred and eleven participants were included in the study, ranging in age from 19 to 90 years (M = 28.51, SD = 13.68). The sample consisted of 138 females, 72 males, and 3 participants who did not provide their gender information. Participants were recruited

through word of mouth and social media links. The survey was conducted using Norwegian language, which suggests that the respondents were likely Norwegian, considering the specificity of the linguistic context employed. OSF link; https://osf.io/gpcqd. REK- approved reference number; 754105. In the current research project, this thesis focuses solely on the analysis and discussion of Scenario 1. Scenario 2, however, serves as an independent extension for another student's research, and thus falls beyond the scope of the present thesis (See supplementary material; "preregistration replication Miller & Gunasegaram, 1990" for more information).

The materials for this replication study were adapted from Miller and Gunasegaram (1990), involving a coin toss scenario (Scenario 1) that described events related to Jonas and Kristian. In this scenario, Jonas and Kristian were depicted as participating in a coin toss game that led to certain outcomes. The scenario was designed to assess participants' perceptions of mutability, guilt, and blame by presenting different situations based on the coin toss results and the resulting consequences for Jonas and Kristian.

Participants were presented with two scenarios, each involving two individuals participating in a coin toss game with a potential reward of NOK 10,000. In Scenario 1, Jonas and Kristian toss coins, with Jonas going first and Kristian going second. The outcome results in neither individual winning the reward. Following each scenario, participants answered questions related to which alternative outcome comes more readily to mind, who is likely to experience more guilt, and who is more likely to be blamed for not winning. Demographic information, including age and gender, was collected at the end of the survey. Wording and phrasing of scenario and question asked were identical to original study, but presented in Norwegian to a Norwegian audience. (See supplementary material; "preregistration replication Miller & Gunasegaram, 1990" for more information).

RESULTS

In this study, we examined the relationships between mutation, guilt, and blame. Findings are presented below:

Table 1: Table 1: Distribution of Participants and Proportions for Mutation, Guilt, and Blame

Dependent variables	**In %**	**Participants**
Mutation		
First	23.7	50
Second	76.3	161
Guilt		
First	6.6	14
Second	93.4	197
Blame		
First	8.1	17
Second	91.9	194
n	211	

(H1) **Mutation**; Our analysis revealed a significant difference in the proportions of mutation between first and second actor (76% vs. 23%). With a sample size of 211 (n = 211) and 161 instances of mutation (k = 161), the *z*-value was 7.64, $p < .001$, indicating a significant difference between the groups. The effect size, measured by Cohen's g, was 0.26, 95% CI [0.2, 0.32]. (76% vs 23%), n = 211, k = 161, $z = 7.64$, $p < .001$ (Cohen's g = 0.26 [0.2, 0.32])

(H2) **Guilt**; The proportion of participants experiencing guilt in first vs. second actor also showed a significant difference (93% vs. 6%). The sample size was 211 (n = 211), with

197 instances of guilt (k = 197). The *z*-value was 12.6, $p < .001$, indicating a significant difference between the groups. The effect size, measured by Cohen's g, was 0.43, 95% CI [0.4, 0.47]. (93% vs 6%), n = 211, k = 197, $z = 12.6$, $p < .001$ (Cohen's g = 0.43 [0.4, 0.47])

(H3) **Blame**; Our findings demonstrated a significant difference in the proportion of participants attributing blame in the context of first vs. second actor (91% vs. 8%). With a sample size of 211 (n = 211) and 194 instances of blame (k = 194), the *z*-value was 12.19, $p < .001$, indicating a significant difference between the groups. The effect size, measured by Cohen's g, was 0.42, 95% CI [0.38, 0.46]. (91% vs 8%), n = 211, k = 194, $z = 12.19$, $p < .001$ (Cohen's g = 0.42 [0.38, 0.46]).

STUDY 2 (REPLICATION BYRNE ET AL., 2000)

SAMPLE AND PROCEDURE

The present study employed a between-subjects experimental design to investigate the effects of the independent variable, scenario version (Same card vs. Different card), on the dependent variables mutation, guilt, and blame. The sample consisted of 339 participants, all of whom were aged 18 years or above and from America. Participants were recruited from the online platform Prolific, which is widely used in psychological research due to its large and diverse participant pool, quality control system, cost-effectiveness, and ethical standards (Chandler & Shapiro, 2016). There were no missing data for age. Of the participants, 157 were female (46%), 176 were male (51%), and 6 identified as non-binary (1%). The mean age of the sample was 39.92 years (SD = 13.82), with an age range of 18 to 93 years and a median age of 36 years. OSF link; osf.io/9a26d

Participants were randomly assigned to two experimental conditions; "Same-Card" and "Different-Card". Both conditions involved a scenario with two game show players, Jones and Bardy, who encountered a technical hitch (the game is stopped and the first actor has to

draw a new card, because of the technical hitch making the first selection invalid. The conditions differed in the sequence of Jones' card colors. In the “Same-Card” scenario, post-hitch, Jones drew black twice, and Bardy drew red. In the “Different-Card” scenario, Jones drew black, then red, while Bardy drew black post-hitch. Participants then imagined an alternative where both could win £1,000 if they had chosen different cards, and responded to questions regarding guilt and blame attribution. Once the participants have responded to the questions related to each scenario, they are asked to provide demographic information, including age, gender, seriousness in filling out the questionnaire, and understanding of the English language. Note; (Original study used the name “Brady”, but because of a misprint the replication study denoted the name “Bardy”).

RESULTS

SAME CARD

(H1) **Mutation;** Second rather than first, One proportion binomial test k = 130 , n = 168, p <.001, Cohen's g = 0.27 95% CI [0.21 , 0.34] 77% chose second (Bardy), 22% chose first (Jones)

(H2) **Guilt**; k = 148 , n = 168 , p <.001, Cohen's g = 0.38 95% CI [0.33 , 0.43] 88% chose that Bardy would experience more guilt, and 11% chose that Jones would experience more guilt.

(H3) **Blame;** k = 139 , n = 168, p <.001, Cohen's g = -0.33 95% CI [-0.39, -0.27]. 82% chose that Jones would blame Bardy more (first would blame second), and 17% chose that Bardy would blame Jones more (second would blame first).

DIFFERENT CARD

(H1) **Mutation**; Second rather than first, One proportion binomial test k = 95, n = 171 , p = 0.168, Cohen's g = 0.06 95% CI [-0.02 , 0.13]. 55% chose that the most readily alternative

in mind for mutability were that Bardy had picked a red card (second rather than first), and 44% chose the most readily alternative in mind were that Jones had picked a black card (first rather than second).

(H2) **Guilt**; One proportion binomial test k = 105 , n = 171 , *p* = 0.003, Cohen's g = 0.11 95% CI [0.04 , 0.19]. 61% chose that Bardy would experience more guilt (second). 38% thought that Jones would experience more guilt (first).

(H3) **Blame**; One proportion binomial test k = 98 , n = 171 , *p* = 0.066, Cohen's g = - 0.07 95% CI [-0.15, 0.00]. 57% chose that Jones would blame Bardy more (first to blame second), and 42% chose that Bardy would blame Jones more (Second to blame first).

Detailed results of replication study 1 Byrne et al. (2000)

Table 2

Percentages and frequency count measures on judgments of who feels worse, blame, and undoing of the first or second sequence through an "if only…" question.

Condition	***n***	**Frequencies**	**In %**	**After rounding**
Same card	168			
Undoings				
First event overall		38	22.6	23
Second event overall		130	77.4	77
Guilt				
First		20	11.9	12
Second		148	88.1	88
Blame				

First		29	17.3	17
Second		139	82.7	83
Different card	171			
Undoings				
First event overall		76	44.4	44
Second event overall		95	55.6	56
Guilt				
First		66	38.6	39
Second		105	61.4	61
Blame				
First		73	42.7	43
Second		98	57.3	57

Note. Frequency count calculations were based on values reported in the replication of study 1 of Byrne et al., 2000.

Table 3

Results from replication study of Byrne et al., 2000, Study 1

Hypothesis	**Dependent variables**	**Statistical test**	**Effect size with 95% CI**
	(Scenario 1) **Same card**	**One sample Binomial**	**Cohen`s *g***

H1	Second rather than first	n = 168, k = 130, $p < .001$	0.27 [0.21 , 0.34]
H2	Guilt	n = 168, k = 148, $p < .001$	0.38 [0.33 , 0.43]
H3	Blame	n = 168, k = 29, $p < .001$	-0.33 [-0.39 , -0.27]
	(Scenario 2)		
	Different card		
H1	Second rather than first	n = 171, k = 95, $p = 0.168$	0.06 [-0.02 , 0.13]
H2	Guilt	n = 171, k = 105, $p = 0.003$	0.11 [0.04 , 0.19]
H3	Blame	n = 171, k = 73, $p = 0.066$	-0.07 [-0.15 , 0.00]

Note. Statistical tests were conducted on the basis on the original study (Byrne et al., 2000, pp. 267)

REPLICATION FINDINGS

The replication findings were evaluated using the criteria outlined by LeBel (2019) to assess the presence and consistency of observed effects between original and replication studies. A signal in this context refers to the presence of an effect in the replication study that is consistent with the original study. Inconsistent signals, on the other hand, indicate differences in the effect size or direction between the original and replication studies.

In the comparison table 1, the replication effect sizes for Miller and Gunasegaram's (1990) coin toss scenario show inconsistent signals for both mutation and guilt, with smaller and larger effect sizes, respectively, compared to the original study. However, it is important to note that the inconsistent signals were in the same direction as the original study. The signal for blame was consistent between the original and replication studies, indicating a similar effect size.

As for comparison table 2, which presents the results for Byrne et al.'s (2000) Study 1, the replication effect sizes for Scenario 1 (mutation, guilt, and blame) showed consistent signals, indicating that the observed effects in the replication study were in line with the original study. In Scenario 2, the replication effect sizes for mutation, guilt, and blame displayed no signal, which is also consistent with the original study. This suggests that the temporality effect was not observed in this particular scenario, supporting the original findings. In summary, the replication study demonstrated a mix of consistent, inconsistent, and no signals when compared to the original studies, with the inconsistent signals for Miller and Gunasegaram's (1990) coin toss scenario still showing the same direction as the original study.

Table 4.

Comparison of original study and replication study

Study	Original study effect size	Replication effect size	Interpretation
(Miller and Gunasegaram, 1990)- Coin toss scenario			
	Cohen's *g*	**Cohen's *g***	
Mutation	0.39 [0.42, 0.45]	0.26 [0.20, 0.32]	Signal – inconsistent, smaller
Guilt	0.36 [0.29, 0.44]	0.43 [0.40, 0.47]	Signal – inconsistent, larger
Blame	0.42 [0.36, 0.48]	0.42 [0.38, 0.46]	Signal - consistent

Table 5

Comparison of original study and replication study

Study	Original study effect size	Replication effect size	Interpretation
(Byrne et al.,2000- Same and different card scenario)			
Scenario 1	**Cohen's *g***	**Cohen's *g***	
Mutation	0.22 [0.05, 0.38]	0.27 [0.21, 0.34]	Signal – consistent
Guilt	0.38 [0.29, 0.50]	0.38 [0.33, 0.43]	Signal – consistent
Blame	-0.30 [-0.47, -0.13]	-0.33 [-0.39, 0.27]	Signal – consistent
Scenario 2			
Mutation	0.02 [-0.17, 0.20]	0.06 [-0.02, 0.13]	No Signal – consistent
Guilt	0.09 [-0.11, 0.29]	0.11 [0.04, 0.19]	No Signal – consistent
Blame	-0.17 [-0.36, 0.02]	-0.07 [-0.15, 0.00]	No Signal – consistent

GENERAL DISCUSSION

The primary objective of the studies was to replicate findings from Byrne et al. (2000) and Miller & Gunasegaram (1990). Specifically, focusing on exploring the dynamics of how recent events are mutated when thinking counterfactually and how guilt and blame are attributed in these contexts

In Study 1we found a significant difference in the proportions of mutation, guilt, and blame between the first and second actor. These findings align with the original study's results, indicating that the second actor is more likely to be mutated and experience guilt, and the first actor is more likely to blame the second actor. The three hypotheses tested in

the replication of Miller and Gunasegaram (1990) are supported by the results. There were significant differences between first and second actors in terms of mutation, guilt, and blame, with more participants attributing these aspects to the second actor, echoing the results of the original study. The direction of the results is consistent with the original study, despite some differences in effect size.

In Study 2 (Replication of Byrne et al., 2000), we found significant differences in the proportions of mutation, guilt, and blame between the Same Card and Different Card conditions. In the Same Card condition, participants were more likely to mutate the second event, attribute more guilt to the second actor, and have the first actor blame the second actor more. All three hypotheses were supported, with significant differences observed between first and second actors in terms of mutation, guilt, and blame, with the second actor (Bardy) being more associated with these aspects. In the Different Card condition, although there were no significant differences in mutation, there were significant differences in guilt attribution, with the second actor experiencing more guilt. This finding extends the original study by suggesting that when the causal order is manipulated (by changing the color of the cards), the second actor still tends to feel more guilt, indicating that people's attributions of guilt may not be solely based on the temporal order of events.

As existing literature goes, the absence of signal for the different card scenario in Byrne et al. (2000) and the consistency of these findings in the replica study (study 2), some plausible explanations are served; Firstly, the absence of the temporality effect may be due to the explicit alternative served to the first event, not making this event presupposed, or to the wrong perception that events are dependent on each other. This may explain why individuals do not focus on the most recent event in their counterfactual thinking, leading to a more even distribution of guilt and blame (Mandel, 2003; Byrne et al., 2000). Secondly, the

temporality effect may be less robust in chance-based scenarios, where events are perceived to be based on luck or randomness and outcomes are not seen as contingent upon the decisions made by the individuals involved (Miller & Gunasegaram, 1990). Thirdly, cognitive load and the difficulty of processing complex or unrelated events while deductive reasoning and answering questions, can play a role in the absence of the temporality effect, making it more challenging for individuals to create counterfactual alternatives, and to use heuristic guided routes instead (Kahneman & Tversky, 1982). Emotional factors, such as the intensity of perceived emotional response to the events, may also influence the temporality effect and potentially overshadow the impact of temporal order on counterfactual thinking and judgments of responsibility and blame (Roese, 1997). Finally, individual differences in cognitive processing, including working memory capacity, attention, and reasoning abilities, could contribute to the absence of the temporality effect, as these factors may affect the way people engage in counterfactual thinking and process and integrate temporal information (Stanovich & West, 2000).

The implications of these findings for our understanding of the temporality effect and counterfactual thinking are multifaceted. The replication studies provide further evidence that the temporality effect is indeed a phenomenon, particularly when the sequence of events are independent. In these situations, individuals are more likely to focus on the most recent event when generating counterfactual alternatives, assigning guilt, and attributing blame. It should be noted that several participants in Replication Study 1 provided feedback in the survey's conclusion, expressing that the scenario was confusing or that it overlooked alternate options. This feedback may have influenced the results to some extent. Nevertheless, it underscores the inherent complexity of constructing counterfactual scenarios, even when the wording of questions are intended to be as straightforward as

possible. Study 2 did not gather comments from the respondents. The results obtained from replicating these studies provide further evidence supporting the existence of the temporality effect/temporal order effect as a causal explanatory factor.

It should be mentioned, that replication does not guarantee the absolute certainty of the effect being present and real. While replication is a crucial step in strengthening the evidence for a phenomenon, it is not sufficient on its own. Additional research, such as conducting meta-analyses and exploring the underlying mechanisms, is necessary to further establish the validity and generalizability of the temporality effect.

HEURISTIC PROCESSES- AVAILABILITY AND SIMULATION

Kahneman and Tversky's (1982) Simulation Heuristic is a psychological theory that explains how individuals generate counterfactual alternatives and make judgments about events. According to the theory, people generate counterfactual alternatives by mentally simulating possible variations of the actual event or situation. These simulations involve making relatively small changes to the original event, which are easier to imagine and process cognitively (Kahneman & Tversky, 1982). The Simulation Heuristic is closely related to the Availability Heuristic, another concept proposed by Tversky and Kahneman (1973), which posits that people tend to rely on readily available or easily accessible information when making judgments and decisions. The underlying mechanism of the Simulation Heuristic is based on the ease with which individuals can mentally simulate alternative scenarios or outcomes (Kahneman & Tversky, 1982). This ease of simulation is influenced by factors such as the similarity between the actual and counterfactual events, the cognitive effort required to generate alternatives, and the availability of relevant information (Galinsky & Moskowitz, 2000). The more easily an alternative can be imagined, the more likely it is to influence judgments and decisions. The Simulation Heuristic can help explain the temporality effect in

counterfactual thinking. As individuals tend to focus on events that are more recent or temporally proximate, these events may be more easily simulated and incorporated into counterfactual alternatives (Kahneman & Tversky, 1982). This can lead to a greater emphasis on recent events when making judgments about causality, responsibility, and blame. One possible explanation for the temporality effect, based on the Simulation Heuristic, is that recent events are more accessible in memory and therefore easier to simulate in counterfactual alternatives (Kahneman & Tversky, 1982). This increased accessibility and ease of simulation could result in individuals assigning greater responsibility and blame to more recent events, consistent with the temporality effect, as it can be seen as a manifestation of these heuristics.

THE INTERPLAY OF COGNITIVE MECHANISMS; TEMPORAL AND CAUSAL ORDER EFFECTS

The cognitive mechanisms contributing to the temporal and causal order effects in counterfactual thinking often interact, shaping the generation and evaluation of counterfactual alternatives. A comprehensive understanding of these interactions is crucial for advancing our knowledge of the phenomenon. However, the literature offers different perspectives on the interactions between these cognitive mechanisms; Some researchers argue that the availability heuristic and the process of attribution causality work together in impacting the generation and evaluation of counterfactual alternatives (Roese & Olson, 1995). They posit that the availability heuristic influences the ease of generating counterfactuals based on the accessibility of event information in memory, while the crediting causality hypothesis identifies earlier events as more causally relevant. When an event is both easily retrievable from memory and perceived as causally significant, individuals are more likely to generate counterfactual thoughts about it. On the other hand, some scholars argue that the availability heuristic and the causal attribution process may

have independent effects on counterfactual thinking (Mandel, 2003). They contend that the availability heuristic may influence the ease of generating counterfactual thoughts but does not necessarily determine the perceived causal relevance of an event.

INTERACTION BETWEEN EMOTIONAL INTENSITY AND PERCEIVED MUTABILITY

While some researchers propose that emotional intensity and perceived mutability interact to shape counterfactual thinking (Gilovich & Medvec, 1994), others argue that these factors may have distinct and independent effects on the generation and evaluation of counterfactual alternatives (Markman & McMullen, 2003). Proponents of hypothesizing the interaction posits that there is a reciprocal relationship between emotional reactions to an event and the perceived mutability of the event in the context of counterfactual thinking. When an event elicits strong emotional responses, individuals are more likely to perceive the event as mutable, i.e., they believe the outcome could have been different under alternative circumstances. This perception of mutability can, in turn, amplify the emotional intensity associated with the event (Davis, Lehman, Wortman, Silver, & Thompson, 1995). For instance, if someone misses a train by a minute and this causes significant inconvenience, the strong negative emotions felt may lead them to perceive the event as highly mutable. They could easily imagine a scenario where they left home a minute earlier and caught the train, thereby avoiding the inconvenience. This perceived mutability may then further intensify their feelings of frustration or regret. However, critics argue that the relationship between emotional intensity and perceived mutability may not be as straightforward. They suggest that other factors, such as the personal relevance of the event or the specific context in which it occurred, could also play a significant role in the generation of counterfactual thoughts (Davis et al., 1995). Therefore, while there may be a relationship between emotional intensity and perceived mutability, it might not be uniformly applicable across all

situations or individuals. More empirical research is needed to fully understand the nuances of this relationship and the conditions under which it holds true.

IMPLICATIONS OF INTERACTING MECHANISMS; A CALL FOR FUTURE RESEARCH

The temporality effect can emerge in academia and counterfactual thinking as a broader term to encompass a wider range of time-related influences on human cognition, memory, and decision-making. The term can prove it selves useful because it covers a broader range of phenomena; Temporality effect serves as an umbrella term for various time-related factors influencing cognition and counterfactual thinking. The emergence of the temporality effect in academia, despite the presence of recency and primacy effect, can be attributed to the need for a more comprehensive understanding of the various ways time-related factors influence human cognition, memory, and decision-making. Both of these effects captures a specific aspect of the relationship between time and cognition, but none of them provide a complete picture on their own. As is demonstrated in the replication studies- an effect is present, mirroring the results of the original studies. As earlier research has tried to eliminate other explanations for the presence of the given effect, one should strongly consider attributing the ascribed findings of temporality effect also on universal basis. Burns and McCormack's (2009) found that 6–7-year-olds are prone to the temporality effect in their judgments of causal structures, thereby underlining the significance of temporality in causal cognition. Notably, this cognitive ability appears to be less developed in 4-year-olds. The discernible contrast between adults and children's use of temporal cues in determining causal structures underscores the universality of the temporality effect. Given that 6-7-year-olds have begun to think counterfactually, it suggests a potentially universal developmental onset of the temporality effect

SUPPORTING THE TENETS OF TEMPORALITY

The results of our research provide compelling evidence for several of the six tenets of counterfactual thinking as outlined by Walsh and Byrne (2004). Our studies, through the use of coin toss and game show scenarios, particularly highlighted the aspects of 'winning conditions', mutation of facts, and anchoring.

The first tenet, which posits that individuals understand scenarios by considering the true possibilities, was substantiated in both our studies. Participants were tasked with understanding the real scenarios, a coin toss or game show, before they could engage in counterfactual thinking. In line with the second tenet, our participants did not consider all possible counterfactual scenarios but a subset of them. This focused consideration was manifested through their responses, as they primarily considered alternative outcomes that were directly related to the given scenarios. Our studies also supported the third tenet, suggesting that the subset of counterfactual possibilities that individuals keep in mind is guided by the winning conditions- that is, the possibilities in which the players would have won. Participants were observed to imagine scenarios in which they could have won the game, reflecting this guiding principle. The fourth tenet was also corroborated through participants engage in mutating aspects of the facts to match the counterfactual possibilities of the winning conditions. For example, they might imagine choosing a different coin side or card that could have led to a favorable outcome.

In line with the fifth tenet, the studies showed that participants used the first element of the facts, i.e., their initial decision in the game, as an anchor. When imagining alternative outcomes, they typically kept their initial decision constant unless it was evident that a different initial choice would have led to a win. Lastly, supporting the sixth tenet, the participants were found to think explicitly about some elements of the true possibilities, such as their choices in the game, while leaving other elements implicit. This was evident in their

focused reflections on the decisions they made during the game and the possibilities directly related to these decisions. Thus, the experiments reinforce Walsh and Byrne's framework of how people engage in counterfactual thinking.

A POTENTIAL FRAMEWORK

Walsh and Byrne's (2004) tenets elucidate key aspects of our temporal thinking, They propose that people comprehend scenarios by assessing the real or true possibilities. Rather than considering all potential counterfactual scenarios, individuals focus on a subset, predominantly guided by “winning conditions”, that is, scenarios in which the outcome would have been advantageous. In this process of counterfactual reasoning, individuals actively alter aspects of reality to align with the counterfactual possibilities that lead to these winning conditions. Walsh and Byrne also highlight the anchoring role of the first element in a sequence of facts. This first element is compared to the winning conditions: if a match is found, the first element remains constant and the second element is modified to resemble the winning possibility; conversely, if no match is found, it's the first element that undergoes change. The tenets emphasize that individuals consciously ponder over some elements of the true possibilities, particularly those explicitly mentioned, while other elements remain tacit.

These tenets provide a substantive lens to understand the mechanisms underpinning and supplemented by the availability and simulation heuristics, it contributes additional layers to this proposed framework. Kahneman and Tversky (1982) succinctly explains, a person evaluates the frequency of classes or the probability of events by availability, i.e., by the ease with which relevant instances come to mind. As Kahneman and Miller (1986) explains the simulation heuristic as a mental rule of thumb according to which the subjective probability of an event, or a decision maker's degree of belief in its occurrence, is

determined by the ease with which instances or occurrences can be imagined. Kahneman is considered a pioneer in the field of psychology and decision making. As the Nobel prizes speak for themselves, his thoughts are still very much prevalent and applicable today, despite being conducted more than thirty years ago. As for the temporality effect goes, it need some backing up by external and well established literature.

Integrating the six tenets of temporality (Walsh & Byrne, 2004) with the availability and simulation heuristics forms a foundation for a potential framework within the temporality effect in counterfactual thinking. This integration, however, does not negate the importance of causality as an essential component of counterfactual thinking.

Walsh and Byrne's (2004) tenets provide an essential lens to understand the mechanisms underpinning counterfactual thinking. The availability heuristic (Tversky & Kahneman, 1973) and the simulation heuristic (Kahneman & Miller, 1986) add to this understanding by accounting for the influence of cognitive ease in recalling or imagining events and constructing hypothetical alternatives, respectively. While these components collectively provide a more comprehensive understanding of counterfactual thinking, the role of causality remains crucial. Counterfactual thinking inherently involves the evaluation of causal relationships as individuals imagine different outcomes based on alternative antecedent events. Roese and Morrison (2009) identify counterfactuals as cognitive constructs that symbolize different possibilities to past events or actions, especially those that could have resulted in avoiding negative outcomes. This perspective emphasizes the inherent causal reasoning that underpins counterfactual thinking, particularly its negative aspects. As such, causality stands out as a significant focal point within the proposed framework. It is through the lens of causal attributions that we can gain a deeper understanding of how individuals create and evaluate counterfactuals.

As our understanding of counterfactual thinking and temporality is still evolving, it is imperative that this framework remains flexible, adaptable, and open to refinement in light of new research findings. As noted by Roese and Olson (1995) counterfactual thinking is a distinctly human capacity that plays a key role in learning from experience, but it can also warp judgment in systematic ways. Recognizing this dual nature, the framework should strive to capture the intricate balance that defines counterfactual thinking. As with any conceptual framework, it should be subjected to empirical scrutiny. Future research should aim to elaborate, validate, and refine this framework, examining its predictive power across varied contexts and populations. Such investigations could contribute significantly to the field of counterfactual thinking and its effects on a plethora of psychological outcomes.

The temporality effect may serve as an overarching concept that includes a wider range of time-related influences on cognition and memory, going beyond the recency effect, and primacy effect. It allows researchers to consider additional aspects of timing, such as time-based decay, interference, and the impact of duration on memory and decision-making. While facilitating a more comprehensive understanding of timing effects and by focusing on the broader temporality effect, researchers can systematically study the various ways timing of events impact counterfactual cognition, memory, and decision-making. This approach helps build a more complete understanding of how time-related factors shape human experience. By doing so, it also encourages interdisciplinary research, with researchers from different disciplines to explore time-related influences on cognition and memory, leading to new insights and collaborations. Most of all it highlights the complexity of human cognition; Human cognition is influenced by numerous factors, and recognizing the temporality effect as a broader concept acknowledges the intricate interplay of factors in shaping counterfactuals. By taking small steps towards a more nuanced truth with simplistic design

and building on the work of both direct replication, a foundation for a potential framework is set.

LIMITATIONS

While the replication studies contributes insights into the field of counterfactual thinking, it is necessary to acknowledge its limitations. The sample was primarily comprised of young individuals, which might limit the generalizability of our findings, particularly considering that the original study included undergraduate students from Ireland (cite original study). Future investigations should seek to replicate these results within more diverse demographic cohorts.

The cultural context of our research is another limiting factor. Conducted in Norway and the United States, the studies reflect predominantly individualistic cultural values characteristic of Western societies. It would be worthwhile for future research to explore how counterfactual thinking might manifest differently in collectivist cultures, where values of group harmony and shared responsibility take precedence (Triandis, 1995).

The simplicity of study design, which involved only two actors and a straightforward sequence of events, is another consideration. Even so the simplistic design serves this research beneficial, future studies could provide more nuanced insights by exploring more complex scenarios involving multiple actors and events. Although various potential confounding variables were controlled for, other unidentified factors might influence counterfactual thinking and attributions of guilt and blame. Future research should strive to identify these variables and understand their potential impact (Nickerson, 1998). The studies did not account for the time participants took to respond, which could be a relevant factor in understanding counterfactual thinking. Investigating the potential differences in responses between participants who took longer versus those who responded more quickly could

provide additional insights. It is reasonable to insinuate that if individuals were forced to think about these scenarios for a longer period of time, it would also yield more reliable responses. Even so if results would not differentiate, more individuals would not be in confusion of the questioning, and perhaps more information from the comments could have given a specific understanding of how the respondents thought. Moreover, supplementary questions could have been asked, to better understand why participants attributed guilt in the way they did. This could provide a more in-depth understanding of the thought processes underlying their responses. Despite its limitations, the research provides substantial evidence for the role of temporal order effect in counterfactual thinking, hinting at the potential influence on mental causal order. It offers a foundation for further exploration in this intriguing field of study.

CONCLUSION

Throughout the course of this thesis, the primary focus has been on exploring the temporality effect in the context of counterfactual thinking. This phenomenon, which can be interpreted as a cognitive bias, has considerable influence on our understanding of causality and the shaping of our emotional responses. By shedding light on these biases, we can gain valuable insights into the ways our thought patterns shape our emotions and decisions. Becoming aware of cognitive distortions such as the temporality effect can lead to awareness of decision-making processes. In the context of the research question, understanding the temporality effect in counterfactual thinking can provide a foundation for developing interventions to mitigate its impact. By raising awareness of the temporality effect and helping individuals recognize their own biases, we can support more accurate assessments of causality, minimize the influence of temporal order effect on counterfactual

thinking, and ultimately foster healthier emotional responses and decision-making processes.

Future research can continue to investigate the temporality effect and counterfactual thinking in various contexts, as well as explore potential interventions that address these cognitive distortions and their emotional consequences. A multifaceted approach to investigating causality within this framework will yield a more comprehensive understanding of counterfactual thinking. Such an approach should ideally integrate experimental, longitudinal, survey, qualitative, neuroscientific, and theoretical methodologies to fully capture the nuances of causality in counterfactual thinking.

These experiments provide evidence that imply the temporality effect is a replicable phenomenon in counterfactual thinking. In all conclusiveness, the emergence of the temporality effect in academia reflects the need for a more comprehensive understanding of the influence of time on human cognition, memory, and decision-making. By providing a broader perspective that encompasses various time-related factors, the temporality effect enables researchers to explore the complexity of human cognition and behavior more thoroughly.

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SUPPLEMENTARY MATERIAL SECTION

PRE REGISTRATION (STUDY 1)
Project working title: **Replication of Miller & Gunasegaram`s (1990) coin toss scenario**

Authors: *left out for blind review of the preregistration*
Affiliation: *left out for blind review of the preregistration*

Summary

This project's aim is to test the predominant tendency people have to consider the second event in an independent two-event sequence more mutable than the first, and to test whether linguistic preferences influence this tendency in a Norwegian sample.

Hypotheses

Common predictions across Scenario 1 and Scenario 2
H1: The most recent event in a sequence of two independent events is considered more mutable than the first.

H2: Given a negative outcome based on a sequence of two independent chance events, participants will judge the second player to experience more guilt than the first player.

H3: Given a negative outcome based on a sequence of two independent chance events, the study participants will judge that the first player will blame the second player more often than the second player blaming the first player.

Contrasting Scenario 1 and Scenario 2
We do not have concrete directional predictions contrasting the responses across Scenario 1 and Scenario 2. We will report the results of the contrast in responses to Scenario 1 and Scenario 2 across each of the three predictions noted above (i.e., H1, H2, & H3).

Exploratory predictions:
The survey will be conducted in the Norwegian language. We will test if the Norwegian participants report “heads-tails” linguistic preference over “tails-heads,” and if such a preference contributes to the pattern of responses across Scenario 1 and Scenario 2.

Study Materials

Study Outline:

In this survey, you will read two separate scenarios about outcomes of chance events (such as a coin toss). As you read the descriptions, please carefully try to form a detailed understanding of the situations related to the decision-makers involved. Following each

scenario, you will answer three short questions about the scenario based on your understanding.

Scenario 1:

Imagine two individuals (Jonas and Kristian) who are offered the following very attractive proposition. Each individual is asked to toss a coin. If the two coins come up the same (both heads or both tails), each individual wins NOK 10,000. However, if the two coins do not come up the same, neither individual wins anything. Jonas goes first and tosses a head; Kristian goes next and tosses a tail. Thus, the outcome is that neither individual wins anything.

There were two ways that Jonas & Kristian could have won NOK 10,000. Which of these alternatives comes more readily to mind?

- Jonas tossing a tail
- Kristian tossing a head

Who would you predict will experience more guilt—Jonas or Kristian?

- Jonas
- Kristian

Will Jonas blame Kristian more or will Kristian blame Jonas more for their failure to win NOK 10,000?

- Jonas
- Kristian

Scenario 2:

Imagine two individuals (Oscar and Chris) who are offered the following very attractive proposition. Each individual is asked to toss a coin. If the two coins come up the same (both heads or both tails), each individual wins NOK 10,000. However, if the two coins do not come up the same, neither individual win anything. Oscar goes first and tosses a tail; Chris goes next and tosses a head. Thus, the outcome is that neither individual win anything.

There were two ways that Oscar & Chris could have won NOK 10,000. Which of these alternatives comes more readily to mind?

- Oscar tossing a head
- Chris tossing a tail

Who would you predict will experience more guilt—Oscar or Chris?

- Oscar
- Chris

Will Oscar blame Chris more or will Chris blame Oscar more for their failure to win NOK 10,000?

- Oscar will blame Chris more
- Chris blame Oscar more

Which of these phrasings appear the most natural to you?

- Heads or tails
- Tails or heads

Demographic questions

Thank you, you completed the main part of the survey.

A couple of quick final questions.

How old are you?

---- (text box here)

What is your gender?

- Female
- Male
- Other

Planned sample

Participants recruited will be Norwegian-speaking adults. The sample size was calculated using G*power 3.1.9.7, and was based on 90% power (and α = .05), with the aim of detecting an effect size of Cohen`s *g* = 0.2. We aim to achieve a sample size of 200 particpants. The details from the power analysis can be found in the power analysis section below.

Suggested Analysis

The original authors did not include the results of the analysis, nor did they report which one proportion test they used, however, we found it appropriate to conduct one sample Z tests to test the predictions.

Detailed results of coin toss scenario by Miller & Gunasegaram (1990)

Table 1

Percentages and frequency count measures on predictions of experience of guilt, judgment of blame, and undoings of the first or second sequence through an "if only…" question.

Question	In %	Conversion	After rounding
Who will experience more guilt?			
First	14%	12,32	12
Second	86%	75,68	76
Who will blame the other more?			
First	92%	80,96	81
Second	8%	7,04	7
Which event is most often mutated?			
First event	11%	9,68	10
Second event	89%	78,32	78
n		88	

Note. Frequency calculations were based on percentage values reported in the original study (Miller & Gunasegaram, 1990, pp. 1111-1112).

Table 2

Results of Study 1 of Miller & Gunasegaram (1990)

Hypotheses	Dependent variables	Statistical test	Effect size with 95% CI
		One sample Z-test	**Cohen`s *g***
H1	**DV1:** Which event is most often mutated?	$k = 78$, $n = 88$, $z = 7.25$, $p < .001$	0.39 [0.32 , 0.45]
H2	**DV2:** Who will experience more guilt?	$k = 76$, $n = 88$, $z = 6.82$, $p < .001$	**0.36 [0.29 , 0.44]**
H3	**DV3**: Who will blame the other more?	$k = 81$, $n = 88$, $z = 7.89$, $p < .001$	0.42 [0.36 , 0.48]

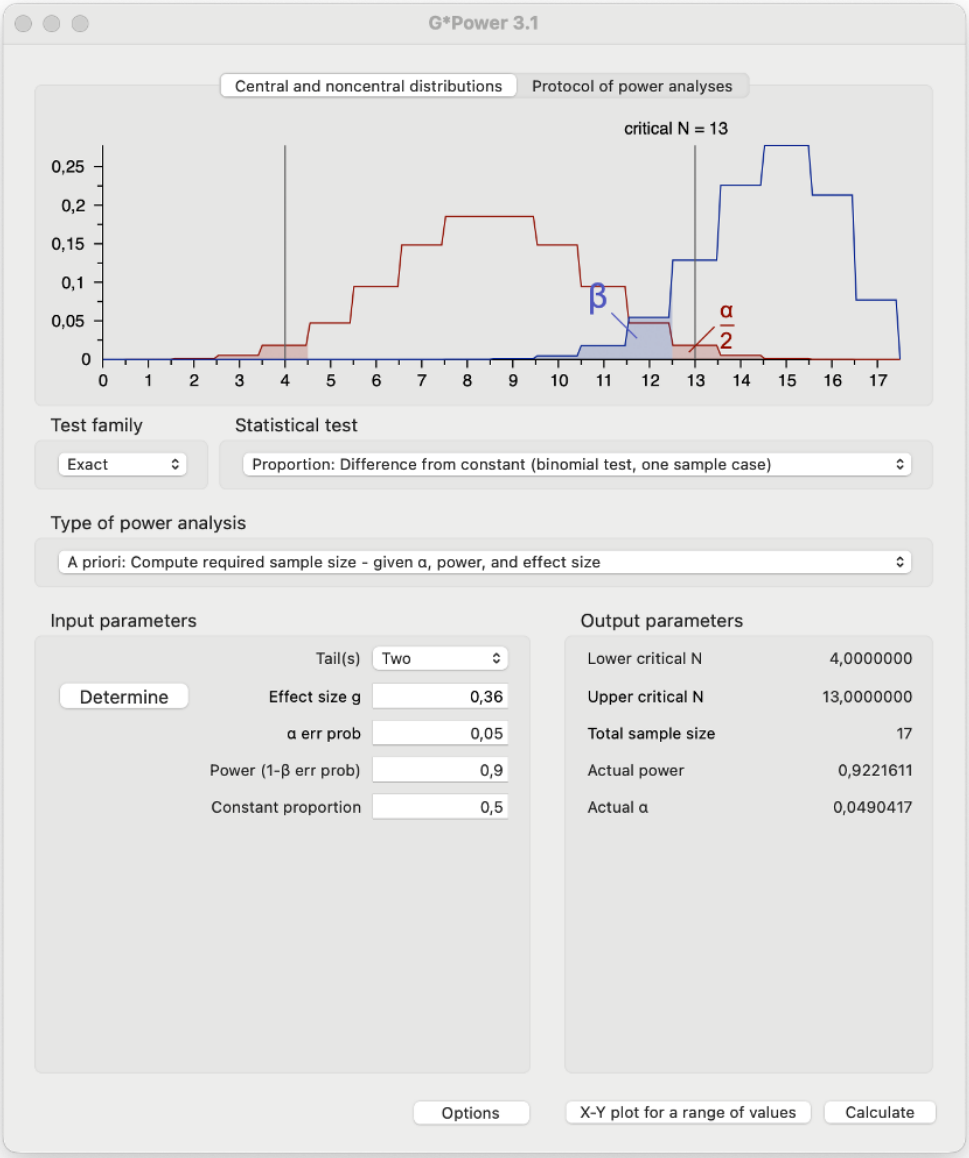
Power analysis

The rationale for reconstructing the original dataset and re-running analysis: authors of the original studies did not report the full statistical results necessary (i.e., effect size measures were missing) to run a power analysis. Hence, we had to re-conduct the analysis reported in the original study based on information available in the description of the study (see Table 1 above).

Steps for power analysis

Hypotheses H1, H2 and H3

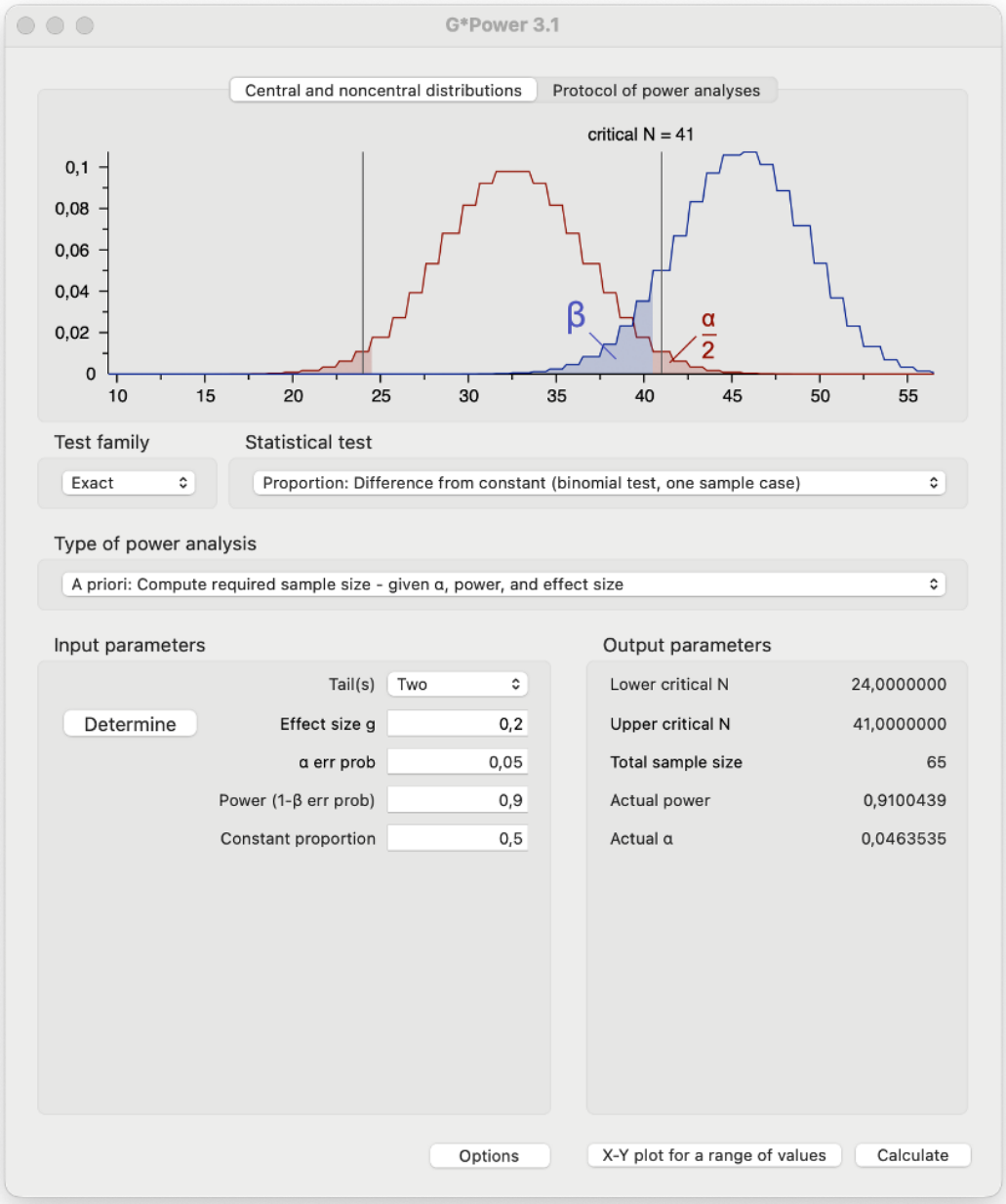
The testing of H1, H2 and H3 involved three One sample Z test. We conducted a power analysis based on the smallest effect size among these results (i.e., Cohen's g = 0.36). The results of the analysis suggest a total sample size of 17 (see screenshot below).



Smallest effect size of interest

We aim to be able to detect a small effect size of Cohen`s g = 0.2 at 0.90 power (alpha =.05). The result of the power analysis suggests a total sample size of 65 (see screenshot

below).



Summary of power analysis:

The analysis suggests a replication sample size of 65 participants. However, we aim to recruit a minimum of 200 participants, because a larger sample size will be more accurate and reliable. The original study also had very large effect sizes, so to include a larger sample will be beneficial to detect smaller effect sizes.

PRE REGISTRATION (STUDY 2)

Project working title: **Replication of study 1 of Byrne et al. (2000)**

Authors: *left out for blind review of the preregistration*
Affiliation: *left out for blind review of the preregistration*

Summary

This project's aim is to test the predominant tendency people have to consider the second event in an independent two-event sequence more mutable than the first.

Hypotheses

Common predictions across Scenario 1 and Scenario 2

H1: The most recent event in a sequence of two independent events is considered more mutable than the first.

H2: Given a negative outcome based on a sequence of two independent chance events, participants will judge the second player to experience more guilt than the first player.

H3: Given a negative outcome based on a sequence of two independent chance events, the study participants will judge that the first player will blame the second player more often than the second player blaming the first player.

Contrasting Scenario 1 and Scenario 2

We do not have concrete directional predictions contrasting the responses across Scenario 1 and Scenario 2. We will report the results of the contrast in responses to Scenario 1 and Scenario 2 across the predictions noted above (i.e., H1, H2, H3).

Study materials

Study outline

In this survey, you will read about a situation where two people are making decisions. As you read the description, please carefully try to form a detailed impression of the situation and of the decision-makers involved. Following the scenario, you will answer three questions about the scenario based on your understanding.

Scenario 1 (Same card)

Imagine two individuals (Jones and Michael) who take part in a television game show, on which they are offered the following very attractive proposition. Each individual is given a shuffled deck of cards, and each one picks a card from their own deck. If the two cards they pick are of the same color (i.e., two from black suits or two from red suits), each individual win $1,000.

However, if the two cards are not the same color, none of the individuals win anything. Jones goes first and picks a ***black*** card from his deck. At this point, the game show host has to stop the game because of a technical difficulty. After a few minutes, the technical problem is solved, and the game can be restarted. Jones goes first again, and this time the card that he draws is a ***black*** card. Michael goes next and picks a ***red*** card. Thus, the outcome is that neither individual win anything.

Jones and Michael could each have won $1,000 if only one of them had picked a different card, for instance if…

- Jones had picked a red card
- Michael had picked a black card

Who would you predict will experience more guilt—Jones or Michael?

- Jones
- Michael

Will Jones blame Michael more or will Michael blame Jones more for their failure to win $1,000?

- Jones (will blame Michael more)
- Michael (will blame Jones more)

Scenario 2 (Different card)

Imagine two individuals (Jones and Michael) who take part in a television game show, on which they are offered the following very attractive proposition. Each individual is given a shuffled deck of cards, and each one picks a card from their own deck. If the two cards they pick are of the same color (i.e., two from black suits or two from red suits), each individual win $1,000. However, if the two cards are not the same color, none of the individuals win anything. Jones goes first and picks a ***black*** card from his deck. At this point, the game show host has to stop the game because of a technical difficulty. After a few minutes, the technical problem is solved, and the game can be restarted. Jones goes first again, and this time the card that he draws is a ***red*** card. Michael goes next and picks a ***black*** card. Thus, the outcome is that neither of the individuals win anything.

Jones and Michael could each have won $1,000 if only one of them had picked a different card, for instance if…

- Jones had picked a black card
- Michael had picked a red card

Who would you predict will experience more guilt—Jones or Michael?

- Jones
- Michael

Will Jones blame Michael more or will Michael blame Jones more for their failure to win $1,000?

- Jones (will blame Michael more)
- Michael (will blame Jones more)

Demographic questions

Thank you, you completed the main part of the survey.

A couple of quick final questions.

How old are you?
---- (text box here)

What is your gender?

- Female
- Male
- Other

Planned sample

Data will be gathered online through the Prolific platform. The sample size was based on 90% power (and α = .05) to detect an effect size of Cohen's g = 0.02. Therefore, we aim to recruit a total of 300 participants to take part in the study. See the power analysis section below for the details. The participants will be randomly and evenly assigned to each of the two conditions.

Suggested analysis

Matching the analysis choice of the original authors, we will conduct one sample Binomial test to test the predictions of hypothesis H1, H2 and H3.

Detailed results of Study 1 of Byrne et al. (2000)
Table 1

Percentages and frequency count measures on judgments of who feels worse, blame, and undoing of the first or second sequence through an "if only…" question.

Condition	***n***	**In %**	**Conversion**	**After rounding**
Same card	39			

Undoings				
First event overall		23	8.97	9
Second event overall		59	23.01	23
Guilt				
First		10	3.90	4
Second		77	30.03	30
Blame				
First		51	19.89	20
Second		13	5.07	5
Different card	36			
Undoings				
First event overall		42	15.12	15
Second event overall		44	15.84	16
Guilt				
First		31	11.16	11
Second		44	15.84	16
Blame				
First		50	18.00	18
Second		25	9.00	9

Note. Frequency count calculations were based on percentage values reported in the original study (Byrne et al., 2000, Table 1, pp. 267)

Table 2

Results from original study (Byrne et al., 2000, Study 1)

Hypothesis	**Dependent variables**	**Statistical test**	**Effect size with 95% CI**
		One sample Binomial	**Cohen`s *g***
	Same card		
H1	Second rather than first	$n = 32$, $k = 23$, $p < .020$	0.22 [0.05 , 0.38]
H2	Guilt	$n = 34$, $k = 30$, $p < .001$	0.38 [0.29 , 0.50]
H3	Blame	$n = 25$, $k = 5$, $p = .004$	-0.30 [- 0.47 , -0.13]
	Different card		
H1	Second rather than first	$n = 31$, $k = 16$, $p = .999$	**0.02 [-0.17 , 0.20]**
H2	Guilt	$n = 27$, $k = 16$, $p = .442$	0.09 [-0.11 , 0.29]
H3	Blame	$n = 27$, $k = 9$, $p = .122$	-0.17 [-0.36 , -0.02]

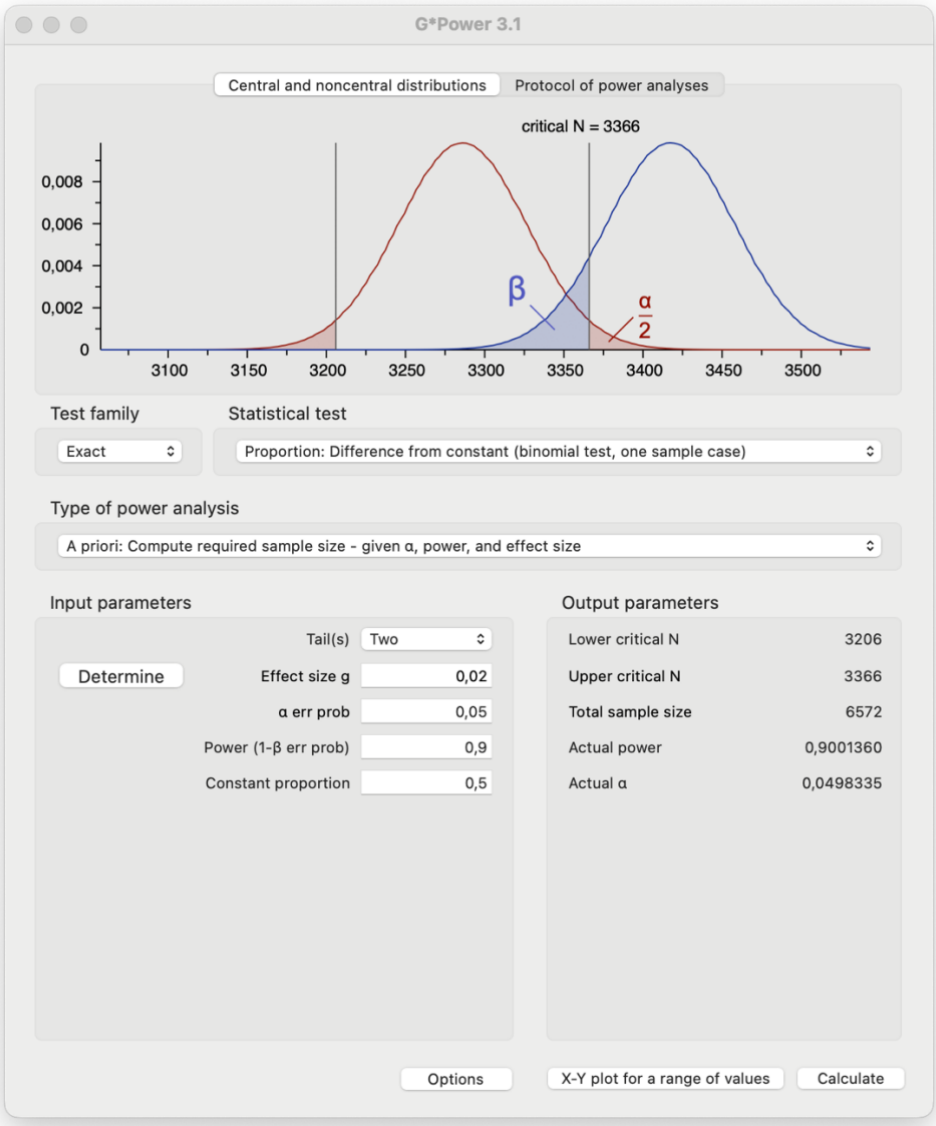
Note. Statistical tests were based on results reported in the original study (Byrne et al., 2000, pp. 267)

Power analysis

The rationale for reconstructing the original dataset and re-running analysis: the authors of the original study did not report all the necessary results (i.e., the effect size measures were missing) to run a power analysis. Hence, we had to re-conduct the analysis reported in the original study based on information available in the descriptions in the results (see Table 1 above).

Steps for power analysis

The testing of H1, H2 and H3 for both conditions involved six One sample Binomial test. We conducted a power analysis based on the smallest effect size among these results (i.e., Cohen's g = 0.02). The results of the analysis suggest a total sample size of (6572 x 2) = 13144 (see screenshot below).



Summary of power analysis:

The analysis suggests a replication sample size of 13144 participants. However, based on our resource constraints, we aim to recruit a total of 300 participants.

CODEBOOK (STUDY 2)

Project working title: **Replication of study 1 of Byrne et al. (2000)**

The current codebook provides information on the structure, and nd contents of a data file.

- **The participants in the current experiment were allocated to one of the two experimental conditions (Same card vs. Different card)**

There will be a variable in the data called "BS1_Condition," that notes which of the two experimental conditions participants were allocated. Therefore, variable will carry two possible values: "Same" vs. "Different."

Scenario 1 (Same card)

Imagine two individuals (Jones and Bardy) who take part in a television game show, on which they are offered the following very attractive proposition. Each individual is given a shuffled deck of cards, and each one picks a card from their own deck. If the two cards they pick are of the same color (i.e., two from black suits or two from red suits), each individual win $1,000. However, if the two cards are not the same color, none of the individuals win anything. Jones goes first and picks a ***black*** card from his deck. At this point, the game show host has to stop the game because of a technical difficulty. After a few minutes, the technical problem is solved, and the game can be restarted. Jones goes first again, and this time the card that he draws is a ***black*** card. Bardy goes next and picks a ***red*** card. Thus, the outcome is that neither individual win anything.

BS1_Same_mutab: Jones and Bardy could each have won $1,000 if only one of them had picked a different card. That is, you try to imagine an alternative series of outcomes in which both players could have won $1,000. Which of below two alternatives comes more readily to your mind?

- Choose an alternative:
  - Jones had picked a red card (0)
  - Bardy had picked a black card (1)

BS1_Same_guilt: Who would you predict will experience more guilt—Jones or Bardy?

- Jones (0)
- Bardy **(1)**

BS1_Same_blame: Will Jones blame Bardy more or will Bardy blame Jones more for their failure to win $1,000?

- Jones will blame Bardy more (1)
- Bardy will blame Jones more (0)

Scenario 2 (Different card)

Imagine two individuals (Jones and Bardy) who take part in a television game show, on which they are offered the following very attractive proposition. Each individual is given a shuffled deck of cards, and each one picks a card from their own deck. If the two cards they pick are of

the same color (i.e., two from black suits or two from red suits), each individual win $1,000. However, if the two cards are not the same color, none of the individuals win anything. Jones goes first and picks a ***black*** card from his deck. At this point, the game show host has to stop the game because of a technical difficulty. After a few minutes, the technical problem is solved, and the game can be restarted. Jones goes first again, and this time the card that he draws is a ***red*** card. Bardy goes next and picks a ***black*** card. Thus, the outcome is that neither of the individuals win anything.

BS1_Diff_mutab: Jones and Bardy could each have won $1,000 if only one of them had picked a different card. That is, you try to imagine an alternative series of outcomes in which both players could have won $1,000. Which of below two alternatives comes more readily to your mind?

- Choose an alternative:
  - Jones had picked a black card (0)
  - Bardy had picked a red card (1)

BS1_Diff_guilt: Who would you predict will experience more guilt—Jones or Bardy?

- Jones (0)
- Bardy (1)

BS1_Diff_blame: Will Jones blame Bardy more or will Bardy blame Jones more for their failure to win $1,000?

- Jones will blame Bardy more (1)
- Bardy will blame Jones more (0)

Demographic questions

Thank you, you completed the main part of the survey. A couple of quick final questions.

Serious: How serious were you in filling out this questionnaire? (1 = not at all, 5 = very much)

English: How would you generally rate your understanding of the English language? (1= very bad; 7 = very good).

Age: How old are you?
---- (text box here)

Gender: What is your gender?

- Female (1)
- Male (2)
- Non-binary (3)
- Prefer not to say (4)

ANALYSIS OF REPLICATION CRITERIONS

Based on LeBel., (2019) these components are designed to give a comprehensive view of the replication study's robustness and reliability, considering not only the replication of results but also the transparency, independence, and adherence to the original methodology.

Methodological Similarity	This refers to the extent to which the replication study adheres to the same operational definitions for the independent and dependent variables as in the original study.
Replication Differences	This involves documenting any differences between the replication study and the original study. These variations can be due to factors within or beyond the control of the researchers. Such differences are vital to consider as they can impact the replicability and generalizability of the results.
Investigator Independence	This refers to whether the researchers conducting the replication study are independent from those who conducted the original study. Independent researchers can help prevent potential confirmation biases that might skew the results.
Study Transparency	This involves providing adequate transparency in the replication study, such as making experimental materials and data publicly available and adhering to appropriate reporting standards. This allows other researchers to scrutinize the methodology and results more effectively.
Analytic Result Reproducibility	This is the ability of another researcher to reproduce the primary results of the study, given the raw or transformed data.
Auxiliary Hypotheses	This involves considering all relevant auxiliary hypotheses in the replication study, such as the validity of measurement instruments and the realization of experimental conditions.

Supplementary material

Evaluation of the Pre-registered Replication of Byrne et al.,2000 experiment 1 (study 2) and Miller and Gunasegaram, 1990 (Study 1) According to LeBel et al.'s (2019) Framework

Component	**Evaluation**	**Result**
Methodological Similarity	The replication uses the same methodological criterion as the original study as it aims to test the same hypotheses and uses similar study materials and scenarios.	Very close
Replication Differences	Difference in sample size and sample.	Close
Investigator Independence	The investigators' identities are not disclosed. investigators are independent from those who conducted the original study.	Very close
Study Transparency	The pre-registration document provides detailed information about the study's hypotheses, materials, planned sample, exclusion criteria, and suggested analysis, indicating a high level of study transparency. Data available through the Open Science Framework	Very close
Analytic Result Reproducibility	The analysis plan is clearly stated, and the results should be reproducible given the raw data.	Very close
Auxiliary Hypotheses	The pre-registration document does not explicitly discuss auxiliary hypotheses or the validity of measurement instruments. It follows the same design and analysis approach as the original study.	Very close

COMMENTS FROM RESPONDENTS (STUDY 1).

Comments are all translated from Norwegian. Only relevant comments is displayed.

"Difficult to answer without a third option like 'none of them' or 'just as easy to imagine' Regards math teacher"

"Very confusing bro"

"Let me know if you guys need brain cells"

"Make it more clear, pointless task. Wasted time of my life. No one's fault, no one should've been upset, they got an offer to win, should've been grateful for the chance to win."

"Weren't the two scenarios exactly the same, just with different names? I didn't quite understand your first question after the task was explained. The question about what I can imagine. What does this mean? I just clicked on one of them."

"A little difficult to read, empathy and understanding of what one answers becomes a bit ??? To relate to."

"I didn't quite understand the question about which scenario is easiest to imagine."

"It seems to me that a third natural possibility is that both have an understanding that it is completely random, and that no one will blame anyone. Just that all the excitement lies in

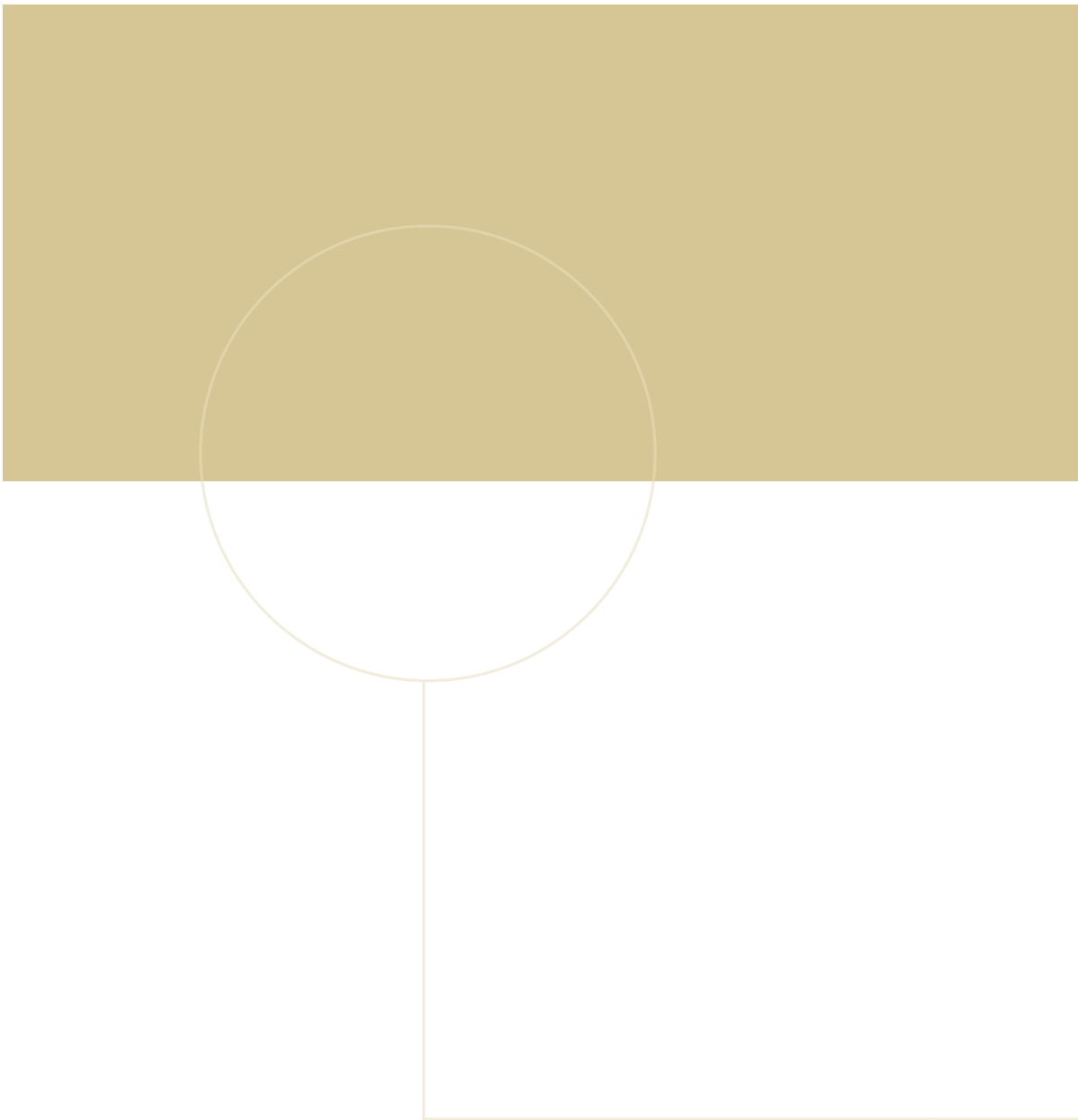
the throw number 2. I didn't want to choose either one or the other option for several of the questions. I wanted to choose 'no difference' as an option. The fact that there are only two answer options is a major source of error in this survey if many actually do not agree with any of the options, but still choose to complete the rest of the survey. To be honest, I didn't really understand the point of this survey (no offense)."

"The language is very confusing. Ruined my experience."

"Question about 'guilt': there should have been an option about shared guilt here given the same probability for each outcome? According to Bayes' theorem, there are 4 outcomes here!"

RAW DATA AND CODEBOOKS;

Both the raw data files and corroborating codebooks can be acquired by requesting supervisor. Email information is the same as given in the attached pre registrations.



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