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# Journal of Psychological Inquiry

# Journal of Psychological Inquiry
# Editorial Board

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Journal Contents

In this issue of the *Journal of Psychological Inquiry*, you will find eight articles—two more than in each of my previous issues as managing editor. I increased the number of articles from six to eight to keep pace with the growing number of submissions this year.

I must admit that I don't know why submissions have increased, but I like to believe it reflects a growing awareness among undergraduate researchers of the value of sharing their work with the world—and how *JPI* can help them achieve that goal. As far as I know, *JPI* is unique in that it is edited and reviewed by university faculty members but publishes only articles with undergraduate students as first authors.

To manage the rising volume of submissions, I recruited several new faculty members to join the editorial board. Alongside familiar names, you'll notice these new members:

- **Preston Bost** (Wabash College)
- **Donna Nelson** (Winthrop University)
- **Jennifer Peszka** (Hendrix College)
- **Mollie Price-Blackshear** (University of Central Arkansas)
- **Grace Sullivan** (Colorado Mesa University)

I extend my sincere thanks to these new members and to all who continue to support *JPI* with their service—without it, the journal would not exist.

This semester, my graduate student assistant was **Madalyn Owens**, who handled all copyediting—until she was offered a much better opportunity. She is now working with kindergarten students in a local public elementary school, helping them learn to manage their emotions. For a graduate student in school psychology, that's a much better gig than editing an undergraduate journal, I must admit. I wish her the best.

This issue's **Best Paper Award** goes to an article investigating how people process numerical size. It provides a crystal-clear explanation of Bayesian analytic techniques—something of great interest and utility as the limitations of traditional hypothesis testing become increasingly apparent.

The articles in this issue span a wide range of topics, including autobiographical recollections of trauma, gender identity issues, the enjoyment of daily commutes, and the role of psychological needs in motivation. Review articles examine how psychological concepts influence airport security and explore the relationship between impulsivity and schizophrenia. A timely special feature investigates the factors contributing to cancel culture.

Great stuff. I look forward to being surprised and gratified by the outstanding psychological research conducted by undergraduate students in future issues!

Ken Sobel
Managing Editor
University of Central Arkansas

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Elizabeth A. Dahl, Ph.D.,
Best Paper Award

# CLOSED-FORM ESTIMATES OF EX-GAUSSIAN RESPONSE TIME MODELS IN TWO-DIGIT NUMBER COMPARISON

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**Abstract** – In the context of two-digit number comparison, the unit-decade compatibility effect (UDCE) refers to a slowdown that occurs during trials that are unit-decade incompatible – that is, trials where the order relationship of the tens digits is reversed from that of the ones digits. This slowdown demonstrates an inability to ignore the irrelevant ones digits when comparing two-digit numbers. The purpose of this paper was to investigate the potential cognitive mechanisms behind the UDCE by using ex-Gaussian modeling. The ex-Gaussian model decomposes a distribution of observed response times into two components: a normal component with mean $\mu$ and an exponential component with mean $\tau$. If the effect appears in the tail component $\tau$, this implies that the UDCE involves analytic processes (e.g., thinking, decision making). If the effect appears in the normal component $\mu$, this implies that the UDCE involves nonanalytic processes (e.g., stimulus driven automatic processes). We used a method of moments technique to develop closed-form equations for estimating $\mu$ and $\tau$ directly from the summary statistics of observed response times. Then, we applied these closed-form equations to an existing dataset. Subsequent Bayesian hypothesis testing demonstrates that the UDCE occurs in the $\mu$ parameter, but not in the $\tau$ parameter. Therefore, the UDCE reflects only nonanalytic processing.

*Keywords:* ex-Gaussian, unit-decade compatibility, number comparison, Bayesian hypothesis testing

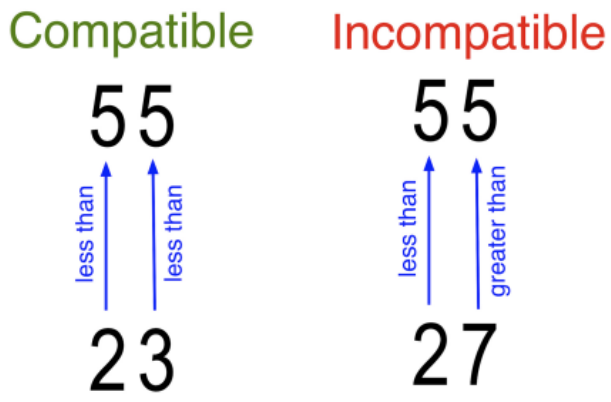
Mental representations of numbers are studied by investigating the various behavioral patterns obtained in cognitive tasks. In the case of symbolic numbers, one popular task is a numerical comparison task, where participants complete a number of trials on which they quickly judge whether each presented number is greater than (or less than) a fixed comparison standard (e.g., 5). A classic finding (Moyer & Landauer, 1967) is the numerical distance effect, where the response time increases as the numerical distance between the stimulus number and the comparison standard decreases. For example, people typically respond "larger" faster when 9 is presented than when 6 is presented; one classic explanation for this is that the internal magnitude representation is inherently imprecise and variable (i.e., "fuzzy"), and increasing the distance between to-be-compared numbers reduces their representational overlap, resulting in a faster decision (Verguts, Fias, & Stevens, 2005).

In the context of two-digit numbers, we observe similar phenomena. Indeed, Hinrichs, Yurko, and Hu (1981) found a numerical distance effect for two-digit number comparison; participants' response times decreased as the numerical distance from the to-be-compared number increased from the comparison standard 55. Dehaene, Dupoux, and Mehler (1990) observed a similar result. In both cases, the observed numerical distance effect was taken as evidence of a holistic representation of two-digit numbers, where the two separate digits (the "tens" and "ones" digits, which are called the "decade" and "unit", respectively) in the two-digit number stimulus are merged into a single representational unit. Despite this simple explanation for the observed numerical comparison behavior, increasing evidence has pointed to a decomposed representation of two-digit numbers. Primary evidence for the decomposed account comes from Nuerk, Weger, and Willmes (2001), who observed a unit-decade compatibility effect in two-digit number comparison. That is, when the decade and unit digits of one number were both smaller (or both larger) than both digits of the other number (i.e., unit-decade compatible), response times were faster than if

the digits were unit-decade incompatible with each other. For example, the comparison of 23 versus 55 would be considered unit-decade compatible, whereas the comparison of 27 versus 55 would be considered unit-decade incompatible (see Figure 1). In the former, the individual comparisons for each digit are in the same ordinal relationship to the digits in the comparison standard. That is, both the decade (2) and unit (3) are less than the corresponding digits from the standard 55. In the latter, the comparisons are reversed; in this case, the decade comparison is less than (i.e., 2 < 5), but the unit comparison is greater than (i.e., 7 > 5). The presence of the unit-decade compatibility effect indicates that people make obligatory comparisons of the decade and unit digits when comparing two-digit numbers, even though (remarkably) the decision can be made entirely by comparing the decade digits alone.

**Figure 1**

*An illustration of unit-decade compatibility (compatible versus incompatible) in two-digit number comparison.*




Since the original discovery of the unit-decade compatibility effect, a number of studies have further confirmed the presence of decomposed processing in two-digit number comparison. For example, while Nuerk et al. (2001) based their conclusion on a comparison task where pairs of two-digit numbers were presented to be compared, Moeller, Nuerk, and Willmes (2009) observed a unit-decade compatibility effect for a comparison task where fixed standards (53 and 57) were held in memory and compared to a single presented two-digit number. In such trials, the decision can be made entirely by comparing the decade digits alone, but Moeller et al. (2009) demonstrated that parallel and separate comparisons of the decade and unit digits occur still. Further probing of these decomposed processing signatures has indicated that the size and nature of the unit-decade compatibility effect can be manipulated by introducing variations in stimulus properties (Macizo & Herrera, 2011) or task instructions (Reynvoet, Notebaert, & Van den Bussche, 2011; Faulkenberry, Cruise, & Shaki, 2017, 2018).

Additionally, several researchers have investigated the unit-decade compatibility effect in the context of a general theory of numerical cognition (Verguts et al., 2005; Verguts & De Moor, 2005), which proposes that such compatibility effects occur due to competition between parallel and partially active responses. This response-competition account has been successful in explaining a variety of phenomena in numerical cognition, including the numerical distance effect (Erb, Moher, Song, & Sobel, 2018; Faulkenberry, 2016), SNARC effect (Gevers, Verguts, Reynvoet, Caessens, & Fias, 2006; Faulkenberry, 2014), decomposed process in fraction comparisons (Faulkenberry, Montgomery, & Tennes, 2015), and the size-congruity effect (Faulkenberry, Cruise, Lavro, & Shaki, 2016; Sobel, Puri, & Faulkenberry, 2016; Sobel, Puri, Faulkenberry, & Dague, 2017). One common thread between these studies is that they provide converging evidence that the time course of numerical compatibility effects tends to reflect late interaction (i.e., decision-related effects) rather than early interaction (i.e., encoding/perceptual effects).

**Response Time Modeling**

One criticism of the studies described above is that they discard a lot of information with their analytic technique. Most of these studies rely on the common technique of collapsing the distribution of response times observed in each design cell of an experiment (usually using the mean). Given that response times typically exhibit a positive skew, collapsing each cell to a single mean results in a loss of information about the shape of each participant's distribution of response times. An alternative approach is to employ a response time model to describe the observed behavior more fully.

One such model is the *ex-Gaussian* distribution, which has a long history of use in cognitive psychology, neuroscience, and other experimental behavioral sciences to model response time data in various tasks such as decision-making, memory retrieval, and attention processes (Matzke & Wagenmakers, 2009). Compared to the Gaussian (normal) distribution, the ex-Gaussian distribution provides a way to better describe the positive skew that is typically observed in response times. Mathematically, the ex-Gaussian distribution is defined as a *convolution*, where a Gaussian distribution is combined with an exponential distribution in such a way

that the shape of the exponential distribution is appended onto the Gaussian distribution as an upper tail. The Gaussian component of the model has two parameters: μ and σ. The parameter μ represents the mean of the Gaussian component and is a measure of the central tendency for the peaked component of the response time distribution. The σ parameter represents the standard deviation of the Gaussian component and measures the spread or variability of the response times around this peak. The exponential component of the model is characterized by its mean τ. This tail parameter τ indexes the skewness of the distribution. For instance, smaller values of τ indicate distributions that are more symmetric around the mean (i.e., less skewed), whereas larger values indicate distributions that are more skewed to the right. In these instances, the larger value of τ predicts a higher probability of observing longer response times in the cognitive task. Altogether, the combination of the distributions captures both the main body of response times as well as the longer response times that contribute to the right-skewed portion.

Over the years, several researchers have proposed cognitive interpretations of the ex-Gaussian parameters, particularly $\mu$ and $\tau$. For example, Balota and Spieler (1988) proposed that $\mu$ represented "more stimulus driven automatic (nonanalytic) processes", whereas $\tau$ represented "more central attention demanding (analytic) processes" (p. 34). In the context of mental arithmetic, Penner-Wilger, Leth-Steensen, and LeFevre (2002) interpreted $\mu$ as an index of memory retrieval and $\tau$ as an index of nonretrieval (i.e., use of procedures). Thus, the ex-Gaussian distribution not only uses normal and exponential distributions to *describe* the complex nature of response time data, capturing both typical (fast) responses and atypical (slow) responses, but it also may help to explain the underlying cognitive processes that contribute to the observable response times. This makes it a valuable tool for researchers modeling human behavior in various experimental contexts.

One downside to using response time models such as the ex-Gaussian model is the relative difficulty of estimating model parameters from observed data. Classically, two approaches are typically employed – (1) maximum likelihood estimation (e.g., Myung, 2003); and (2) Bayesian estimation (e.g., Farrell & Ludwig, 2008). Both approaches require significant amounts of computer programming and technical mathematical knowledge to implement. In maximum likelihood estimation, the basic workflow is to first define a likelihood function based on the underlying model, and then use computer algorithms to find the parameter value(s) that maximize the likelihood function, conditional on the observed data. In Bayesian modeling, one must derive a posterior distribution via Bayes theorem, then use computer algorithms to sample from the posterior distribution (e.g., Markov chain Monte Carlo methods). Both methods provide a significant barrier to more widespread use of the ex-Gaussian model, making the development of an easy-to-use fitting method a highly desirable goal.

**The Present Study**

The goals of the present study were two-fold. First, we describe how to derive *closed-form* equations that compute the ex-Gaussian parameters $\mu$, $\sigma$, and $\tau$ directly from the summary statistics of a response time distribution (e.g., mean, variance, and skewness). Closed-form equations are just mathematical expressions which give one answer for a given set of inputs. Their ease of use makes them advantageous over other model-fitting techniques like maximum likelihood estimation which require time-intensive computer algorithms to search a large space of parameter values for the ones which maximize a likelihood function and may or may not actually converge. The second goal was to then apply these closed-form equations to an existing data set from an experiment on two-digit number comparison. This study adds value to the field in two ways. First, we will provide a new, easy-to-use closed-form method for estimating parameters of the ex-Gaussian distribution. Second, we will apply this new computational method to a real data set in the context of numerical cognition and use the results to shed light on the cognitive processes involved in two-digit number representation.

## Developing Closed-Form Estimates of Ex-Gaussian Parameters

Before considering any response time data on two-digit number comparison, our first goal is to develop a set of closed-form equations to estimate the parameters of an ex-Gaussian model: $\mu$, $\sigma$, and $\tau$. One way to do this is to use the method of moments technique (Mishra & Datta-Gupta, 2018), which starts by representing the first three "moments" of the distribution (i.e., mean, variance, skewness) in terms of the model parameters μ, σ, and τ, and then using algebra to solve the resulting system of equations for μ, σ, and τ. For the ex-Gaussian distribution, the mean, variance, and skewness are given as follows (Soch et al., 2024):

$$\text{mean} = \mu + \tau$$
$$\text{variance} = \sigma^2 + \tau^2$$
$$\text{skewness} = \frac{2\tau^3}{(\sigma^2 + \tau^2)^{3/2}}.$$

From any sample of observed response times, estimates of the sample's mean, variance, and skewness can be computed, and these estimates can be substituted directly into this system of equations. Algebraically, this leaves a system of three equations with three unknowns: the ex-Gaussian parameters $\mu$, $\sigma$, and $\tau$. Thus, our goal is to solve this system, which will give the closed-form equations necessary for estimating the ex-Gaussian parameters directly from summary statistics.

The first step involves starting with the equation for the third moment (i.e., skewness) and recognizing that the expression for the second moment (i.e., variance) is embedded within:

$$\text{skewness} = \frac{2\tau^3}{(\text{variance})^{3/2}}.$$

Now we solve for $\tau$; to do this, we multiply both sides of the equation by the denominator $(\text{variance})^{3/2}$, resulting in the expression:

$$\text{skewness} \times (\text{variance})^{3/2} = 2\tau^3$$

Then we divide by 2 and take the cube root of each side, leaving the final equation for $\tau$:

$$\tau = \sqrt[3]{\frac{\text{skewness} \times (\text{variance})^{3/2}}{2}}.$$

Now that we have a value for $\tau$, the next step is to solve for $\mu$ using the equation for the first moment (i.e., mean):

$$\text{mean} = \mu + \tau .$$

Here, it suffices to subtract $\tau$ from both sides to isolate $\mu$:

$$\mu = \text{mean} - \tau .$$

The final step is to solve for $\sigma$ using the expression for the second moment:

$$\text{variance} = \sigma^2 + \tau^2 .$$

First, we get $\sigma^2$ on one side of the equation:

$$\sigma^2 = \text{variance} - \tau^2 .$$

We then solve for $\sigma$ by taking the square root of both sides:

$$\sigma = \sqrt{\text{variance} - \tau^2} .$$

From this preliminary work, we can now describe a step-by-step algorithm of how to use this closed-form approach to estimate ex-Gaussian parameters directly from the summary statistics of any response time distribution:

1. Starting with a sample of observed response times, calculate the sample's mean, variance, and skewness.
2. Calculate $\tau$ directly from the observed variance and skewness using the equation:

$$\tau = \sqrt[3]{\frac{\text{skewness} \times (\text{variance})^{3/2}}{2}}$$

3. Calculate $\mu$ directly from the observed mean and the value for $\tau$ obtained in Step 2, using the equation:

$$\mu = \text{mean} - \tau .$$

4. Calculate $\sigma$ directly from the observed variance and the value for $\tau$ obtained in Step 2, using the equation:

$$\sigma = \sqrt{\text{variance} - \tau^2} .$$

## Application to an Existing Dataset

Our second goal is to use these closed-form equations to apply the ex-Gaussian model to response times observed in a two-digit number comparison task. For this part, we used an existing unpublished dataset from Cipora et al. (2022), which we downloaded from https://osf.io/pm4zt. The dataset includes trial-by-trial data from 48 students from Loughborough University (43 females, mean age = 23.2 years, age range 18 to 29 years) who completed a two-digit number comparison task in a single session. The design and procedure of the experiment are fully described in the dataset's metadata, available at https://osf.io/dpjm2, but we will describe it briefly here for completeness. During the task, two-digit number pairs were presented vertically above and below a centrally presented fixation cross. The stimuli were presented in 24-point white bolded Courier New font on a black background. Stimuli remained on the screen until a response was recorded or a maximum of 3000 ms elapsed. Each trial was followed by an intertrial interval of 500 ms. Participants were assigned to groups of 6 where they worked individually on assigned laptops. Before the task began, each participant was given 12 practice trials, where they were instructed on the basic

guidelines of the task as well as instructed to press T for an upper number stimulus-response and V for lower number stimulus response. All participants used a standard QWERTY keyboard. After the practice trials, there were 4 blocks of 60 trials per participant, and participants were given the option to rest after each block. The trial order was completely randomized for each participant with compatible (e.g., 23 versus 55) and incompatible trials (e.g., 27 versus 55) mixed randomly throughout each block.

Across all participants, the dataset contained a total of 12,720 trials. After removing 17 trials lasting less than 200 ms and an additional 76 trials exceeding 3000 ms, a total of 12,627 trials remained for analysis, retaining 99.3% of the original trials. We applied the closed-form ex-Gaussian equations to the Cipora et al. (2022) data using the following workflow. First, retained responses were separated into 106 design cells, formed by crossing the 48 participants with the 2 trial types (compatible, incompatible). In each design cell, we computed the mean, variance, and skewness of the observed response times. Then we applied the closed-form equations to compute values for the ex-Gaussian parameters $\mu$, $\sigma$, and $\tau$.

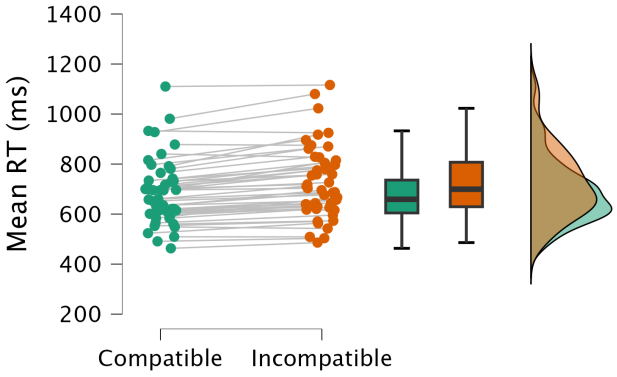
To test for compatibility effects in the parameter estimates, we conducted both traditional frequentist and Bayesian paired-samples *t*-tests using the open-source software package JASP (JASP Team, 2024). A key output of the Bayesian paired-samples *t*-test is the Bayes factor (BF), which expresses the relative likelihood of the observed data under both the null and alternative hypotheses. This method offers several benefits over traditional inference based on *p*-values, including providing clear measures of evidence, interpretability, and a balanced analysis which assesses the fit of data to *both* hypotheses (Wagenmakers, 2007; Faulkenberry, Ly, & Wagenmakers, 2020). Unlike a *p*-value, which only indicates how likely the observed data would be if the null hypothesis were true, a Bayes factor provides a relative likelihood of the data under both hypotheses. For instance, a Bayes factor of $BF_{10} = 100$ would suggest that the observed data is 100 times more likely under the alternative hypothesis, while a $BF_{01} = 100$ would imply that the data is 100 times more likely under the null hypothesis. All *t*-tests were carried out on the difference scores obtained by subtracting each individual's relevant parameter value (e.g., mean RT, $\mu$, $\tau$) for compatible trials from the parameter value for incompatible trials. Given our prior expectation of observing a unit-decade compatibility effect, we performed directional tests predicting *positive* difference scores under the alternative hypothesis. For the Bayesian tests, we further specified our *a priori* uncertainty in these (standardized) difference scores as a positively-truncated Cauchy distribution with scale $r = 0.707$. That is, our tests were directional, predicting an increase in our dependent measures[1]. We additionally performed sensitivity analyses to assess the impact of specifying different scales on the Cauchy prior.

## Response Time Analysis

We conducted two different analyses on the design cells: one using the classical method of collapsing the distribution to a single mean, and another based on our new closed-form ex-Gaussian estimates. First, we collapsed each design cell's distribution of response times into a single mean response time. The paired-samples *t*-test revealed the expected unit-decade compatibility effect on mean response times, $t(47) = 8.38$, $p < 0.001$, Cohen's $d = 1.21$. The raincloud plot in Figure 2 shows that response times were longer for incompatible trials ($M = 726$ ms) than for compatible trials ($M = 686$ ms). A Bayesian paired-samples *t*-test on the mean response times resulted in a Bayes factor of $BF_{10} = 2.83 \times 10^8$, indicating that the observed data was 283 million times more likely under the alternative hypothesis than under the null hypothesis. As we can see in Figure 3, the posterior distribution for the population-level effect size $\delta$ had a median value of 1.17, with a 95% credible interval

**Figure 2**

*Raincloud plot demonstrating the difference in reaction times between compatible and incompatible trials.*




[1]In JASP, Bayes factors for a directional test with predicted increase are given the notation $BF_{+0}$ instead of $BF_{10}$. However, in the text, we retain the traditional notation $BF_{10}$.

**Figure 3**

*Prior and posterior plot for the population-level standardized effect size δ, which indexes the difference in mean response times between incompatible and compatible trials.*

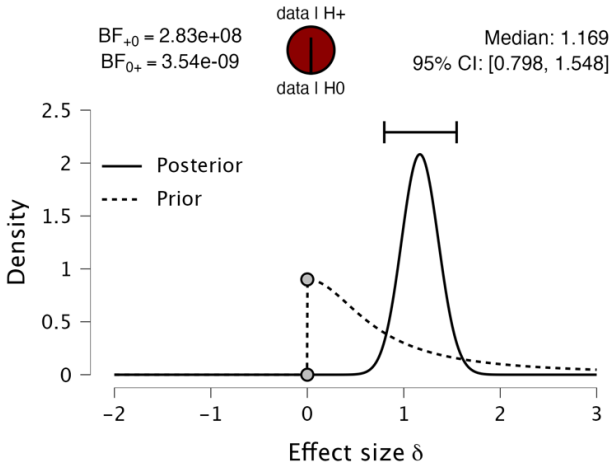
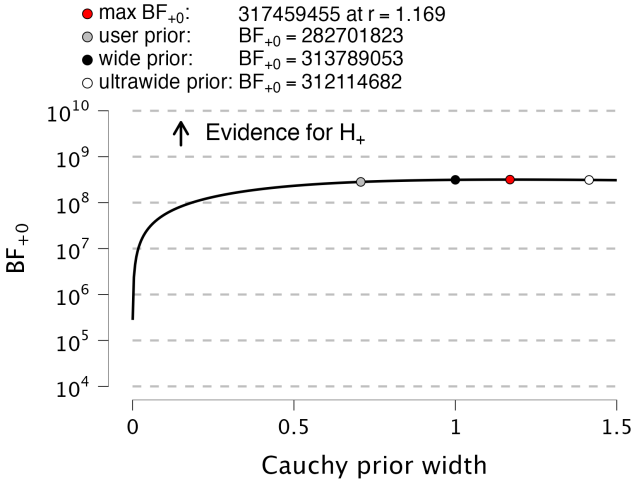



**Figure 4**

*Sensitivity plot for mean response times, displaying the range of Bayes factors obtained when varying the scale (width) of the Cauchy prior for the Bayesian t-test.*

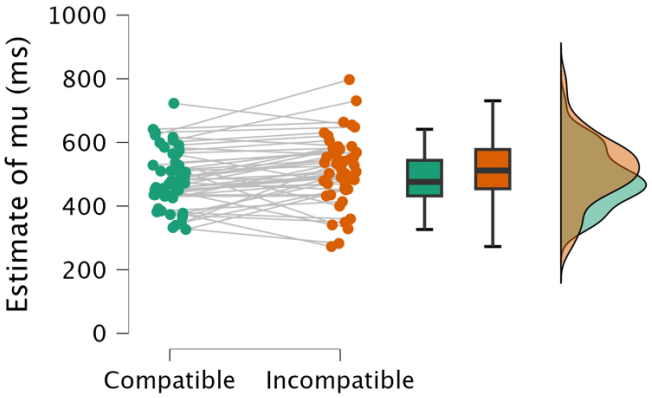



of [0.80, 1.55]. Finally, our sensitivity analysis (see Figure 4) confirmed that the extremely large Bayes factors we observed did not depend on our choice of prior scale. In all, we have extreme evidence for a unit-decade compatibility effect on the mean response times.

Having observed the expected compatibility effect, we then went further by testing for compatibility effects individually in the ex-Gaussian parameters. For each design cell, we used our new closed-form equations to derive the ex-Gaussian parameters $\mu$, $\sigma$, $\tau$ from the distribution of response times. We then performed both traditional and Bayesian paired sample *t*-tests on the collection of means for the $\mu$ and $\tau$ estimates[2]. The normal component means $\mu$ were the first to be considered. Similar to the analysis of mean response times conducted above, there was an effect of compatibility on the estimates for the ex-Gaussian parameter $\mu$, $t(47) = 2.53$, $p = 0.007$. As can be seen in Figure 5, individual estimates for the ex-Gaussian parameter $\mu$ were larger for incompatible trials ($M$ = 513 ms) than for compatible trials ($M$ = 485 ms). A Bayesian paired-samples *t*-test on the mean response times resulted in a Bayes factor of $BF_{10} = 5.38$, indicating that the observed data was approximately 5.4 times more likely under the alternative hypothesis than under the null hypothesis. This is considered moderate evidence for a unit-decade compatibility effect on the ex-Gaussian parameter $\mu$. As we can see in Figure 6, the posterior distribution for the population-level effect size $\delta$ had a median value of 0.34, with a 95% credible interval of [0.08, 0.63]. Finally, our sensitivity analysis (see Figure 7) confirmed that the observed level of evidence was consistent across the range of possible values of the Cauchy prior scale. In all, we have moderate evidence for a unit-decade compatibility effect on ex-Gaussian parameter $\mu$, which implies that the effect may involve nonanalytic processes.

**Figure 5**

*Raincloud plot demonstrating the difference in values of the ex-Gaussian parameter μ between compatible and incompatible trials.*




[2] As the mean response time is composed only of the ex-Gaussian parameters $\mu$ and $\tau$, we focused our analyses solely on these two parameters.

**Figure 6**

*Prior and posterior plot for the population-level standardized effect size δ, which indexes the difference in estimates of the ex-Gaussian parameter μ between incompatible and compatible trials.*

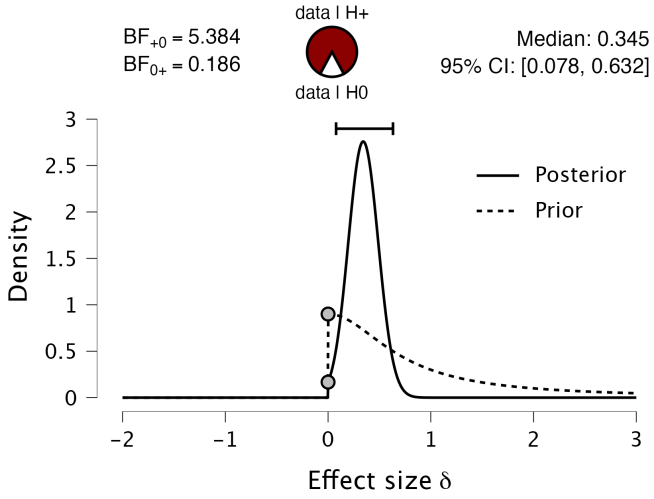
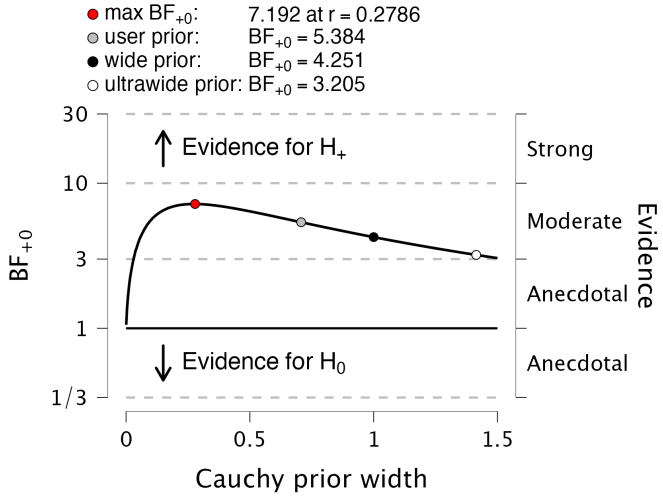



**Figure 7**

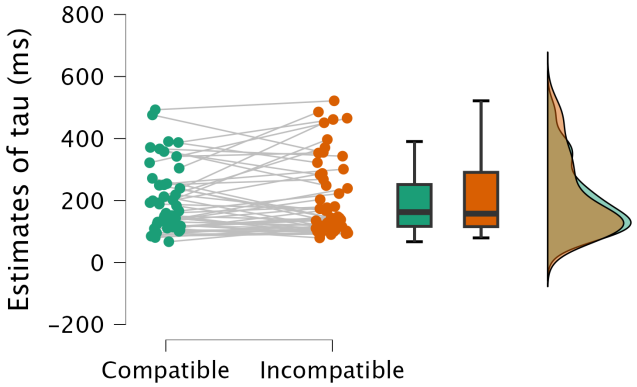
*Sensitivity plot for the ex-Gaussian parameter μ, displaying the range of Bayes factors obtained when varying the scale (width) of the Cauchy prior for the Bayesian t-test.*




Finally, we performed the same analysis for the tail component means $\tau$. A paired-samples *t*-test did not demonstrate a significant difference between congruent trials and incongruent trials, $t(47) = 0.99$, $p = 0.163$. Accordingly, the mean value of the tail component means $\tau$ for compatible trials was $M = 201$ ms, whereas the mean value of the tail component means $\tau$ for incompatible trials was $M = 213$ ms (see Figure 8).

**Figure 8**

*Raincloud plot demonstrating the difference in values of the ex-Gaussian parameter τ between compatible and incompatible trials.*




Critically, a Bayesian paired samples *t*-test revealed a Bayes factor of $BF_{01} = 4.01$, indicating that the observed data were approximately 4 times more likely *under the null hypothesis* than under the alternative hypothesis. As we can see in Figure 9, the probability that the population-level effect size $\delta = 0$ increases by a factor of 4 after observing data. Further, our sensitivity analysis (see Figure 10) confirmed that the observed level of evidence for the null was moderate across a reasonable range of possible values of the Cauchy prior scale. In all, these data provide positive evidence in favor of a null effect, suggesting that there is no compatibility effect in the tail component means $\tau$. Overall, the ex-Gaussian analysis demonstrated that the compatibility effect we observed in mean response times occurs primarily in the μ parameter, not the $\tau$ parameter. This implies that the unit-decade compatibility effect appears to be primarily driven by nonanalytic processes, but no such contribution of analytic processes.

## Discussion

The first aim of this paper was to develop closed-form equations for estimating parameters in ex-Gaussian response time models. We were able to successfully use the "method of moments" technique to mathematically derive these equations, which resulted in a simple 4-step process to compute estimates for the ex-Gaussian parameters $\mu$, $\sigma$, and $\tau$ directly from summary statistics of the distribution of a response time distribution: mean, variance, and skewness. Importantly, these equations are closed-form, meaning they require only basic operations of arithmetic to compute.

The second aim of this paper was to apply these new closed-form equations to an existing dataset. We chose to focus our application on an example in

**Figure 9**

*Prior and posterior plot for the population-level standardized effect size δ, which indexes the difference in estimates of the ex-Gaussian parameter τ between incompatible and compatible trials.*

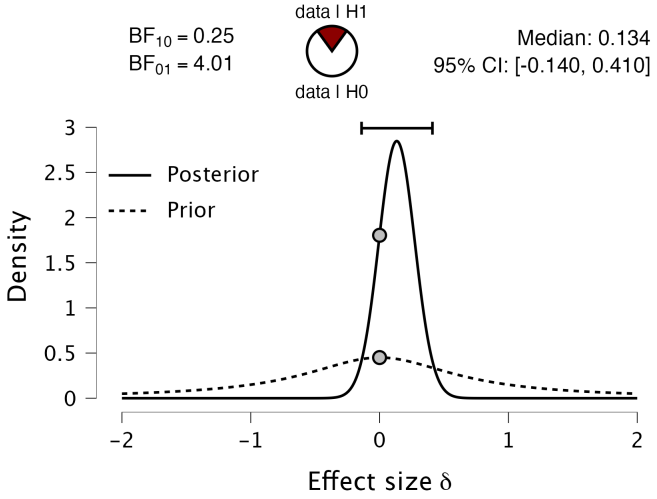
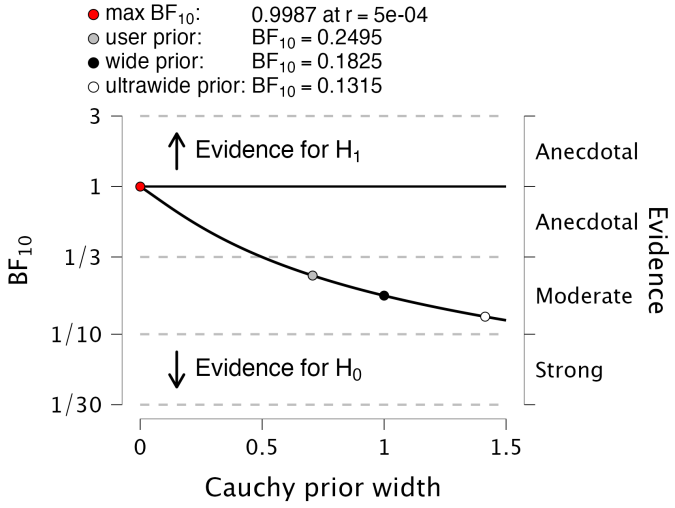



**Figure 10**

*Sensitivity plot for the ex-Gaussian parameter τ, displaying the range of Bayes factors obtained when varying the scale (width) of the Cauchy prior for the Bayesian t-test.*




numerical cognition involving two-digit number representation. In the two-digit number comparison task, participants were instructed to correctly identify the larger number as quickly as possible. There were two trial types imposed: compatible trials, where both the decades and units digit were greater than the comparison standard, and incompatible, where one digit was greater and the other was less than the comparison standard. The known consequence of introducing incompatible trials is a slowdown in the reaction time of individuals, a phenomenon known as the unit-decade compatibility effect. Our analysis not only replicated this well-known effect, but also allowed us to further probe where and how the effect takes place.

In our analysis, we used our closed-form ex-Gaussian equations to decompose the observed response times into components which represent analytic and nonanalytic processes. This approach makes sense in this context, as a typical observation is a positive skew in response time distribution. The ex-Gaussian model decomposes a given distribution into two components: a Gaussian component with mean μ and an exponential tail component with mean $\tau$. The normal mean $\mu$ has been previously discussed in the literature as a parameter representing nonanalytic processes, whereas the exponential component mean $\tau$ has been discussed as a parameter representing analytic processes. Analytic processes can be characterized as mental tasks that require central attention, often observed as attentional lapses, intentional cognitive processes, recall latency, and higher cognitive functioning. Nonanalytic processes, on the other hand, are more instinctual in nature, with an automatic and stimulus-driven process that manifests unconsciously. Both cognitive channels contribute to the overall decision-making process in an individual when a stimulus is presented.

Using the ex-Gaussian model to decompose the observed response times into corresponding analytic and nonanalytic processes adds to the small but emerging literature in numerical cognition that also uses this approach. For example, both Penner-Wilger, Leth-Steensen, & LeFevre (2002) and Campbell & Penner-Wilger (2006) used an ex-Gaussian decomposition method to probe the processes involved in simple mental arithmetic tasks. In these studies, Penner-Wilger and colleagues found that retrieval-driven trials exhibited a problem size effect that was prevalent in the $\mu$ parameter, but trials that involved procedures shifted this effect to $\tau$. They concluded that $\mu$ may reflect memory processes, whereas $\tau$ reflects the use of procedures.

In the present study, the unit-decade compatibility effect was evident only in the $\mu$ parameter of the ex-Gaussian model. The considerable evidence for this observed increase in the $\mu$ estimates between compatible and incompatible trials was quantified by a Bayesian hypothesis test. However, there was no increase found in the tail component means $\tau$ between the two trial types. Subsequent Bayesian analysis confirmed this null effect, finding the data three times more likely under a null model where the unit-decade compatibility effect is

not observed in the tail component means. These findings illustrate that the origin of the unit-decade compatibility effect is located in nonanalytic processes, meaning that the reaction time slowdown is due to instinctual stimulus-driven processes in incompatible trials. Using the work of Penner-Wilger and colleagues as a backdrop for the present results, the unit-decade compatibility effect may better reflect nonanalytic memory retrieval processes rather than analytic processes such as procedural calculation. The individual increases in the $\mu$ parameter likely reflect a disruption in memory retrieval of numerical order relations, possibly due to dynamic competition between parallel and partially active memory representations (Faulkenberry, 2014; 2016). The nature of individual differences in ex-Gaussian parameters is an open question, and recent work in hierarchical Bayesian models of individual differences could prove to be an exciting area of further research (e.g., Haaf & Rouder, 2017; Faulkenberry & Bowman, 2023; Faulkenberry, 2024).

In summary, we developed closed-form equations for estimating ex-Gaussian parameters, which we found to be useful for making inference on the mental processes involved in two-digit number comparisons. Results of these closed-form equations demonstrated the effect is localized in the mean of the normal component of the response time distribution. Therefore, the unit-decade compatibility effect appears to be due entirely to nonanalytic processes, potentially related to memory retrieval rather than procedural calculation.

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Author Note

The research reported in this paper comprised a portion of the first author's Senior Honors thesis. All materials used for the analyses contained within the paper, including an R script for pre-processing raw data, a CSV file containing parameter estimates, and a JASP file containing all hypothesis tests, can be downloaded from https://osf.io/dvs26/

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# PERSONALITY DIFFERENCES IN EFFECTIVENESS OF EMOTION REGULATION FOLLOWING AUTOBIOGRAPHICAL RECOLLECTION OF TRAUMA

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**Abstract** – In this study, we tested the relationship between personality traits and effectiveness of emotion regulation following recall of a traumatic memory. We focused on the emotion regulation strategy known as cognitive reappraisal, a process of reinterpreting distressing events to reduce their negative emotional effects. Participants wrote about a past traumatic event and were then randomly assigned to one of two conditions. In the experimental condition, they were instructed to execute cognitive reappraisal to downregulate negative emotions tied to the memory. In the control condition, they simply recalled their past emotions associated with the memory. Supporting our hypotheses, persons high in conscientiousness and high in openness to experience reported less negative affect following the recall and reappraisal tasks. Overall, persons high in neuroticism reported more negative affect, irrespective of experimental condition. Our findings suggest that although reappraisal can be an effective approach for many individuals, it may be less advantageous for persons with particular personality profiles. Future research should investigate the value of alternate emotion regulation approaches to meet the needs of persons with different personalities.

*Keywords:* emotion regulation, personality, trauma

Emotion regulation is a goal-directed process whereby people manage their emotional states (Gross, 1998). This is essential for social competence and psychological well-being, particularly following adversity (Hughes et. al 2020; Baranczuk, 2019). Emotion regulation occurs both consciously and unconsciously, and emotion regulation strategies can be healthy or unhealthy. For example, evidence suggests a strategy such as suppression (i.e., intentionally ignoring emotions) to be effective in regulating negative affect but can be harmful to memory (Kobylińska et. al, 2020). Effective and healthy emotion regulation is imperative to retain the beneficial qualities of emotion while limiting the destructive qualities (John & Gross, 2004). One emotion regulation strategy that has received a great deal of research attention and is associated with adaptive coping is cognitive reappraisal (John & Gross, 2004). This involves reinterpreting an emotionally charged event to alter its impact (Gross & John, 2003). Empirical evidence has suggested that reappraisal is an effective strategy to downregulate negative emotions such as stress, disgust, sadness, and fear (John & Gross, 2004) and has been linked to greater experience of positive emotion and diminished experience of negative emotion (Gross & John, 2003) as well as enhanced long-term wellness (Troy et. al, 2018).

Reappraisal has been described as an effortful process that requires skill as well as motivation, conviction and a belief that emotions can be altered (Gutentag et al, 2016). Detailed investigations of the reappraisal process indicate that it requires cognitive processes including memory, restructuring, and task switching (Troy et. al, 2018; Vaughn-Johnston et. al, 2020). Past research suggests that individuals differ in their trait-like tendency to utilize cognitive reappraisal (Gross & John 2003). The Emotion Regulation Questionnaire (Gross & John, 2003) was developed to measure these individual differences. Research has shown that greater tendency to utilize cognitive appraisal is associated with more resilience in response to life stress (Garnefski et al., 2001), reduced psychological distress (Aldao et al., 2010; De France, 2022) and greater overall psychological well-being (Riepenhausen et al., 2022).

There is also evidence that tendencies to use specific emotion regulation strategies are linked to stable individual differences in personality. These personality differences have been investigated through the lens of the Big Five Factor theory of personality (Costa & McCrae, 1992; McCrae & Costa, 2008). This paradigm is widely used in personality research, clinical practice, and related fields (John & Srivastava, 1999). This model suggests that individual differences in personality can be categorized into five main dimensions that include openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (McCrae & Costa, 2008). In-depth exploration of the dimension of agreeableness indicates that agreeableness taps a person's level of cooperation, empathy, and concern for others (Costa et al., 1991). Whereas the dimension of conscientiousness reflects a person's degree of achievement-striving, self-discipline, responsibility, and deliberation (Costa et al., 1991). The openness dimension has been characterized as an individual's willingness to experience new ideas, feelings, and behaviors (McCrae & Costa, 1997). Extraversion has been found to reflect an individual's level of social interaction, assertiveness, and positive emotionality (Watson & Clark, 1997). Finally, neuroticism reflects a person's emotional instability, and tendency to experience negative emotions (Costa & McCrae, 1980) as well as vulnerability to stress due to ineffective coping (McCrae & Costa, 1986).

A recent meta-analytic review (Barańczuk, 2019) found associations between each of the big five factors and tendencies to utilize emotion regulation strategies. Specifically, the meta-analysis revealed associations between a tendency to utilize maladaptive emotion regulation strategies such as suppression or avoidance with higher levels of neuroticism and lower levels of extraversion, openness to experience, agreeableness, and conscientiousness. Conversely, a tendency to utilize adaptive emotion regulation strategies such as reappraisal or problem solving was associated with lower levels of neuroticism and higher levels of openness to experience, conscientiousness, agreeableness, and extraversion.

To expand on the aforementioned findings concerning differences in *tendency* to utilize emotion regulation strategies, we sought to investigate the extent to which personality differences might be tied to differential *ability* to effectively leverage emotion regulation. To investigate this question, we focused specifically on differences in effective use of cognitive reappraisal. Our study's aim was to investigate the impact of personality on the effectiveness of attempts to use reappraisal to manage negative emotions associated with autobiographical recollections of trauma. We expected that three of the big five factor dimensions would be particularly relevant to individual differences in the ability to execute this emotion regulation strategy to downregulate negative emotions. Because reappraisal is an effortful process that requires deliberate cognitive effort (Gutentag et al, 2016), we expected it to be impacted by the trait of conscientiousness, which involves a willingness to exert effort (Bidjerano & Dai, 2007) and a tendency toward deliberate thinking (Costa et al., 1991). We therefore hypothesized that those high in conscientiousness would be more successful in lowering negative affect through cognitive reappraisal. Furthermore, because reappraisal involves cognitive restructuring (Vaughn-Johnston et. al, 2020), we expected it to be facilitated by an ability to see multiple perspectives. This flexibility in thinking is characteristic of the trait of openness to experience (Chamorro-Premuzic et al., 2007). We therefore hypothesized that those high in openness would be more successful in reducing negative affect through cognitive reappraisal. Finally, reappraisal is influenced by perceptions that emotions are controllable (Gutentag et al., 2016). Persons high in the trait of neuroticism tend to lack efficacy in managing negative emotions (Cheng, 2001). We therefore expected that those low in the trait of neuroticism would be more likely to invest effort in reappraisal due to greater optimism about managing negative affect. Consequently, we hypothesized that persons low, versus high, in neuroticism would be more successful in lowering negative affect through use of reappraisal.

## Method

### Participants

The participants were 105 adults with a mean age of 21 years (*SD*=5.4) who were recruited from college classrooms and completed the study. The majority identified as female (67%), while 21% identified as male, 1 % identified as transgender male, 1% identified as transgender female and 2% identified as “other”. The majority of participants were white (64%), while 29% were Black, 4% were Hispanic/Latino, 2% were Asian and 1% were Middle Eastern. Furthermore, 67% percent identified as heterosexual, 20% as bisexual, 7% as homosexual and 6% identified as “other”

### Procedure and Materials

#### *Trauma Recollection and Ratings*

Participants were tested in a group setting. After reading the informed consent form and agreeing to take part, they were asked to recall and briefly write about an adverse/traumatic event. They then completed two items based on the procedure followed by Troy et al., (2018).

First, they rated the extent to which the event they recalled was stressful. These ratings were made on a Likert scale ranging from 1 (not at all) to 10 (to an extreme degree). Next, they rated the extent to which the recalled event has a current negative impact in their lives. These ratings were made on a Likert scale ranging from 1 (not at all) to 10 (to an extreme degree).

### *Manipulation of Emotion Regulation*

Next, participants were randomly assigned to one set of instructions for the emotion regulation task, based on Troy et al., (2018). For the reappraisal condition, participants were asked to try to think about the previously recalled event in a more favorable light and briefly describe any positive effects of the event, such as what they may have learned or how the event had a positive influence on their life. They were asked to write those positive thoughts in the space provided on the paper. For the control condition, participants were asked to think about and briefly describe the feelings evoked by the recalled event in the space provided.

### *Affect Ratings*

After completing the brief writing task, participants were asked to complete a series of emotion ratings, based on Troy et al., (2018). Specifically, they rated the extent to which they were feeling 7 different negative emotions, ranging from "hopelessness" to "anger". Ratings were made on a Likert response scale ranging from 1 (strongly disagree) to 5 (strongly agree). A composite negative affect score was obtained by summing and averaging responses to the 7 emotion ratings. Cronbach's α for this measure was .87, suggesting acceptable internal reliability.

### *Personality Assessment*

To measure the traits of conscientiousness, openness and neuroticism, participants were asked to respond to the corresponding subscales of The Big Five Inventory (John & Srivastava, 1999). All responses were made using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Participants responded to the conscientiousness subscale by rating their agreement with 9 items such as "does a thorough job" and "is a reliable worker". We obtained a Cronbach's α score of .81 for this subscale, indicating acceptable internal reliability. Participants responded to the openness subscale by rating their agreement with 10 items such as "is original, comes up with new ideas" and "has an active imagination". We obtained a Cronbach's α score of .76 for this subscale, suggesting acceptable internal reliability. Participants responded to the neuroticism subscale by indicating their agreement with 8 items such as "can be tense" or "can be moody". Cronbach's α for this measure was .83, suggesting acceptable internal reliability.

### *Demographics*

Finally, participants were asked to respond to commonly used demographic items (e.g., age, gender, race).

## Results

Participants' mean rating of stress caused by their recalled event was 8.5 (*SD* = 1.5). Their average rating of current impact for the recalled event was 6.67 (*SD* = 2.5). The mean negative affect score was 3.06 (*SD* =.9). The mean for the conscientiousness subscale of The Big Five Inventory (John & Srivastava, 1999) was 3.33 (*SD* = .6). Participants scoring above the average were categorized as high in conscientiousness and those scoring below the average were categorized as low in conscientiousness. The mean for the openness to experience subscale of The Big Five Inventory (John & Srivastava, 1999) was 3.61 (*SD* = .5). Participants scoring above the average were categorized as high in openness and those scoring below the average were categorized as low in openness. The mean for the neuroticism subscale of The Big Five Inventory (John & Srivastava, 1999) was 3.43 (*SD* =.7). Participants scoring above the average were categorized as high in neuroticism and those scoring below the average were categorized as low in neuroticism.

No statistically significant differences were found across our variables of interest as a function of demographics and thus, they will not be discussed in the results section.

### Negative Affect as a Function of Emotion Regulation and Personality

A 2x2 between groups ANOVA yielded a nonsignificant main effect for Conscientiousness on negative affect $F(1, 101) = 2.48$, $p = .12$ and a nonsignificant main effect for Emotion Regulation condition on negative affect, $F(1, 101) = 3.42$, $p = .07$. The analysis also yielded the predicted significant interaction between Conscientiousness and Emotion Regulation condition on negative affect, $F(1, 101) = 4.374$, $p = .04$. Post-hoc LSD pairwise comparisons revealed that those high in Conscientiousness had lower negative affect in the Reappraisal condition versus the Control condition ($p = .01$). However, no significant differences were found across conditions for those low in Conscientiousness ($p = .87$). See Table 1 for means and standard deviations.

**Table 1**

*Means and Standard Deviations for Negative Affect Across Emotion Regulation Conditions and Conscientiousness Conditions.*

| | Control | Reappraisal |
|---|---|---|
| Low Conscientiousness | 3.17 (.76) [a] | 3.20 (.91) [a] |
| High Conscientiousness | 3.21 (.70) [a] | 2.90 (1.0) [b] |

*Note*. Means with different superscripts are statistically different, $p < .01$.

In addition, a 2x2 between groups ANOVA yielded a significant main effect for Openness to Experience on negative affect $F(1, 101) = 8.26$, $p = .01$ and a nonsignificant main effect for Emotion Regulation condition on negative affect, $F(1, 101) = 2.81$, $p = .10$. The analysis also yielded the predicted significant interaction between Openness to Experience and Emotion Regulation condition on negative affect, $F(1, 101) = 6.07$, $p = .02$. Post- hoc LSD pairwise comparisons revealed that those high in Openness had lower negative affect in the Reappraisal condition versus the Control condition ($p = .01$). However, no significant differences were found across conditions for those low in Openness ($p = .57$). See Table 2 for means and standard deviations.

**Table 2**

*Means and Standard Deviations for Negative Affect Across Emotion Regulation Conditions and Openness Conditions.*

| | Control | Reappraisal |
|---|---|---|
| Low Openness | 3.24 (.56)[a] | 3.37 (.88)[a] |
| High Openness | 3.17 (.86)[a] | 2.51 (.94)[b] |

*Note.* Means with different superscripts are statistically different, $p < .01$.

Finally, a 2x2 between groups ANOVA yielded a significant main effect for Neuroticism on negative affect $F(1, 101) = 12.81$, $p = .001$ and a significant main effect for Emotion Regulation condition on negative affect, $F(1, 101) = 3.82$, $p = .05$. The analysis also revealed that the interaction between Neuroticism and Emotion Regulation condition on negative affect did not reach statistical significance, $F(1, 101) = 3.45$, $p = .07$. See Table 3 for means and standard deviations.

**Table 3**

*Means and Standard Deviations for Negative Affect Across Emotion Regulation Conditions and Neuroticism Conditions.*

| | Control | Reappraisal |
|---|---|---|
| Low Openness | 3.10 (.67) | 2.49 (.76) |
| High Openness | 3.37 (.72) | 3.35 (1.06) |

## Discussion

The aim of our study was to test the relationship between personality traits and the ability to effectively leverage cognitive reappraisal to downregulate negative affect following recall of a traumatic memory. Our findings suggest that although reappraisal can be an effective approach for many individuals, it may be less advantageous for persons low in conscientiousness and those low in openness.

Supporting our first hypothesis, participants high (versus low) in conscientiousness who were instructed to leverage cognitive reappraisal after writing about prior trauma reported less negative affect. This suggests they were better able to effectively leverage reappraisal to regulate unpleasant emotions that may have been activated during the recall task. This finding may be explained by the fact that conscientiousness is a trait associated with self-control and goal-directed behavior (DeYoung, 2015; John & Srivastava, 1999). These tendencies are likely to facilitate the process of cognitive reappraisal, which requires self-regulation and investment in effortful thinking (Gross, 2015).

Supporting our second hypothesis, participants high (versus low) in openness to experience reported less negative affect following the recall and reappraisal tasks. This suggests that similar to those high in conscientiousness, they were better able to effectively execute reappraisal to regulate negative emotions tied to their recall of trauma. Openness to experience is a trait associated with curiosity, creativity, and flexible thinking (DeYoung, 2015; John & Srivastava, 1999). Cognitive reappraisal is likely facilitated by these tendencies, as it requires the generation of novel and flexible interpretations of situations (Gross, 2015).

With respect to our final hypothesis, although participants low (versus high) in neuroticism reported less negative affect following the recall and reappraisal tasks, this difference did not reach statistical significance. However, we found a significant main effect for neuroticism on negative affect. Irrespective of whether they were in the reappraisal condition or the control condition, those high in neuroticism reported more negative affect. This suggests that the overall influence of neuroticism on the experience of negative emotions was rather powerful. These results are consistent with prior research that suggests individuals high in neuroticism tend to lack confidence in their ability to manage negative emotions (Cheng, 2001).

### Theoretical Implications

Overall, our study adds to the existing literature by highlighting the importance of considering personality traits as a key factor in predicting the *ability* to effectively employ specific emotion regulation strategies. This expands on previous research showing that personality traits are associated with differential *tendencies* to utilize emotion regulation strategies (Barańczuk, 2019). In particular, we found evidence that cognitive reappraisal, which involves generating alternative interpretations of situations, requires cognitive flexibility and investment of effort, may not be equally advantageous for everyone. Specifically, our results suggest that individuals low in

conscientiousness and low in openness to experience may experience less benefit from cognitive reappraisal as a tool for regulating emotion. This implies that individuals with these personality traits may need to rely on alternative strategies to effectively regulate their emotions. By considering these individual differences, we enhance our understanding of emotion regulation processes.

### Practical Implications

Our findings have practical implications as well. Individuals who have difficulty regulating negative affect after adverse life experiences are more vulnerable to onset of mental health conditions such as depression (Hammen, 2005). There is evidence that a large percentage of adults report a history of past traumatic events (Benjet et. al., 2016). For those who struggle with negative emotions tied to their past adverse events, discovery of effective coping strategies is important. Understanding the factors influencing the effectiveness of emotion regulation strategies can help identify efficacious interventions suited to the needs of individuals. Future research should investigate the value of alternate emotion regulation approaches (e.g., acceptance, suppression) for persons with different personality profiles.

### Limitations

This study was subject to limitations. The first of these is an absence of diversity in the sample, as the majority of participants were college-aged, white females. This outcome reflects the campus population where the study was conducted and limits the generalizability of findings. Future researchers should actively broaden the scope of gender, age, and race when testing similar research questions. Another potential limitation of our study is the method we used (similar to a median split) to categorize participants as high or low in conscientiousness, openness and neuroticism. We may have obtained more robust effects if we had a large enough sample to utilize upper and lower quadrants to categorize our participants into the different personality groupings. Another limitation of our findings is that we focused on one emotion regulation strategy (cognitive reappraisal). Future researchers should explore whether the differences in effectiveness of cognitive reappraisal found in our study as a function of personality would generalize to different emotion regulation strategies.

### Final Conclusions

In summary, we supported our hypotheses that people high in conscientiousness and high in openness to experience were more successful in utilizing cognitive reappraisal to downregulate negative affect following recall of a traumatic memory. This suggests that although reappraisal can be an effective approach for many individuals, it may be less advantageous for persons with particular personality profiles. By considering the versatility of personality, the most efficacious interventions for coping with negative emotions associated with trauma can be identified.

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# IMPACT OF SEXUAL ORIENTATION AND GENDER IDENTITY ON UNWANTED SEXUAL EXPERIENCES AND DISCLOSURE DECISIONS

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**Abstract** – This project aims to further understand the barriers and experiences of female LGBTQIA+ survivors of sexual assault in disclosing their experience. Studies have shown that queer women experience sexual assault at higher rates, face more victim blaming, and report more negative mental health outcomes following an assault than straight women (Canan et al., 2021; Ford & Soto-Marquez, 2016; Long et al., 2007; Martin et al., 2011). To gain a deeper understanding of these trends, three focus groups of three participants were conducted. Groups were separated by sexual assault history and disclosure: two groups of LGBTQIA+ survivors and one group of LGBTQIA+ individuals who have not experienced sexual assault. This study will provide insight on the experiences of this at-risk group. The information gained from this study will allow the creation of better interventions and resources for LGBTQIA+ survivors of sexual assault.

*Keywords:* sexual assault, sexual orientation, gender identity, disclosure

In the United States, 11-17% of women and 2-3% of men report experiencing sexual assault (Basile et al., 2007; Tjaden & Thoennes, 2000).(Basile et al., 2007; Tjaden & Thoennes, 2000). Experiences with sexual assault lead to a variety of negative mental health outcomes including depression, anxiety, substance use, and suicidality (Carey et al., 2018; Chang et al., 2015; Coulter et al., 2017; Sabina & Ho, 2014). Resources to help survivors work through their experience and manage mental health struggles exist; however, to access these resources a survivor must seek help and disclose their experience. In some cases, disclosure can lead to additional victimization through negative experiences with law enforcement or support services (Campbell, 2008),(Campbell, 2008), but generally formal and informal disclosure of a sexual assault experience are helpful in the coping process (Ullman & Peter-Hagene, 2014).(Ullman & Peter-Hagene, 2014). Lack of formal disclosure may hinder survivor coping and recovery, and due to the negative mental health outcomes associated with experiencing sexual assault, it is important to understand more about why this process may not occur generally and in specific at-risk populations.

The entire experience of sexual assault, ranging from prevalence to reactions to help-seeking, is affected by one's identity. In particular, the literature suggests that gender and sexual orientation both impact survivors' experiences significantly and across all facets of the experience (Meyer, 2003).(Meyer, 2003). For starters, women are much more likely to be victims of sexual assault, and men are far more likely to be the perpetrators of sexual assault than women (Balsam et al., 2005; Johnson et al., 2016; Tjaden & Thoennes, 2000).(Balsam et al., 2005; Johnson et al., 2016; Tjaden & Thoennes, 2000). Given these relative rates in relation to sexual orientation, then, it might be expected that women who identify as bisexual or lesbian would thus experience sexual assault at lower rates than heterosexual women because these women have less exposure to men and male partners. However, this is not the case. The prevalence of sexual assault does vary by sexual orientation, but in fact bisexual women report experiencing sexual assault at higher rates than both lesbian and heterosexual women (Canan et al., 2021; Ford & Soto-Marquez, 2016; Martin et al., 2011). Overall, research indicates that 24-48% of bisexual women, 13-25% of heterosexual women, and 11-18% of lesbians report experiencing sexual assault during college (Ford & Soto-Marquez, 2016; Martin et al., 2011). More recently, studies have suggested that 63% of bisexual women, 49%

of lesbian women, and 35% of heterosexual women reported experiencing rape in their lifetime (Canan et al., 2021).(Canan et al., 2021). Alarmingly, when compared with other demographic characteristics, sexual orientation has been shown to be the most strongly correlated with sexual victimization (Canan et al., 2021).(Canan et al., 2021).

Sexual orientation also plays a role in the individual outcomes of sexual assault. Sexual assault leads to a variety of negative physical and mental health effects, and victims that hold a marginalized sexual orientation are more likely to experience these negative effects (Coulter et al., 2017; Cramer et al., 2012; Long et al., 2007). After trauma and/or violent crimes, LGBTQIA+ victims are more likely to report negative mental health outcomes (Cramer et al., 2012), and this trend includes sexual assault survivors, particularly bisexual women. Following a sexual assault experience, bisexual women had more depressive symptoms and higher levels of PTSD in comparison with heterosexual and lesbian survivors (Long et al., 2007). All of these statistics support the idea that sexual minority women need even more support when coping with a sexual assault experience.

Disclosure of sexual assault also varies by sexual orientation. Despite the particular importance of supporting queer survivors, research shows mixed findings regarding disclosure rates in heterosexual and lesbian, gay, and bisexual survivors. One common finding indicated that most sexual assault survivors who identify as a sexual minority disclosed their experience informally rather than formally (Grocott et al., 2022). Informal disclosure involves telling a family member, friend, or partner about the sexual assault, while formal disclosure refers to telling the police, medical professionals, or mental health counselors (Starzynski et al., 2005). Findings indicate that 64-94% of sexual assault survivors informally disclose to family or friends (Ahrens et al., 2009; Krebs et al., 2016), but less than 7% of survivors formally disclose (Orchowski & Gidycz, 2012). A review article reported that 9-44% of sexual and gender minority participants disclosed to an informal source, while a smaller percentage, 4-21%, disclosed to a formal source (Edwards et al., 2022). Informal disclosure is also more common than formal disclosure in heterosexual survivors (Starzynski et al., 2005). Understanding the most common type of disclosure in survivors is imperative to consider when conceptualizing resources and changes that could be made to improve the comfortability of survivors and encourage help-seeking. While some studies have indicated that lesbians were less likely to seek help than heterosexual women following a sexual assault experience (Bernhard, 2000), alternative studies have shown no significant difference in formal or informal disclosure between heterosexual and LGBTQIA+ survivors (Richardson et al., 2015). These mixed reports suggest that additional research is needed for clarity. This will allow for the improvement of resources available to sexual minority survivors.

It is further important to consider the outcomes of disclosure in sexual minority women. For example, even if disclosure does occur, bisexual women perceive less social support and are more likely to receive negative reactions when disclosing a sexual assault experience (Sigurvinsdottir & Ullman, 2016). In addition, victim blaming, or placing the responsibility of a crime on the individual affected, is more prevalent when the victim is gay or bisexual in comparison to a heterosexual victim (Davies et al., 2011; Morrison & Pedersen, 2020). This increase in blame in addition to reduced social support may further inhibit disclosure for queer women, as well as contribute to the increased negative mental health outcomes experienced.

It is clear that sexual orientation plays a role in sexual assault experience, disclosure, and support, but it is important to consider why this is the case. This may be explained by an inequity in both protective and risk factors between heterosexual and non-heterosexual individuals. Protective factors, such as a strong social support network, decrease one's risk of victimization, while risk factors increase this likelihood. LGBTQIA+ individuals have fewer protective factors and more risk factors than those who do identify as heterosexual (Blake et al., 2001; Mintz et al., 2021; Oshri et al., 2014). The inequity in protective and risk factors can be explained by Minority Stress Theory, an explanation of the heightened levels of stress experienced by those who are a part of marginalized groups due to pervasive discrimination and prejudice (Meyer, 1995). This theory suggests that people in minority groups experience more stress and are therefore more likely to struggle with their mental health and engage in unhealthy coping mechanisms such as using substances or engaging in risky sexual behavior. This ongoing stress of holding a minority identity increases the likelihood of individuals engaging in behaviors that increase the risk of sexual assault due to constant heightened stress as a result of discrimination (Blake et al., 2001; Oshri et al., 2014).

Minority stress for LGBTQIA+ individuals in particular may manifest as internalized homophobia. This concept can explain the increase in stress experienced by sexual minorities in particular, as well as the heightened risk of sexual assault faced by sexual minority women. Internalized homophobia can be

described as stigmatized self-perception LGBTQIA+ individuals have of themselves due to negative societal and cultural messages received about their identity (Meyer, 2003). These negative messages cause additional stress and may lead to additional risk behaviors in LGBTQIA+ individuals. In fact, similarly to minority stress, increased rates of internalized homophobia are related to a higher risk of having an unwanted sexual experience (Murchison et al., 2017). This increased risk of sexual victimization could be explained by the increase in risk behaviors such as a greater number of sexual partners and regular use of alcohol that are also correlated with higher levels of internalized homophobia (Baiocco et al., 2010; Combs-Lane & Smith, 2002; Martin et al., 2011; Rosario et al., 2006). When considering sexual assault among sexual minority women, it is important to understand the intersectionality of that identity. Intersectionality is a concept that emphasizes the interactions between various social identities (including race/ethnicity, gender, class, age, sexuality, religion, etc.) all affected by societal power structures. Therefore, those who hold multiple marginalized identities experience unique barriers. For the purpose of this study examining sexual minority women, as both a woman and a sexual orientation other than straight, these survivors face layered challenges (Hankivsky, 2022).

Given that women who identify as a part of LGBTQIA+ communities have higher risk for problems after sexual assault in addition to more issues surrounding support and disclosure, it is particularly important to understand their help-seeking process. To understand why people may choose to seek help or not seek help following a sexual assault, a model addressing health behaviors can be a useful tool. The Health Belief Model outlines various factors that may alter an individual's health behaviors (Green et al., 2020). In this model, the likelihood of taking action is affected by one's motivation, perceived susceptibility and severity of their condition, perceived benefits of taking action, and perceived barriers they may face when taking action. These factors are affected by the demographic variables and psychological characteristics of an individual, providing a comprehensive understanding of the variety of elements that may affect one's decision to take action (Green et al., 2020). In the case of survivors of sexual assault, action refers to seeking help through formal and informal disclosure.

It is integral to understand barriers survivors may face when disclosing their experience, especially for at-risk groups such as sexual minority women. All individuals who experience sexual assault may face barriers when disclosing their experience, regardless of sexual orientation. Barriers may include fear of experiencing stigma, feelings of shame or self-blame, belief that their experience was not serious, and desire to deal with their experience in their own way (DeLoveh & Cattaneo, 2017; Sabina & Ho, 2014). Feelings of self-blame and shame could be considered a perceived barrier by the Health Belief Model and decrease the likelihood that an individual seeks help. The barriers previously mentioned may be magnified for sexual minority women. This is because female sexual minority survivors face more victim blaming in comparison to heterosexual survivors, which may lead to additional self-blame and feelings of shame (Davies et al., 2011; Morrison & Pedersen, 2020).

In addition to barriers, perceived severity is a second factor from the Health Belief Model that can relate to help-seeking for sexual assault. For example, it is typical for survivors to believe their experience was not "serious enough" to report, lessening their likelihood of seeking help (Holland & Cortina, 2017). This phenomenon is also certainly affected by demographic variables such as sexual orientation. If an individual experiences greater levels of victim blaming and societal judgment surrounding their experience, they may feel that the severity of their experience is minimal. Sexual minority women are more likely to experience higher levels of victim blaming, and therefore the perceived severity of their experience may decrease. This could lead to less action, or help seeking, after a sexual assault experience for this group in particular.

A third factor from the Health Belief Model that is relevant in the context of disclosure is perceived benefits (Green et al., 2020). Perceived benefit refers to the idea that taking an action will in some way benefit the individual, in this case, for example, getting support from a loved one or getting resources by disclosing to a formal source. In survivors of sexual assault, sometimes perceived benefits can be low due to fear of experiencing stigma and a desire to manage their experiences independently (Holland & Cortina, 2017), which can limit help-seeking behavior. Perceived benefits of disclosing an experience also vary based on a survivor's sexual orientation and the resources available to a survivor. LGBTQIA+ survivors are more likely to disclose to others who are affirming of their identity rather than a non-affirming individual or organization (Hackman et al., 2020), however trusted organizations or individuals may not be available to all survivors. The higher rates of victim blaming among LGBTQIA+ survivors may contribute to the lack of specific affirming resources for this group. If no affirming support is available, a sexual

minority survivor may perceive less benefit in disclosure, and therefore not seek help.

Taken together, past research has shown that sexual assault has negative effects on those who experience it, and that there are unique risk factors and barriers for sexual minority women that affect their experience and subsequent outcomes. These differences may be accounted for by the effects of minority stress and internalized homophobia faced by sexual minority women, as well as negative societal stereotypes that lead to heightened levels of victim blaming of bisexual women. As explained by the Health Belief Model, high perceived barriers and low perceived severity and benefit may decrease one's likelihood of taking action. Consequently, further research is needed to better understand and mitigate the connection between negative societal perceptions of LGBTQIA+ women and the decreased likelihood that these women seek help in comparison to those who do not identify within these communities.

To increase our understanding of this phenomenon, this study aims to answer the question: How does an individual's identity affect their perception and experience with unwanted sexual attention? More specifically, this study will explore perceived benefits and barriers to disclosing a sexual assault experience, recommendations received by queer survivors and provided by the general public, and experience with unwanted sexual attention in those who hold a queer identity. Understanding these variations will allow us to gain a better understanding of how to create interventions and education programs to specifically target helping this group that is at a greater risk of both sexual assault and negative outcomes. The study was qualitative and exploratory in nature to give voice to individuals in this high-risk population.

## Methods

### Participants

Participants included nine college students from a small private university who self-identified within the LGBTQIA+ community. A majority of participants identified as Caucasian/white Non-Hispanic (89%), with remaining participants identifying as Asian Non-Hispanic (11%). The class rank of participants represented all four years of undergrad, with 44% seniors, 22% juniors, 11% sophomores and 22% freshman. In Table 1, participants are listed via their code name, gender identity, sexual orientation, and survivor status.

**Table 1**
*Participant Information*

| Name | Gender Identity | Sexual Orientation | Survivor Status |
|---|---|---|---|
| Parker | Cisgender Woman | Gay/Queer | Survivor |
| Quinn | Woman | Lesbian/Queer | Survivor |
| Logan | Woman | Lesbian | Survivor |
| Alex | Genderfluid | Queer | Survivor |
| Cameron | Intersex/Woman | Bisexual | Survivor |
| Riley | Nonbinary | Bisexual/Queer | Survivor |
| Avery | Woman/Genderqueer | Lesbian | Nonsurvivor |
| Carson | Gender-ambiguous | Gay/Queer | Nonsurvivor |
| Blake | Cisgender Woman | Bisexual | Nonsurvivor |

### Procedure

Elon University's Institutional Review Board approved this study prior to participant recruitment. Convenience and snowball sampling was used to recruit participants. All participants attended Elon University and were contacted through the distribution of study materials through LGBTQIA+ students and organizations. Participants had to self-identify as LGBTQIA+ and as female, nonbinary, or any other gender identity that was not male to participate in this study. We distributed advertisements across the university's campus via physical and virtual flyers to LGBTQIA+ groups and organizations and to the general student population. Flyers included a link to a preliminary survey. This survey ensured that interested participants met the inclusion criteria, provided researchers with informed consent, and allowed researchers to separate participants into focus groups. This survey also asked participants to report demographics and assault history. Interested individuals who met the criteria were contacted via email and assigned to a focus group based on their availability and survivor status. Focus groups were conducted via Zoom,

and participants were informed before joining the meeting and at the beginning of the focus group that they were welcome to change their Zoom name and turn their camera off to preserve confidentiality if preferred. Individuals who participated in a focus group received a $10 gift card.

**Measures**

We used the Sexual Experiences Survey (Koss & Oros, 1982)(Koss & Oros, 1982) to separate interested participants into focus groups composed of either survivors or individuals who had not experienced sexual assault. In this study individuals who indicated experiencing anything beyond unwanted touching were classified as survivors. We altered the survey language in to be more inclusive, and the Sexual Experiences Survey has been validated to assess sexual assault and rape in lesbian and bisexual women (Canan et al., 2020). Based on participant and researcher availability, three focus groups with three participants each were formed. Of these groups, two were composed of survivors while one group contained nonsurvivors. Each group was asked the same questions, as shown in Table 2, with framing appropriate for survivor/nonsurvivor status. Survivors were also asked to discuss what recommendations they had actually received.

**Qualitative Analysis**

Audio recordings from each Zoom focus group meeting were transcribed via Otter.ai software. We coded the transcripts following inductive thematic analysis (Braun & Clarke, 2006). This method was utilized to analyze the qualitative data from the three focus groups, and included six steps, starting with step one, researchers familiarizing themselves with the data. This process began with each researcher reading through the transcripts and taking individual notes, identifying possible themes within each question participants were asked. This process allowed researchers to complete step two, the generation of initial codes, and step three, the search for themes. Step four involved reviewing and refining themes, made possible through conversation between researchers that allowed themes to be solidified and further understood in relation to other themes and subthemes that emerged. Through this process, researchers last completed step six, defining and naming themes through discussion. Unless specifically noted, each theme was brought up across focus groups.

## Results

**Barriers to Disclosure**

Participants were first asked about general barriers to disclosure of sexual assault. When asked about barriers to sexual assault disclosure, participants' answers could be categorized into the theme *Concern Around Social Reactions*. This was expressed by participants as fear of judgment of themselves or their situation. More specifically, when expressing fear of being judged themselves, participants expressed feelings

**Table 2**
*Questions For Participants*

| Questions for Survivors | Questions for Nonsurvivors |
|---|---|
| What are the barriers to disclosing sexual assault or unwanted sexual experiences? | What are the barriers to disclosing sexual assault or unwanted sexual experiences? |
| What are perceived benefits to disclosing a sexual assault or unwanted sexual experience? | What are perceived benefits to disclosing a sexual assault or unwanted sexual experience? |
| What kinds of recommendations did you receive upon disclosure? | |
| What recommendations would you provide to others who have this kind of experience? | What kind of recommendations would you provide to a friend who experienced a sexual assault or unwanted sexual experience? |
| Are there ways in which your sexual orientation or gender identity affected your decision to disclose or to not disclose? | Are there ways in which one's sexual orientation or gender identity might affect their decision to disclose or not disclose? |
| Are there ways in which your sexual orientation or gender identity affected your experience of unwanted sexual behavior? | Are there ways in which sexual orientation or gender identity might affect someone's experience of an assault? |

of embarrassment, experiencing stigma, and fear of being blamed or not believed. Some participants expressed a fear of their situation being judged, reporting concern that disclosure would result in pressure not to report, a misunderstanding of LGBTQIA+ relationships and identities, or a worry that others would feel that too much time had passed since the experience. Additionally, the nonsurvivors identified a lack of benefits as an additional barrier to disclosure.

**Benefits to Disclosure**

Participants were also asked to relay their perceived benefits of disclosure. The two themes that emerged from these responses were *Support* and *Justice*. Participants expressed the theme *Support* often throughout focus group discussion. This theme emerged from reports that disclosure could aid in the processing of emotions and gaining help and assistance through professional services. In addition, participants discussed that disclosure could provide them with emotional and social protection. Avery explained this, saying "...the more people who know about something, the more people who can ...help protect you or ...keep you safe in any situation ...not even like in a physical sense, necessarily, but just in the sense of ...it's nice to have somebody where ...if you're triggered by something, or if something's going on that you can ...turn to and they know what's going on enough to be able to help you through it." Finally, participants noted that disclosure could assist in finding those with similar experiences, aiding survivors in feeling less alone. The theme *Justice* was expressed by participants as they talked about disclosure leading to holding perpetrators accountable. Parker described this saying "...let it hold the person accountable for their actions."

**Recommendations Received by Survivors**

Participants in the two focus groups composed of survivors were asked what recommendations they received after disclosing their experience. Themes included *Formal Support, Informal Support,* and *Lack of Support*. *Formal Support* developed from the common recommendation received by participants to seek counseling and therapy. *Informal Support* included recommendations to seek support from family and friends. This theme also included one participant's recommendation to seek informal justice through disclosure to family, friends, or colleagues of a perpetrator to achieve justice. The theme *Lack of Support* emerged as participants reported experiencing invalidation of their experience and the discouragement to further disclose. Participants indicated that following disclosure, the validity or nonconsensual aspect of their experience was often questioned. Cameron expressed this, saying "...I was kind of just told to shut up personally." Additionally, participants reported individuals being unsure of how to react following disclosure. Parker shared "...my parents didn't know how to approach situations. And then they just kind of were like, extra delicate around me in a way that was unnecessary." Quinn also reported this, saying "...they just kind of were like, oh, you know, if you need anything, let me know. But also ...telling me that ...oh, this doesn't usually happen like this, this, you know, they tried to tell me ...Oh, this is ...not normal, which didn't really help in the moment when it was ...something that had just happened. And so obviously it does still."

**Recommendations Provided to Others**

All participants were asked which recommendations they would provide to someone who experienced an unwanted sexual experience. Themes in this domain included *Formal Support*, *Informal Support*, and *Tentative Justice*. Like recommendations received, most participants discussed recommending *Formal Support* in the form of therapy or professional counseling. Also similarly to recommendations received, participants recommended seeking *Informal Support* from friends and family. *Tentative Justice* arose as a theme from survivors' recommendations to gather evidence and consider a formal report if that is what they feel is best. This theme name was chosen by the researchers in response to the varying opinions and advice surrounding formal reporting given by participants. Cameron expressed "...I would recommend someone reports anyway, just because ...at the time, you know, I didn't really like understand ...why I should report, but it's something I regret a lot. So I'd say report even if you don't ...feel like it in the moment. But if you don't have a lot of I don't want to say evidence because ...your word is evidence. But if you don't have ...a lot of ...hard evidence, it might not be worth ...rehashing everything." Alex expanded on this saying "I would also have some hesitation with suggesting that anyone report formally, however, I would if that person was really uncomfortable with the idea of reporting it formally, I think my first thought would be to gather the evidence anyway, have screenshots or whatever, you can write down whatever you can, so that maybe if you don't want to report it, now, you can report it later."

**Sexual Orientation and Gender Identity: Effect on Disclosure**

Participants were also asked if their sexual orientation or gender identity did or would affect their decision to disclose. Themes that emerged included participants who answered no because they were *Not Out,* no because their experience was *Not Identified as*

*Nonconsensual,* yes due to *Societal Issues,* or yes due to *Queer Community*. Some participants said no as they were not out to themselves at the time, resulting in the theme *Not Out*. The theme *Not Identified as Nonconsensual* refers to participants who did not disclose due to their lack of recognition that their experience was not consensual. The theme *Societal Issues* emerged from participants' expression that societal pressures on women discouraged them from disclosing. This theme was named by researchers due to the common report that societal pressures discouraged disclosure, particularly for women or those perceived as feminine. Survivors expressed that their identity as a queer person did not affect their decision to disclose, but their identity as a woman did. Quinn stated "...it doesn't relate to ... a queer identity ...but yeah, definitely recommendations typically were aimed towards women." The focus group of nonsurvivors uniquely reported that considerations of someone's identity should be considered when providing them with support following disclosure.

The theme *Queer Community* was formed in response to participants who expressed that their identity did affect their disclosure decision. In particular, participants reported that they were more comfortable disclosing to other queer individuals due to the increased empathy and increased likelihood of a common experience. As stated by Alex,"...I really only disclose anything to my friends or partners, who are almost all queer in one way or another. And I think that shared understanding made me more willing to disclose to them whereas to a straight or cis person, there's just a level that they wouldn't understand." Cameron expanded on this, saying "I feel like if you're queer, you, you've either experienced it, or you at least know someone personally, who's experienced gender violence."

**Sexual Orientation and Gender Identity: Effect on Experience**

When asked if their sexual orientation or gender identity did or would affect their experience of unwanted sexual behavior, participant responses were reflected in one of three themes: No because they were *Not Out*, yes due to fear of *Targeting* of a particular identity, or no but their experience led to an *Adjustment of Gender/Sexuality Presentation*.

Like above, the theme *Not Out* was drawn from participants who reported their sexual orientation and/or gender identity did not affect their experience due to them not being out at the time of the assault. The theme *Targeting* reflected participant reports of fear of targeting due to gender identity, in particular the increased targeting of trans women and the added discomfort of unwanted attention from men as a lesbian due to their lack of attraction. Carson stated "...women are disproportionately affected. And there are other cases of assault, like trans women are also targeted a lot of times and so like, definitely, people experience things differently, and cisgender men are disproportionately affected less. Just because that's how society has been set up." While Avery said "... it just feels ...strange to me, because ...I'm a lesbian. ...it's just weird to me when ... that kind of attention comes from a man. And ...not that it would be better from a woman or anything like that. But it's just like, different. And it's a different processing that happens in my brain."

The theme *Adjustment of Gender/Sexuality Presentation* reflected participant reports of changes in their sexuality and or gender presentation following their experience of sexual assault. In part, this theme captured participant reports of changing their sexuality and/or gender presentation to discourage male attention or to seek male validation following their experience. Participants varied in type of adjustment, as some expressed they presented as more masculine, while others reported presenting more feminine. For example, Quinn stated "after the first like main experience, I really ...started to embrace more ...masculine parts of my gender identity. Although I still identified as ...a cisgender woman throughout the whole process, I ...expressed a lot less femininity and more masculinity at times. And ...I tried to do that. And a lot of times, it was as a way of like, I wanted men to leave me alone." However, on the other hand, Alex stated "I think that I ended up not accepting being gender fluid for a while because I had this underlying trauma where I wanted to be feminine and pretty and desirable."

This theme also takes into account participants' explanation that their experience caused them to later feel less comfortable with men and safer with women. Cameron, who identifies as bisexual, stated "...for a really long time, I was ...unable to ...handle the concept of a man touching me. So I identified as a lesbian for a very long time because I couldn't tell the difference between ...the trauma ...repulsed touch, versus like attraction. So eventually, I started ...somewhere in my healing process, I realized my attraction to men." Logan, who identifies as a lesbian, also mentioned "...it just kind of made me more uncomfy towards the opposite gender, which so I don't think it was ...my gender and sexuality influenced that. I think it was almost the other way around. But I think it made me ...feel safer with the same gender and probably pushed me closer to ...coming out to myself." Participants agreed that their experience affected their identity in certain ways, as Cameron expressed, "I wouldn't

necessarily say my identity influenced it, I would say what happened influenced my identity…" and Alex reiterated, saying "…it shaped my experience as a person more so than as a queer person."

## Discussion

Studies have shown that queer women experience sexual assault at higher rates, face more victim blaming, and report more negative mental health outcomes following an assault than straight women (Canan et al., 2021; Ford & Soto-Marquez, 2016; Long et al., 2007; Martin et al., 2011). We conducted the current study to gain a deeper understanding of the variation in sexual assault experience and disclosure among queer individuals and investigate ways to better support queer survivors given that they receive less support and more blame. Participants were asked to describe perceived barriers to disclosing a sexual assault experience. It was found that participants reported barriers such as fear of being judged, stigma, being blamed or not believed, and feelings of embarrassment. These barriers are consistent with the current literature and therefore these results were expected (DeLoveh & Cattaneo, 2017; Sabina & Ho, 2014). The current literature provides knowledge of general barriers faced by survivors, while this study confirms that queer individuals perceive the same barriers, through the theme *Concern Around Social Reactions*. Additionally, this data provides a deeper understanding of the perception of these barriers by queer participants through qualitative data that highlights the voices of these individuals. It is important to know the barriers to disclosure that are perceived by survivors and queer survivors in particular because this can guide the creation of resources or interventions that minimize said barriers, encouraging help seeking among survivors. Participants also reported that a misunderstanding of queer relationships may contribute to barriers faced by queer survivors. This further highlights the need for more specific research to examine this phenomenon.

In addition to asking questions to understand participants' perceived barriers to disclosure, participants were also asked to describe benefits to disclosure. Participants reported benefits to disclosure such as gaining support through family and friends or professionals and getting justice through holding a perpetrator responsible. Holding a queer identity was not mentioned as a factor by participants. These responses were also in line with previous research and are important to note as a comprehensive understanding of the benefits perceived by survivors can also guide resource creation, implementation, and advertisement. In general, the knowledge of survivors' expectations following help seeking can help programs, resources, and individuals meet and exceed those expectations, improving survivors' support following a sexual assault experience.

Additional questions aimed to gain a deeper understanding of how participants' gender identity and sexual orientation affected their disclosure decision and experience. This was assessed to gain understanding of how minority stress theory might play a role in these experiences (Meyer, 2003, p. 2). We expected that due to minority stress theory, holding a queer identity would affect the sexual assault experience and disclosure decisions of participants, potentially leading to lower rates of disclosure and an experience that differed from their straight counterparts (Meyer, 1995, p. 199). However, this is not what participants indicated in their responses. Queer participants instead expressed that their experience affected their identity more than the other way around. Participants explained a variety of responses following their experience that could be categorized into the theme *Adjustment of Gender/Sexuality Presentation*. The adjustments described varied by participant, as some expressed a change in the label of their sexuality due to a discomfort around men while others reported a difference in gender expression, either favoring a more feminine or more masculine presentation, as an attempt to repel men or a desire to fill societal expectations. Participants' perception of their own identity, and in turn their presentation of said identity, was altered following their experience. These unexpected results counter the prediction of how minority stress may influence a survivor's experience, providing an alternative result in need of further investigation. This valuable qualitative data contributes insight into the experiences and processing of queer survivors. This will allow for the creation of more helpful resources for said survivors and shape future research projects aimed to gain further understanding of this phenomenon.

Participants were also asked to indicate factors that impacted their disclosure decision, and our expectation was that minority stress would relate to decreased disclosure in queer survivors (Meyer, 1995). However we were once again surprised by the results. Participants reported that their disclosure decision was more prominently impacted by their gender identity as a woman, or societal perception as a woman, rather than their sexuality. In fact, many participants reported that their sexuality did not impact their disclosure decision. Their gender identity, however, did have an impact due to societal pressures on women that increase blame and discourage disclosure surrounding sexual assault. This

highlights the major effect of patriarchal ideals and societal concepts of femininity on survivors and their disclosure decision. This finding suggests that interventions should be aimed at altering these societal pressures on women to create the most positive change in survivors' comfortability with disclosure and help seeking.

A few of the themes that emerged require additional research to further understand its relationship with a queer identity, particularly themes *Not Out* and *Not Identified as Nonconsensual*. The theme *Not Out* brings to attention the possibility that survivors who were out at the time of their unwanted sexual experience have a very different experience, and a different relationship with their queer identity, than survivors who were out. The theme *Not Identified as Nonconsensual* emerged as participants reported that they did not identify the experience as nonconsensual which is true of many survivors but also may have been affected by participants' evolving gender identities and sexualities.

Participants who reported that their sexuality did have an effect on their disclosure decision explained that they were more likely to disclose to other queer individuals. This provides a possible explanation for lower rates of disclosure among queer survivors, as a lack of access to trusted queer individuals or queer resources may decrease the likelihood of disclosure. This finding highlights the importance of queer and queer affirming resources for survivors. In addition, this finding allows us to consider the interaction between survivors' identities. Queer women face societal pressures discouraging disclosure due to their gender identity, and they also may only feel comfortable disclosing their experience to another queer person, further decreasing the likelihood of seeking help. The combination of these barriers for queer women contributes to their heightened risk of negative mental health outcomes and minimized likelihood of disclosure. This further emphasizes the need for focused interventions put in place for this at risk group.

## Clinical Implications

Several of the themes that emerged provide suggested directions to take services for survivors. The theme *Queer Community* highlighted the increased comfortability of queer survivors to disclose their experiences to those within the LGBTQIA+ communities. This finding emphasizes the importance of the existence of queer healthcare providers, as well as queer affirming healthcare services. The availability and advertisement of these services, from mental health to physical health, is crucial for many queer survivors to feel comfortable seeking help. More education surrounding gender and sexuality, and the challenging of societal norms is necessary to improve care for survivors of all gender identities and sexual orientations. The theme *Societal Issues* also brings to light the need to challenge societal blame pushed on women when it comes to sexual violence, as many participants voiced that due to being socialized as a woman, they felt discouraged to disclose and seek help.

## Limitations and Future Directions

It is possible that the generalizability of the results of this study are limited due to the nature of the sample obtained. Although the sample size was intentionally limited given the qualitative and personal nature of data collection, it is possible that the responses obtained do not reflect the full spectrum of experiences across gender and sexuality. The study focused on female-identified and gender minority experiences, and there is room for expansion to be even further inclusive of multiple and intersecting identities. Additionally, all participants were students at one private university in the Southeast. While useful information was obtained, it is possible that culture, beliefs, and ideas vary in individuals in other settings. Finally, only individuals who had disclosed and felt comfortable discussing their experience participated, potentially restricting the variation in experiences of focus group participants. Further research is essential to further explore the experience of sexual assault in the larger queer community, and particularly needed to investigate the theme of participants' adjustment of gender/sexuality presentation in response to a sexual assault experience. The emergence of this theme provides a complex glimpse into the experience of queer survivors and their viewpoint on their identity and experience, but further examination would be beneficial to deepen our understanding of this phenomenon.

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# PREDICTORS OF AUTOMOBILE COMMUTERS' ENJOYMENT DURING THEIR COMMUTES TO AND FROM WORK

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**Abstract** – This research project involved evaluating predictors of commute enjoyment. Not much research has been conducted on this topic. However, Higgins et al. (2018) found that satisfaction and enjoyment of commute declined as travel time and congestion increased. A total of 490 participants completed the online survey about both their commutes to and from work. We ran regression analyses for commutes to and from work and we found the following results. Commute time, having someone else in the vehicle, predictability of the commute, lack of time pressures, and seeing one's commute as useful predicted enjoyment with the commute to work (the model accounted for 46.3% of the variance, $F(7, 463) = 58.961$, $p < .001$). Gender identity and an uncongested commute were not predictors of commute enjoyment to work. Commute time, having someone else in the automobile, predictability of the commute, an uncongested commute, and seeing one's commute as useful predicted enjoyment with the commute from work (the model accounted for 56.7% of the variance, $F(7, 464) = 89.12$, $p < .001$). We did not find gender identity or time pressures to predict commute enjoyment from work. By understanding the predictors of commute enjoyment, commuters can take steps to create a more enjoyable commute experience. For example, commuters could create a more predictable commute by using a less congested route. Commuters could also link a motive to their commute or reevaluate the purpose of their commute to increase the perceived usefulness of their commute, which can influence enjoyment of the commute.

*Keywords:* commute, commuting, enjoyment, automobile, carpooling, commute time, predictability, congestion, time pressures, useful

The research literature on commuting to and from work using automobiles primarily focused on commuter stress from the 1970s until the 2000s (Chatterjee et al., 2020). Many of the researchers studied the effects of impedance (i.e., frustration or stress from obstacles to travel mobility; Novaco et al., 1979) and congestion (e.g., Schaeffer et al., 1988), which were found to create commuter stress (e.g., Sposato et al., 2012). In addition, predictability was found to be a predictor of commuter stress (e.g., Novaco & Gonzalez, 2009). To reduce commuter stress, commute predictability—the ability to properly estimate the duration and circumstances—is essential (Koslowsky, 1998). When transportation routes are constant, people may strategically manage their schedules, thereby reducing stress from potential disruptions. However, unpredictable commuting may increase stress by causing a sense of insecurity and doubt (Gottholmseder et al., 2009).Source Credibility of Information

More recently, researchers have proposed that commuting can have positive utility (Basmajian, 2010; Mokhtarian & Salomon, 2001; Mokhtarian et al., 2001; Ory & Mokhtarian, 2005; Redmond & Mokhtarian, 2001; Singleton 2018; Singleton & Clifton, 2021), which calls into question whether commuting should be viewed as always negative (Higgins et al., 2018). Positive utility looks at commuters' motives for and the benefits of commuting including using time productively, positive feelings and emotions during commuting, and the enjoyment of driving (Mokhtarian & Salomon, 2001). Singleton and Clifton (2021) note that much of the recent research has found that around half or more of the participants report feeling positive when they commute, or they consider commuting to be pleasant. According to Ory et al. (2004), people who view commuting as

productive and do not find it overly stressful are more likely to enjoy it. Blumen (2000) also notes that some commuters view commuting as a useful transition between work and home.

This research specifically focused on automobile commute enjoyment to and from work and factors that predicted it. The factors used to predict commute enjoyment were gender identity, trip attributes (i.e.., commute time, having someone else in the automobile, predictable commutes, lack of time pressures, and uncongested commutes), and drivers' perceptions of the commute (i.e., usefulness of the commute) and will be reviewed next.

Although much of the research on gender identity has been about evaluating the differences in length of commute times for men and women, a few studies have evaluated their responses to the commute. Handy and Thigpen (2019) found women to rate their commutes as more stressful, see it as wasted time, and were less satisfied with their selected mode of transportation (i.e., automobile, public transport, waking, and biking). This could be because of many women's greater responsibility for childcare and other household responsibilities, which could make them more sensitive to perceived lost time during their commute time (McQuaid & Chen, 2011, Roberts et al., 2011). Sweet and Kanaroglou (2016) add that women often have more complex travel and time use patterns than men because of these responsibilities. Kunn–Nelen (2015) found that longer commute times were more strongly related to decreased sleep quality for women than men and that women were less likely to have regular physical exercise if they had a longer commute. Based on this research, we assumed that gender identity would predict commute enjoyment to and from work.

Commute time is a commonly assessed trip attribute, and it is often evaluated by using minutes commuted. The average daily commute for those in the United States lasts approximately 27.6 minutes one way, and most view commuting as a necessary part of their job (U.S. Census Bureau, 2021b). Workers are spending more time commuting to and from work. According to data collected by the United States Census Bureau (2021a) in 2019, people who drove their own vehicles to work saw changes in their commute times. In 2006, 14.8% of commuters indicated that their trip times were shorter than 10 minutes; by 2019, this group had decreased to 11.9%. On the other hand, the percentage of employees who reported having commutes of 60 minutes or more climbed from 7.9% in 2006 to 9.8% in 2019. The trend towards longer commute times using various travel modes have had adverse effects on commuters' health, including elevated levels of stress and a decline in overall well-being (Han et al., 2023). Longer commute times also can impact how drivers feel about their commutes, as long commutes have both monetary and social costs (Basmajian, 2010).

Researchers have found that commuters favor moderate commute times as compared to very short or long commutes, or they prefer eliminating the commute altogether (Ory et al., 2004; Redmond & Mokhtarian, 2001). Recently, He and Zhao (2017) found that Chinese commuters' ideal commute time to be 18.6 minutes. For this study, commute time to and from work was used as a predictor of commute enjoyment and we assumed that a long commute would decrease enjoyment.

Not much research has been conducted on having someone else in the automobile, and the research that has been conducted has not looked at the psychological effects. Instead, it has looked at factors such as incentives for carpooling (e.g., Buliung et al., 2009). However, a study published 30 years ago evaluated ridesharing and found those who shared a vehicle were less bothered by congestion and were more satisfied with their commute (Novaco & Collier, 1994). Another more recent study evaluated commute stress and found those in vanpools reported less commute stress and especially for the commute from work (Ditmore & Deming, 2018). This could be because travel time can be used to maintain social relationships (Jain & Lyons, 2008). In addition, for those who have children in the car with them, they might see the trip as utilitarian. Based on Novaco and Collier's (1994) findings we assumed that having someone else in the automobile would predict commute enjoyment.

Unpredictability has been found to be a significant component of commuting stress among automobile drivers (Evans et al., 1987; Gottholmseder et al., 2009; Kluger, 1998; Sposato et al., 2012). Evans et al. (2002) found that train commuters who felt their commutes were unpredictable experienced higher stress as measured by higher levels of salivary cortisol. Evans et al. note that being able to predict one's commute can be a form of cognitive control that gives commuters ways to deal with stress and cope with it. In addition, Novaco et al. (1990) found that automobile commuters who have a variety of commuting options, which included different driving routes, helped decrease stress. Based on this research, we assumed that having predictable commutes to and from work would predict greater commute enjoyment.

Time pressures and feelings of time urgency have been shown to increase stress, aggression, frustration, and irritability for automobile commuters (Hennessy et

al, 2000; Koslowsky, 1997; Lucas & Heady, 2002). Hilbrecht et al. (2014) found that it was not just the quantity of time devoted to commuting that impacted automobile commuters' wellbeing, but that time pressures and congestion influenced it as well. Lucas and Heady (2002) found that automobile commuters with greater flextime (i.e., flexible work schedules) showed less perceived time urgency and driver stress. Based on this research, we assumed that having less time pressures will predict a more enjoyable commute.

Congestion is related to predictability in that it negatively impacts predictability and can increase delays for automobile commuters (Higgins et al., 2018). Hennessy (2011) defined congestion as when drivers perceive that there are too many vehicles or too little space in the location they are commuting in. Much of the research literature on congestion has found that it negatively affects automobile commuters in terms of their stress and wellbeing (Higgins et al., 2018). For example, congestion has been found to impact commuter stress and aggression (Hennessy & Wiesenthal, 1999). In addition, Gulian et al. (1989) found that traffic congestion took a physical toll on automobile commuters over time. Finally, Wener and Evans (2011) found for automobile commuters that congestion made them feel like their commute was less predictable and produced feelings of lack of control. Based on this research we assumed that having an uncongested commute would predict commute enjoyment.

Researchers recently have become interested in knowing not just the activities people do while commuting but also the usefulness of the commute, which often involves an assessment of multitasking (Singleton, 2018). Mokhtarian and Salomon (2001) found that half of their sample of varying types of commuters (i.e., automobile, public transport, waking, and biking) thought their commute was not wasted time and a third thought the commute was a useful transition. Commutes can give people time alone (Handy & Thigpen, 2019), they can serve as a time buffer between work and home (Jain & Lyons, 2008), and they can allow people to do something besides driving such as listening to music (Ettema & Verschuren, 2007). Based on this research we assumed that seeing one's commute to and from work as useful would predict commute enjoyment.

In summary, the following possible predictors of commute enjoyment were evaluated. Those included gender identity, and trip attributes (i.e., commute time, having someone else in the automobile, predictable commutes, lack of time pressures, and uncongested commutes), and drivers' perceptions of the commute (i.e., usefulness of the commute).

## Method

### Participants

We used the example demographic questions written by Hughes et al. (2022) in our survey. Those questions helped us to describe our sample.

Of the 490 participants who completed the survey, 220 identified as men, 251 identified as women, 10 identified as non-binary, and 2 identified as agender. Seven participants preferred not to answer the question. The average age of the participants was 36.92 (*SD* = 11.60, Range 19–71). Just over half of the participants identified as White or European American (58.6%) and the remainder identified as Asian or Asian American (7.3%), Black or African American (15.5%), Hispanic or Latino (8.4%), Arab, Middle Eastern, or North African (.4%), Native American or Alaska Native (1.2%), or multiracial (6.7%). Another 1.9% reported that they preferred not to answer. Many of the participants reported residing in the Southern part of the United States (62.8%) and drove an average of 22.84 (*SD* = 22.13) miles roundtrip to and from work. The commute to work took an average of 25.83 (*SD* = 17.26) minutes and the commute from work took an average of 29.70 (*SD* = 22.21) minutes. Of the participants, 63.7% drove alone in their automobile, 26.5% reported driving with family members or carpoolers most of the time, and 9.8% said that they drove some of the time with family members or carpoolers.

### Measures

#### *Commute Time*

We asked commuters the number of minutes it took them on average to commute to work and the number of minutes it took them on average to commute from work.

#### *Enjoyment of the Commute*

Researchers have evaluated enjoyment of the commute in past studies by using a question such as "I enjoy my commute" (Abou-Zeid, 2009; Turcotte, 2006). For this study we used "Please rate how you feel about your typical commute" and participants evaluated this to work and from work. A 7-point scale was used ranging from 1 (*it is not enjoyable*) to 7 (*it is enjoyable*).

#### *Lack of Time Pressures During Commute*

Hennessy and Wiesenthal (1999) and Lucas and Heady (2002) used questions like "I am in a hurry" to assess time urgency. We used one broader question that asked about time pressures in general: "Please rate your typical commute and the time pressure you feel:" and participants evaluated this to and from work. A 5-point

scale was used ranging from 1 (*significant time pressure*) to 5 (*no time pressure*).

### *Predictable Commute*

Koslowsky (1998) suggested that a single item could be used to assess predictability by asking if the commute takes the same amount of time each day and therefore is predictable. In addition, Denstadli et al. (2017) used one item to assess predictability by asking if the commute was predictable. For this study we also used one general question: "Please rate your typical commute time as far as predictability (i.e., being able to consistently predict how long your commute will take):" and participants evaluated this for to and from work. A 5-point scale was used ranging from 1 (*very unpredictable*) to 5 (*very predictable*).

### *Someone Else in the Automobile During the Commute*

This was assessed using the question: "Do you drive with others (e.g., kids, partners, carpoolers, etc.) in your vehicle during your commutes?" and participants evaluated this for to and from work. A 5-point scale was used, ranging from 1 (*almost never or never*) to 5 (*almost all of the time or all of the time*).

### *Uncongested Commute*

Researchers have often assessed congestion by asking if commuters are bothered by it. For example, Novaco and Collier (1994) used the following item to assess commuters' reactions to congestion: "How often do you feel bothered by traffic congestion in commuting to or from work?" Hilbrecht et al. (2014) assessed traffic congestion by asking participants, "Overall, how serious a problem is traffic congestion for you?" We wanted to know the commuters' perception of congestion in general and used the question: "Congestion is defined as traffic jams, start-stop conditions, or moving at less than 20 miles per hour. Please rate your typical commute as far as congestion:" and participants evaluated this for to and from work. A 5-point scale was used, ranging from 1 (*very congested*) to 5 (*uncongested*).

### *Usefulness of the Commute*

Cao and Mokhtariah (2005) and Handy and Thigpen (2019) used a question about travel time being seen as wasted time. We used this as one anchor while the other anchor stated that "it is useful." We used the following question: "Please rate how you feel about your typical commute" and participants evaluated this to and from work. A 7-point scale was used ranging from 1 (*it is wasted time*) to 7 (*it is useful*).

## Procedure

After obtaining IRB approval, 10 research lab members recruited 316 participants by seeking faculty and staff at our college, friends, and family to take the survey. The participants had to be 18 years or older, employed, and commute to and from work using an automobile. The survey was made accessible to all participants via a Qualtrics link, which allowed them to review and complete the survey at their convenience from any location with internet access. This method ensured that the survey was easily accessible and could be completed in a timely manner. Because the sample did not have enough male participants to analyze gender identity, the lab members recruited another 174 participants who identified as men using MTurk. All the participants were put into a drawing for one of four $50 Amazon gift cards and each participant from MTurk was also paid $1.00 for completing the survey.

We compared the two samples using independent *t* tests and they did not differ on the amount

**Table 1**

*Correlations for the Commute Variables and Commute Enjoyment to Work*

| Variable | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Commute enjoyment to work | 4.54 | 1.64 | — | | | | | | |
| 2. Gender identity | .61 | .64 | -.10* | — | | | | | |
| 3. Commute time | 25.83 | 17.26 | -.29*** | -.05 | — | | | | |
| 4. Someone else in the automobile | 2.20 | 1.49 | .27*** | -.33*** | -.01 | — | | | |
| 5. Commute predictability | 3.97 | .83 | .33*** | -.04 | -.34*** | .10* | — | | |
| 6. Lack of time pressures | 3.31 | 1.23 | .24*** | .09* | -.25*** | -.31*** | .24*** | — | |
| 7. Uncongested commute | 3.40 | 1.29 | .13** | .22*** | -.27*** | -.39*** | .28*** | .65*** | — |
| 8. Usefulness of commute | 4.45 | 1.82 | .62*** | -.20*** | -.22*** | .26*** | .25*** | .16** | .03 |

*Note.* Higher score indicates greater magnitude. All analyses were two-tailed. *$p < .05$, **$p < .01$, ***$p < .001$.

**Table 2**

*Correlations for the Commute Variables and Commute Enjoyment from Work*

| Variable | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Commute enjoyment to work | 4.37 | 1.74 | — | | | | | | |
| 2. Gender identity | .61 | .64 | -.14*** | — | | | | | |
| 3. Commute time | 29.70 | 22.21 | -.37*** | .01 | — | | | | |
| 4. Someone else in the automobile | 2.19 | 1.49 | .27*** | -.33*** | -.06 | — | | | |
| 5. Commute predictability | 3.86 | .89 | .40*** | -.08* | -.38*** | .13** | — | | |
| 6. Lack of time pressures | 3.80 | 1.29 | .03*** | .16*** | -.21*** | -.46*** | .12** | — | |
| 7. Uncongested commute | 3.17 | 1.35 | .26 | .13** | -.37*** | -.31*** | .27*** | .63*** | — |
| 8. Usefulness of commute | 4.34 | 1.82 | .72*** | -.17*** | -.30*** | .31*** | .32*** | -.02 | .14*** |

*Note.* Higher score indicates greater magnitude. All analyses were two-tailed. *$p < .05$, **$p < .01$, ***$p < .001$.

of miles commuted, $t(478) = -.10$, $p = .92$, minutes commuted to work, $t(481) = -1.18$, $p = .24$, or minutes commuted from work, $t(482) = -.12$, $p = .90$. However, they did differ on age with the MTurk sample being younger ($M = 33.40$, $SD = 7.46$) than the first sample collected ($M = 38.91$, $SD = 12.98$), $t(478) = 5.13$, $p = .001$.

## Results

Prior to conducting our multiple regressions, we tested the relevant assumptions as put forth by Tabachnick and Fidell (2012). First, the assumption of singularity was met. An examination of correlations (see Tables 1 and 2) revealed that none of our independent variables were too highly correlated. We used the cutoff of .80 that was proposed by Shrestha (2020). Our collinearity statistics, including Tolerance (using cutoffs of above .25) and VIF (using cutoffs below 4), were within acceptable limits. Next, our residual and scatterplots indicated the assumptions of normality, linearity, and homoscedasticity were met.

Using regression analyses for the commute to and from work, we found the following results. Commute time, having someone else in the automobile, predictability of the commute, lack of time pressures, and seeing one's commute as useful predicted enjoyment with the commute to work (the model accounted for 46% of the variance, $F(7, 463) = 58.961$, $p < .001$). The strongest predictor was seeing one's commute as useful. Gender identity and congestion were not predictors of commute enjoyment to work. See Table 3.

Commute time, having someone else in the automobile, predictability of the commute, lack of congestion, and seeing one's commute as useful predicted enjoyment with the commute from work (the model accounted for 57% of the variance, $F(7, 464) = 89.12$, $p < .001$). Again, the strongest predictor was seeing one's commute as useful. We did not find gender identity or time pressures to predict commute enjoyment to or from work. See Table 4.

## Discussion

This study aimed to identify predictors of an enjoyable commute to and from work using gender identity, trip attributes (i.e., commute time, having someone else in the automobile, predictable commutes, lack of time pressures, and uncongested commutes), and drivers' perceptions of the commute (i.e., usefulness of the commute). All our variables, except for gender identity, accurately predicted commute enjoyment during the journey to and from work. We found commute time, having someone else in the automobile, predictability of the commute, lack of time pressures, and seeing one's commute as useful predicted enjoyment with the commute to work. Those same variables predicted enjoyment with the commute from work, except for lack of time pressures. An uncongested commute was found to be an additional predictor from work.

The finding that gender identity did not predict commute enjoyment to or from work is inconsistent with some previous research that has found that men enjoyed their commutes more than women (e.g., Handy & Thigpen, 2019). However, it should be noted that gender has not been a consistent predictor in the research literature. For example, Lucas and Heady (2002) and Wickens et al. (2015) evaluated gender when examining driver stress and did not find significant gender differences.

**Table 3**
*Summary of Regression Analysis for Commute Variables Predicting Commute Enjoyment to Work*

| | *Model* | | |
|---|---|---|---|
| Variable | *B* | *SE B* | *β* |
| Gender identity | .12 | .09 | .04 |
| Commute time | -.01 | .01 | -.09* |
| Someone else in the automobile | .23 | .05 | .21*** |
| Commute predictability | .22 | .08 | .11** |
| Lack of time pressures | .20 | .06 | .15*** |
| Uncongested commute | .05 | .06 | .04 |
| Usefulness of commute | .46 | .03 | .51*** |
| *Adjusted* $R^2$ | | .46 | |
| *F* for change in $R^2$ | | 58.96*** | |

*Note.* $N = 470$, $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

**Table 4**
*Summary of Regression Analysis for Commute Variables Predicting Commute Enjoyment from Work*

| | *Model 1* | | |
|---|---|---|---|
| Variable | *B* | *SE B* | *β* |
| Gender identity | -.03 | .09 | -.01 |
| Commute time | -.01 | .01 | -.09* |
| Someone else in the automobile | .10 | .04 | .09* |
| Commute predictability | .23 | .07 | .12*** |
| Lack of time pressures | -.08 | .06 | -.06 |
| Uncongested commute | .23 | .06 | .18*** |
| Usefulness of commute | .57 | .03 | .60*** |
| *Adjusted* $R^2$ | | .57 | |
| *F* for change in $R^2$ | | 89.12*** | |

*Note.* $N = 471$, $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Commute time was a predictor for commute enjoyment for both the commute to work and from work. This supports prior research by Wachs and Taylor (1993) who found that travel satisfaction decreased with longer commutes. Han et al. (2023) also found longer commute times to increase stress and decrease overall well-being.

The finding that having someone else in the automobile is a predictor of commute enjoyment for both the commute to and from work supports prior research using carpoolers and vanpoolers. That research found those commuters to have greater satisfaction with their commute (Ditmore & Deming, 2018; Novaco & Collier, 1994). The findings from this study support adding enjoyment as a possible outcome as well.

Having a predictable commute was found to be a predictor of enjoyment for both the commute to and from work. This supports prior research that has found that unpredictability was a significant component of commuting stress among automobile drivers (Evans et al., 1987; Kluger, 1998). This stress might decrease their commute enjoyment.

In addition, our findings support Ettema et al.'s (2016) research that found that time pressures were related to commuter dissatisfaction. When we evaluated the commutes to and from work, we found lack of time pressures to only be a predictor for the commute to work. This makes sense in that there can be consequences for being late to work, which could make those who do not have time pressures enjoy their commute more. Employers might want to consider flextime if the jobs permit for its use (Lucas & Heady, 2002; Xiao et al., 2014).

Previous research has found that automobile commuters' satisfaction and enjoyment decline as congestion increase (Higgins et al., 2018). This was found to be a predictor for the commute from work. Those who reported less congested commutes reported greater commute enjoyment. This could be because many people's commutes from work happen in the late afternoon or evening when congestion is greater because of not only workers going home but also children going home from schools and people going to afterwork activities.

Finally, this research supports seeing one's commute to and from work as useful and contributing to enjoyment of the commute. Commutes can give people time alone or serve as a buffer between work and home (Handy & Thigpen, 2019; Higgins et al., 2018; Jain & Lyons, 2008). In addition, commuters can multitask while they commute, which could create commute enjoyment (Ettema & Verschuren, 2007).

This research highlights the importance of considering not only the objective aspects of the commute, such as travel time and congestion, but also subjective factors like usefulness. The individual's perception of their commute, such as its usefulness, is a strong predictor of commute enjoyment both to and from work. The daily commute can significantly impact an individual's well-being, and we found several factors can influence this impact. By understanding these predictors, commuters can take steps to create a more enjoyable commute experience.

One of the key takeaways from this study is the importance of perceived usefulness of the commute. When individuals see their commute as useful, they are more likely to enjoy it. Commuters can reevaluate the purpose of their commute to increase the perceived usefulness of their commute, which could influence their enjoyment of the commute. Furthermore, they can use their commute time productively by listening to music or podcasts, talking with friends or relatives, or catching up on the daily news, which could make them enjoy the commute more.

In addition, commuters might want to evaluate the number of minutes they are spending commuting to see if it is optimal for them. They also could assess how predictable their commute is and if it is not predictable, they could work to make it more predictable by changing their routes or times they commute. Finally, commuters could work to lessen time pressures for their commute to work and avoid congestion on their commute from work to make their commutes more enjoyable.

Additionally, this study provides valuable insight for organizations and urban planners. The findings of the study can be utilized by urban planners to devise pathways that reduce the likelihood of the occurrence of external events that are unpredictable. Companies can encourage their workers to make their commutes more predictable by offering flexible work hours (Lucas & Heady, 2002) or resources for different modes of transportation.

Overall, this study provides valuable insights into predictors of enjoyable commutes to and from work. A significant strength of our research was the ability to recruit many participants using an online survey. As a result, we had a large and diverse sample size of 490 commuters from different genders, ages, and ethnic backgrounds. Another strength is that the commute to work and the commute from work were both assessed. Much of the prior research has not distinguished between the two. In addition, the wording of "to work" and "from work" was used instead of "morning commute" and "evening commute" to be inclusive of those who do not

work standard hours and commute to work in the afternoon or evening.

The present study contributes valuable insights into the knowledge of commuting. However, like any research, future studies need to consider some limitations. First, the study relied on a questionnaire, which used closed-formatted questions and may not have captured the complexity of participants' thoughts about commuting. One way to address this limitation in the future would be to use an alternative methodology, such as interviews where commuters could elaborate in their answers. Second, the questionnaire used one question to assess each of the predictors for commutes to work and one question to assess each of the predictors for commutes from work. This was done to intentionally keep the questionnaire short. These questions were based on questions that other commute researchers had used and this has been common practice for commute researchers in that they often use single questions to assess commute factors (Singleton & Clifton, 2021). It should be noted that there are some established scales about commuting factors, but their questions often are not specific to the commute and instead evaluate driving behaviors (e.g., Lajunen et al., 2004), driving ability (e.g., Tronsmoen, 2008), driver styles (Taubman-Ben-Ari et al., 2004), or driver dispositions (e.g., Beck et al., 2013). One area of growth for commuting research would be to develop new multi-item scales that assess a broader range of commute factors. Third, the study was conducted within the United States, which could limit the generalizability of the findings. Future research should include a more diverse and representative sample of participants in other countries and other regions of the United States. Fourth, one of the possible predictors for our study was gender identity, but we were unable to recruit enough men to statistically analyze gender identity. This happened because our participants were recruited from a historically women's college where most of the students, faculty, and staff identify as women. We decided to collect additional participants who identified as men using MTurk. We compared the two samples, and they did not statistically differ on commute characteristics (i.e., miles or minutes commuted to and from work). However, the MTurk sample was younger, and this is a limitation of this research. Finally, the study only considered a limited set of predictors that could influence commute enjoyment. To broaden the scope of the research, future studies could investigate other factors such as social support, commute mode, and job satisfaction. These additional variables could provide a more comprehensive understanding of commute enjoyment and contribute to developing more effective recommendations.

Additional considerations include conducting future research over an extended period to determine if other factors, such as season, influence commuters' perceptions of commute enjoyment. For example, some commuters might especially enjoy commuting when it is football or basketball season, and they can listen to analyses of the games. In addition, we would like to determine if the type of person the commuter is commuting with (i.e., a coworker, family member, or friend) influences the automobile commuter's enjoyment in different ways. For example, would someone prefer to commute with a friend as compared to a coworker and would one cause more stress or enjoyment than the other? Another topic of interest is whether participants have additional stops to make, such as running errands or picking up food, and how that may affect commute enjoyment as well as the commute's perceived usefulness (Bhat, 1999; Christian, 2012). Finally, it would be interesting to evaluate commuters who commute in more urban areas as compared to more rural areas. Although Ettema et al. (2012) did not find significant differences in commute satisfaction for commuters from different sizes of Swedish cities, it would be interesting to compare the enjoyment of these different types of commutes.

In conclusion, this study provides important insights into the predictors of enjoyable commutes to and from work. By understanding these predictors, commuters can take steps to create a more enjoyable commute experience, which could significantly impact the well-being of commuters.

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# EXAMINING PSYCHOLOGICAL NEEDS AS PREDICTORS OF EXERCISE MOTIVATION AND INTRINSIC MOTIVATION IN COLLEGE STUDENTS

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**Abstract** – The purpose of this study was to examine whether psychological needs for fulfillment or happiness predicted college students' exercise motivation and intrinsic motivation. A total of *N* = 100 undergraduate college students were recruited to complete self-report measures of exercise motivation, intrinsic motivation, need for psychological fulfillment, and need for happiness. We also measured participants' current levels of psychological fulfillment and happiness. We tested the preregistered hypotheses that both need for fulfillment and need for happiness would be significantly and positively associated with both exercise motivation and intrinsic motivation. We also hypothesized that, in these models including both needs as predictors, need for happiness would be a stronger predictor of exercise motivation, whereas need for fulfillment would be a stronger predictor of intrinsic motivation. Results showed that needs for fulfillment and happiness were not significantly associated with exercise motivation, contrary to our hypotheses. The overall model predicting intrinsic motivation from needs for fulfillment and happiness was statistically significant, however, although neither predictor was uniquely associated with intrinsic motivation. In exploratory analyses, we examined current psychological fulfillment and current happiness as predictors of exercise motivation and intrinsic motivation and found that current fulfillment predicted intrinsic motivation, which is consistent with motivation research more broadly. The pattern of findings observed suggests that needs for fulfillment and happiness may not be critical for exercise motivation, highlighting the importance of more research to examine other psychological needs that may play a larger role in motivating college students to exercise.

*Keywords:* exercise motivation; intrinsic movitation; psychological needs; happiness; health

Psychological models and theories of wellness emphasize that health and well-being follow from optimal functioning of both the body and mind (e.g., Ryan & Deci, 2000b, 2001). Unfortunately, college students experience myriad stressors (e.g., Dill & Henley, 1998; Heikka et al., 2023; Robotham, 2008), which can result in unhealthy behaviors, subsequently negatively impacting physical and mental health (e.g., O'Connor et al., 2021; Shankar & Park, 2016). For example, college students can become overwhelmed by the pressures of school, resulting in deleterious health behaviors (e.g., Fruehwirth et al., 2023), including poor sleep (e.g., Valerio et al., 2016; Wang & Bíró, 2021), unhealthy eating (e.g., Araiza & Lobel, 2018; Hill et al., 2022), and alcohol use (e.g., Brenman et al., 2024; Park et al., 2004). These behaviors also may have downstream consequences, such as overall poor health (e.g., Kennett et al., 2021; Ribeiro et al., 2018). Attempting to cope with the pressures of college also may result in students gaining weight due to excessive eating related to stress, depression, poor body image, and sleep disorders (Phillips et al., 2016). To combat stress, college students can focus on engaging in healthy behaviors. Exercise, for example, is one of the best available tools to reduce stress and to improve and maintain overall physical and psychological health (e.g., Herbert et al., 2020; Huang et al., 2023; Ruegsegger & Booth, 2018; Warburton & Bredin, 2017; Zhou, et al., 2023). However, people do not exercise enough and attempts to increase exercise engagement often are unsuccessful (e.g., Thivel et al., 2018; Marteau et al., 2012). Because of how beneficial exercise is for health, it is important to understand what motivates college students to exercise. Accordingly, in the present study, we examined psychological needs as potential predictors of college students' motivation for exercise, as well as for their general intrinsic motivation.

Motivation refers to one's reason for engaging in an activity to make effective choices and actions to achieve goals (e.g., Higgins, 2012; Schunk & DiBenedetto, 2021). "To be motivated means *to be moved* to do something" (Ryan & Deci, 2000a, p. 54). Motivated individuals are determined or persistent when attempting to accomplish or gain some outcome. Motivation can be categorized as extrinsic and intrinsic. Extrinsic motivation drives a person to act through external forces or outcomes (e.g., money, a good grade, social status) that are independent of one's own internal desires and interests (e.g., Morris et al., 2022; Ryan & Deci, 2020). Intrinsic motivation, on the other hand, is an internal feeling or desire that drives a person to act (Ryan & Deci, 2020). Individuals who are intrinsically motivated engage in those actions because of interest or internal enjoyment in the absence of external rewards (e.g., Kruglanski et al., 2018; Morris et al., 2022; Ryan & Deci, 2020). In other words, intrinsic motivation is an internally driven pursuit to accomplish something that has personal significance to an individual.

Intrinsic motivation relates to satisfaction of basic psychological needs that people are personally trying to fulfill and that promote psychological growth (e.g., Legault et al., 2017; Ryan & Deci, 2020; Ryan et al., 2019; Vansteenkiste & Ryan, 2013; Vansteenkiste et al., 2023; Warburton et al., 2020). Because of these features, intrinsic motivation is highly useful for promoting maintenance of goal-related behaviors that require motivation and sustained effort over time. According to Basic Psychological Needs Theory (BPNT), a sub theory of the self-determination theory of motivation, satisfaction of one's basic psychological needs for autonomy (i.e., the ability or right to govern oneself and one's activities), competence (i.e., mastery or self-efficacy over one's activities), and relatedness (i.e., the sense of belonging or connection to other people) promote maximum goal-related persistence and performance (e.g., Deci & Ryan, 2000; Ryan & Deci, 2000b; Vansteenkiste et al., 2020). Such persistence and performance are indicative of high levels of motivation and engagement related to a variety of tasks and activities (e.g., Ryan & Deci, 2000b; Vansteenkiste et al., 2020). Previous research supports this, showing that intrinsic motivation is closely linked to feeling fulfilled in life, as indicated by such psychological need satisfaction (e.g., Deci & Ryan, 2000; Ryan & Deci, 2000b; Vansteenkiste & Ryan, 2013). Self-determination theory also posits that peak psychological health and well-being stem from fulfillment of these basic psychological needs. Specifically, satisfaction of needs leads to further motivation and positive psychological health outcomes, whereas a lack of satisfaction of basic psychological needs (i.e., not meeting one's needs) is linked to low motivation and poor health and well-being (e.g., Martela et al., 2023; Ryan & Deci, 2000b; Ryan & Deci, 2017).

Among college students, motivation and achievement tend to be negatively associated with unhealthy behaviors (e.g., Allen et al., 2022; El Ansari et al., 2013; Hershner, 2020; Petrucci et al., 2020). This is concerning because motivation can be especially important for health behaviors such as exercise, which, as noted earlier, requires sustained effort and is an important tool for reducing stress and optimizing health. Fortunately, motivation related to physical health and physical activity itself also can be psychologically satisfying for people (e.g., Ipolyi et al., 2021; Xu et al., 2021). To increase motivation for exercise, then, it may be helpful to understand what drives that motivation. Some people might be motivated to exercise by a need to feel fulfilled in life. For example, studies have shown that fulfilled psychological needs such as autonomy are associated with motivation for physical activity (e.g., Cox et al., 2008; Schneider & Kwan, 2013), greater intentions to participate in physical activity in the future (e.g., Sánchez-Oliva et al., 2020; Shen et al., 2007), and physical activity behavior (e.g., Hagger et al., 2003; Kang et al., 2020). However, if a person's need for fulfillment is not yet met, but rather is desired, that desire also may drive motivation. Accordingly, it is possible that a person's need for psychological fulfillment (e.g., how *important* it is to them that they are free to decide how to live their life, versus whether they feel they *are* free to do so) relates to their exercise and/or intrinsic motivations, as well.

Research also has shown that happiness is associated with intrinsic motivation (e.g., Patrick et al., 2007). Happiness is perceived as a mental state (e.g., Jongbloed & Andres, 2015; Raibley, 2012) and conceptualized by most people as positive emotions or life satisfaction, with the absence of negative emotions as a third commonly noted component (Argyle, 2001). People may feel happy when they attain either their intrinsic or extrinsic aspirations (Kasser & Ryan, 1996) or when they pursue or engage in acts that align with their goals (e.g., Sheldon et al., 2010; Wang & Milyavskaya, 2020). Studies have shown that positive affect predicts intrinsic motivation and motivation to devote additional time and effort to attaining goals (e.g., Haase et al., 2012; Løvoll et al., 2017). Aside from these benefits of *current* happiness for motivation, people might be motivated generally and/or to exercise by a desire, or *need*, to feel happy (e.g., how *important* it is to them that they consider themselves a happy person, versus whether they

*do* consider themselves happy). This is especially possible given popular knowledge of the empirically supported relationship between exercise and happiness (e.g., Richards et al., 2015; Zhang & Chen, 2019).

There is limited research, however, examining whether psychological *needs for* fulfillment (i.e., autonomy, competence, and relatedness) or happiness (i.e., positive emotion and life satisfaction) might relate to intrinsic and/or exercise motivations. Researchers have expanded on self-determination theory to propose a distinction between psychological needs themselves serving as motivation and psychological needs existing as requirements to be satisfied (e.g., McClelland, 1985; Sheldon, 2011). According to this two-process model, met (i.e., satisfied) needs differ from not-yet-met (i.e., dissatisfied) needs in that they reflect different timepoints in a motivated action sequence (Sheldon, 2011). Need satisfaction and need dissatisfaction are thought to be related but conceptually distinct from each other, and it has been suggested that an unmet need should be motivating (see Neubauer et al., 2018 for a review). However, findings on the motivational effects of unmet needs are mixed (Neubauer et al., 2018). Therefore, more research is needed to understand how desired, or unmet, needs relate to intrinsic motivation and whether they also may relate to exercise motivation, specifically.

### The Present Study

As outlined above, intrinsic motivation is closely related to fulfilled psychological needs and successful goal attainment, and understanding both unmet and met needs is important for understanding motivation. In the present study, we investigated whether a person's unmet but desired needs for fulfillment and happiness relate specifically to exercise motivation and to general intrinsic motivation. Our key interest was in examining whether a need for fulfillment and/or a need for happiness predicted college students' exercise motivation, given that exercise may serve as a healthy way for college students to mitigate the negative health effects of stress. Additionally, because college students regularly engage in a wide range of academic and personal tasks that require motivation, we tested whether either need was associated with intrinsic motivation in our sample of college students. We hypothesized that need for fulfillment and need for happiness would be positively associated with exercise motivation, but that need for happiness would be a stronger predictor of exercise motivation. We also predicted that need for fulfillment and need for happiness would be positively associated with intrinsic motivation, but that need for fulfillment would be a stronger predictor of intrinsic motivation. Prior to data collection, the study hypotheses and analyses plan were preregistered via the Open Science Framework (osf.io/2n95c).

## Method

### Participants

A total of $N = 100$ undergraduate students were recruited from the psychology subject pool at Angelo State University to participate in this research online in exchange for course credit. A power analysis was conducted using G*Power 3.1.9.6 for a multiple regression analysis with two predictor variables. This yielded a target sample size of 100 to detect a small-to-moderate effect size of $f^2 = .10$ at alpha .05 with .80 power. The study was available on Sona Systems during a single semester. Participants signed up for the study through their Sona Systems account and completed the study via Qualtrics survey software. For their involvement, participants received Sona credit to be applied toward requirements and/or extra credit opportunities in their psychology courses.

Participants were primarily female (Sex: 85 Female, 14 Male, 1 declined to respond) and ranged in age from 18 to 52 years old ($M = 20.27$, $SD = 4.84$). Most of the study participants were between the ages of 18 and 25, but three participants reported ages above 25 (i.e., 36, 48, 52). Although these participants are older than traditional college students, it is not unusual for us to have a few older participants in some samples at our university. As such, we retained their data. Importantly, whether including or excluding two age outliers (i.e., 48 and 52 years old, which are greater than 3.5 standard deviations above the mean age), the pattern of results across the analyses are the same. Reported race/ethnicity of the sample was 42% European American/White, 32% Hispanic/Latino American, 15% more than one race, 4% African American, 3% Other, 2% Asian American, and 1% Native American/American Indian (1 declined to respond). There were no statistically significant sex or race/ethnicity differences in any of the study variables of interest, and age was not significantly correlated with any of the study variables. Further details regarding participant characteristics are presented in Table 1. All protocols and procedures of this study were approved by the human-subjects review board at Angelo State University.

### Procedure

This study was conducted online in one session. The survey informed participants that they were participating in a study that would assess student

**Table 1**
*Full report of sociodemographic characteristics of the study participants.*

| Sample Characteristic | *n* | % | Range | *M* | *SD* |
|---|---|---|---|---|---|
| **Sex** | | | | | |
| Female | 85 | 85.9% | | | |
| Male | 14 | 14.1% | | | |
| Declined to Respond | 1 | | | | |
| **Gender** | | | | | |
| Woman | 82 | 82.8% | | | |
| Man | 13 | 13.1% | | | |
| Non-binary/Third gender | 2 | 2.0% | | | |
| Genderqueer/Gender non-conforming | 2 | 2.0% | | | |
| Something else | 0 | 0.0% | | | |
| Prefer not to say | 0 | 0.0% | | | |
| Declined to Respond | 1 | | | | |
| **Race/Ethnicity** | | | | | |
| African American | 4 | 4.0% | | | |
| Asian American | 2 | 2.0% | | | |
| Hispanic/Latino American | 32 | 32.0% | | | |
| Native American/American Indian | 1 | 1.0% | | | |
| European American/White | 42 | 42.0% | | | |
| Other | 3 | 3.0% | | | |
| More than one race/ethnicity selected: | | | | | |
| African American and Hispanic | 3 | 3.0% | | | |
| African American and White | 1 | 1.0% | | | |
| Asian American and White | 2 | 2.0% | | | |
| Hispanic and White | 9 | 9.0% | | | |
| Declined to Respond | 1 | | | | |
| **Age** | 99 | | 18-52 | 20.27 | 4.84 |
| Declined to Respond | 1 | | | | |
| **Body Mass Index** | 97 | | 16.46-55.91 | 26.10 | 7.46 |
| Declined to Respond | 3 | | | | |

*Note*: Total sample size = 100

motivation and health. Participants completed a consent form and then completed the study questionnaires presented in randomized order. Upon completion of the survey, participants were provided with an online debriefing statement and thanked for their participation.

**Measures**

The two predictors of interest were "*need for* fulfillment" and "*need for* happiness." To measure these needs, we modified existing questionnaires of *current* psychological fulfillment and *current* subjective happiness to reflect how important these needs were to participants. These measures and their necessary modifications are described below.

***Need for Fulfillment***

The 21-item Basic Psychological Needs Satisfaction Scale (Ryan & Deci, 2000b) was used to assess psychological need fulfillment. This scale measures the extent to which basic psychological needs for autonomy, competence, and relatedness are met. Here, however, we were interested in measuring *need for* fulfillment, therefore we modified the items. For example, the original item "I feel like I am free to decide for myself how to live my life" was changed to "[It's important to me that] I feel like I am free to decide for myself how to live my life;" another example modified item is "[It's important to me that] people are generally pretty friendly towards me." Participants rated the extent to which each statement was true for them on a scale from 1 (*not at all true*) to 7 (*very true*). The items were averaged to create an overall score, with higher values reflecting a greater need for fulfillment. Participants also completed the original measure to assess *current* psychological need fulfillment. Both versions showed very good reliability. Need for fulfillment: Range = 1 to 7, $M$ = 5.03, $SD$ = .76, α = .84; Current fulfillment: Range = 1 to 7, $M$ = 4.81, $SD$ = .83, α = .87.

***Need for Happiness***

The 4-item Subjective Happiness Scale was used to assess happiness (Lyubomirsky & Tucker, 1998). Here, we were interested in measuring one's *need for* happiness, therefore we modified the items. For example, the original item "In general, I consider myself:" rated on a scale from 1 (*not a very happy person*) to 7 (*a very happy person*) was changed to "In general, [it's important to me to] consider myself:" rated from 1 (*not a very happy person*) to 7 (*a very happy person*). Another example is "Compared to most of my peers, [it's important to me to] consider myself:" rated from 1 (*less happy*) to 7 (*more happy*). Each item was assessed using its own response scale. Scores on all items were summed, with higher values indicating a greater need for happiness. Participants also completed the original scale to measure *current* happiness levels. Reliability was acceptable for the modified version and adequate for the

original version (Taber, 2018). Need for happiness: Range = 4 to 28, *M* = 17.81, *SD* = 3.89, α = .60; Current happiness: Range = 4 to 28, *M* = 16.70, *SD* = 4.80, α = .77.

### *Exercise Motivation*

The Behavioral Regulation of Exercise Questionnaire 3 was used to assess exercise motivation (Markland & Tobin, 2004; Wilson et al., 2006). We included 20 items to measure motivation related to exercise. Some example items include "It's important to me to exercise regularly" and "I enjoy my exercise sessions." Participants rated each item on a scale from 0 (*not true for me*) to 4 (*very true for me*). The measure assesses several types of motivation, but we averaged all items into a single score reflecting overall motivation for exercise. This 20-item version showed very good reliability; Range = 0 to 4, *M* = 2.48, *SD* = .65, α = .87.

### *Intrinsic Motivation*

The achievement motivation items of the Work and Family Orientation Questionnaire (Spence & Helmreich, 1983) were used to assess three facets of intrinsic motivation (i.e., work motivation/achievement, mastery, and competitiveness). Due to researcher error, the competitiveness subscale was omitted and only the 14 items reflecting the work motivation/achievement subscale and the mastery subscale were included in this study. The work motivation/achievement factor represents "the desire to work hard and to do a good job" and the mastery factor reflects "a preference for difficult, challenging tasks and for meeting internally prescribed standards of performance excellence" (Spence & Helmreich, 1983). Participants rated items such as "I like to work hard" and "Once I undertake a task, I persist" on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). A total score was calculated by summing all work motivation/achievement and mastery items. The scale showed adequate reliability, with higher scores reflecting more intrinsic motivation; Range = 14 to 70, *M* = 52.28, *SD* = 6.81, α = .78.

### *Demographics*

Participants reported their sex, gender identity, age, height, weight, and race/ethnicity.

## Results

Data were analyzed using Pearson product-moment correlations and simultaneous multiple regression analyses. Correlations for all study variables are presented in Table 2. Full regression results for hypothesis tests are presented in Table 3.

### Exercise Motivation

Correlational analyses showed that neither need for fulfillment ($r$ = .11, $p$ = .274) nor need for happiness ($r$ = -.03, $p$ = .797) were statistically significantly correlated with exercise motivation, contrary to our hypotheses.

### *Preregistered Analysis*

To test our predictive hypotheses related to exercise motivation, we entered need for fulfillment and need for happiness into a simultaneous multiple regression model predicting exercise motivation. No significant associations were observed between either predictor variable of interest and exercise motivation. The overall model was not statistically significant, $R^2$ = .02, $F(2, 97)$ = .72, $p$ = .490. Need for fulfillment ($\beta$ = .12,

**Table 2**

*Correlations among all study variables, both primary and exploratory.*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Need for Fulfillment | | | | | |
| 2. Need for Happiness | .20* | | | | |
| 3. Current Fulfillment | .46*** | .50*** | | | |
| 4. Current Happiness | .09 | .76*** | .59*** | | |
| 5. Exercise Motivation | .11 | -.03 | .13 | .12 | |
| 6. Intrinsic Motivation | .19 | .22* | .37*** | .34** | .11 |

*Note*: Pearson product-moment correlation coefficients presented. *$p$ < .05, **$p$ < .01, ***$p$ < .001

**Table 3**

*Full regression output for primary hypothesis tests predicting exercise motivation and intrinsic motivation from need for fulfillment and need for happiness.*

| **Dependent Variable:** | Exercise Motivation | | | Intrinsic Motivation | | |
|---|---|---|---|---|---|---|
| **Overall Model:** | $R^2$ = .02<br>$F(2, 97)$ = .72, $p$ = .490 | | | $R^2$ = .07<br>$F(2, 97)$ = 3.64, $p$ = .030 | | |
| **Predictor Variables:** | ***β*** | ***SE*** | ***p*** | ***β*** | ***SE*** | ***p*** |
| Need for Fulfillment | .12 | .09 | .245 | .16 | .90 | .119 |
| Need for Happiness | -.05 | .02 | .628 | .18 | .18 | .069 |

SE = .09, $p$ = .245) and need for happiness ($\beta$ = -.05, SE = .02, $p$ = .628) were not significantly associated with exercise motivation, contrary to our hypotheses.

### *Exploratory Analysis*

Next, we explored associations between current fulfillment and current happiness with exercise motivation. The overall model predicting exercise motivation from current fulfillment and current happiness also was not statistically significant, $R^2$ = .02, $F(2, 97)$ = .98, $p$ = .380. Neither fulfillment ($\beta$ = .10, SE = .10, $p$ = .437) nor happiness ($\beta$ = .06, SE = .02, $p$ = .631) predicted exercise motivation when considered uniquely.

Results did not support any associations of needs for fulfillment or happiness nor current fulfillment or happiness with exercise motivation.

### *General Intrinsic Motivation*

Contrary to expectations, need for fulfillment was not statistically significantly correlated with intrinsic motivation ($r$ = .19, $p$ = .054). However, need for happiness was significantly, positively correlated with intrinsic motivation ($r$ = .22, $p$ = .030), supporting our hypothesis that these variables would be positively associated.

### *Preregistered Analysis*

To test our hypotheses related to intrinsic motivation, we entered need for fulfillment and need for happiness into a simultaneous multiple regression model predicting intrinsic motivation. The overall model was statistically significant, $R^2$ = .07, $F(2, 97)$ = 3.64, $p$ = .030, providing some support for our hypothesis that these predictors combined would account for variance in intrinsic motivation. However, neither variable was uniquely associated with intrinsic motivation in this model; specifically, need for fulfillment ($\beta$ = .16, SE = .90, $p$ = .119) and need for happiness ($\beta$ = .18, SE = .18, $p$ = .069) both were non-significant predictors of intrinsic motivation in the context of one another. This result does not support our additional hypothesis that need for fulfillment would be more strongly associated with intrinsic motivation.

### *Exploratory Analysis*

Next, we explored associations of current fulfillment and current happiness with intrinsic motivation. The overall model was statistically significant, $R^2$ = .16, $F(2, 97)$ = 9.16, $p$ < .001. In this model, current fulfillment was significantly positively associated with intrinsic motivation ($\beta$ = .26, SE = .94, $p$ = .025), indicating that intrinsic motivation is higher among participants who report higher levels of current need fulfillment. However, the unique association of current happiness with general intrinsic motivation was not significant ($\beta$ = .18, SE = .16, $p$ = .112).

## Discussion

In a preregistered study, we examined whether college students' exercise motivation and intrinsic motivation were driven by a psychological need for fulfillment or a need for happiness in life. We hypothesized that need for fulfillment and need for happiness would be positively associated with exercise motivation, and that need for happiness would be a stronger predictor of exercise motivation. We also predicted that need for fulfillment and need for happiness would be positively associated with intrinsic motivation, and that need for fulfillment would be a stronger predictor of intrinsic motivation. Results showed that needs for psychological fulfillment and happiness may not be important factors for predicting exercise motivation or for uniquely predicting intrinsic motivation. More specifically, none of the needs variables were statistically significantly associated with exercise motivation. Although need for happiness was positively associated with intrinsic motivation, as hypothesized, this association did not remain statistically significant when considered simultaneously with need for fulfillment. However, needs for fulfillment and happiness together did account for significant variance in intrinsic motivation. Finally, the exploratory analyses showed that current fulfillment uniquely predicted intrinsic motivation in the model considering it together with current happiness. This finding is consistent with previous literature on intrinsic motivation and provides further support for current psychological need fulfillment as a key predictor of intrinsic motivation.

Neither need for fulfillment nor need for happiness were associated with exercise motivation in this study. These null findings suggest many interesting possibilities for other variables not included here that may be more informative for understanding exercise motivation. For example, research has shown that exercise motives are related to body image (e.g., Panão & Carraça, 2020; Teixeira et al., 2012; Tylka & Homan, 2015). Considering this, it is possible that aesthetic needs may be more useful than needs for fulfillment or happiness for predicting exercise motivation. It also has been suggested that the rejection and discrimination people higher in body weight experience may prevent them from fulfilling the fundamental need for belonging (Magallares et al., 2011). Research does support this notion, as people higher in body weight have lower quality social relationships (e.g., Albano et al., 2019; Carr & Friedman, 2006). Relatedly, individuals whose social network accepts, rather than rejects, their weight tend to

show more positive psychological and physical health outcomes (e.g., Ata et al., 2007; Logel et al., 2014). Thus, another potential predictor of exercise motivation may be a need for belonging. Specifically, individuals who value their social life may be more inclined to exercise to achieve a desired weight/figure that affords them acceptance from others, which may help them meet their psychological need to belong.

Another potential important need related to exercise motivation may be the need to protect or bolster self-esteem to avoid social exclusion (Leary et al., 1995). For example, individuals concerned about weight-based rejection may be motivated to exercise to protect their self-esteem from threats of ostracism. Additionally, those who equate worth to their body weight or figure may be more motivated to exercise in the service of body- or self-esteem (e.g., Sani et al., 2016; Wilson & Rogers, 2002; Zervou et al., 2017). Each of these variables reflects an interesting target for future research, building on the knowledge gained from the present work that needs for fulfillment and happiness may not relate to exercise motivation.

Our tests of current fulfillment and current happiness predicting exercise motivation were exploratory and the lack of a significant association between current fulfillment and exercise motivation is inconsistent with previous research on psychological need fulfillment and exercise. For example, overall psychological need fulfillment (i.e., all three facets of the Basic Psychological Needs Satisfaction Scale: autonomy, competence, and relatedness) and the separate autonomy and relatedness facets of psychological need fulfillment have been associated with motivation for physical activity (Cox et al., 2008). However, Cox et al. (2008) studied adolescents and the present work utilized adult college students, for whom other needs (e.g., physical thriving, pleasure) or life circumstances (e.g., sports training, dating) may be more salient in relation to exercise motivation. Other researchers have observed positive associations between psychological need satisfaction and exercise motivation among college students but have noted that various scoring protocols for the exercise motivation questionnaire used here may explain differences in findings and interpretations across studies that use the measure (Chu & Zhang, 2022). It also is important to note that the non-significant observed predictor variables' associations with exercise motivation were small and may not have been detectable with the a priori powered sample size, which we calculated using a more moderate effect size based on effect sizes in previous studies relating psychological need satisfaction to exercise (e.g., Chu & Zhang, 2022; Cox et al., 2008). Regardless of statistical significance, however, the associations observed in our sample were much smaller than in previous studies. This highlights a need for further research into psychological needs for fulfillment and happiness as they relate to exercise motivation among college students both similar to and different from those in the present sample.

Although the hypotheses related to exercise motivation were not supported, the exploratory finding that current psychological fulfillment was a significant predictor of intrinsic motivation, even in the context of current happiness, is consistent with previous research showing that when an individuals' needs are fulfilled, they are more motivated (e.g., Ryan & Deci, 2000b; Vansteenkiste & Ryan, 2013). This may be because those whose needs are fulfilled do not have to expend as much energy satisfying needs and instead can focus on motivating themselves. This predictive utility of current psychological need fulfillment for intrinsic motivation observed here is consistent with BPNT and unsurprising based on a wealth of motivation literature. As such, this adds validity to the overall contributions of this work.

**Limitations and Future Directions**

One limitation of the present study is that we modified the original measures of psychological need fulfillment and subjective happiness to assess *needs for* fulfillment and happiness. The happiness measure, in particular, may have been confusing for participants following modification, given that the items and response scales of the original measure have different wording and may not clearly represent opposite ends of a continuum once modified. For example, responding to the item "In general, it is important to me to consider myself: *not a happy person* versus *a very happy person*." may not be the same as responding to the original item (i.e., "In general, I consider myself: *not a happy person* versus *a very happy person*."). Furthermore, the endpoints of the response scale for such an item may not reflect the same construct. Although reliability coefficients for the modified fulfillment and happiness measures were acceptable, it is possible that the items and/or response scales may have been confusing for participants or may require further/other modifications to ensure they are measuring the same construct. As such, future research should use other measures of these needs or conduct preliminary studies to assess clarity and accuracy of the items as modified in this study.

Also related to our measures, need for fulfillment was negatively skewed in the present data. There was still variability in the scores on need for fulfillment, but its skew could be a potential explanation for its unexpected non-significant association with general intrinsic

motivation here, which is inconsistent with the literature on current need fulfillment and intrinsic motivation. Additionally, the competitiveness subscale of the intrinsic motivation measure was omitted from the survey administered to participants, due to researcher error. Although this concern is alleviated somewhat because the remaining items for each scale were adequately reliable, future research should replicate this study including the competitiveness subscale of the intrinsic motivation measure. Future studies also should include other measures of exercise motivation, given the varied scoring procedures for the exercise questionnaire used in this study.

Another limitation is that this study was conducted using a general sample of undergraduate college students. However, exercise motivation may be related to needs for fulfillment and happiness in life in more targeted samples, such as student athletes. Therefore, future research could examine whether needs for fulfillment and/or happiness are important predictors of exercise motivation among athletes or students who regularly engage in exercise. Relatedly, we also did not measure participants' current exercise behavior, which may be important. Although our focus was on psychological needs and their relation to motivation (rather than behavior), future research extending this work to exercise behavior or controlling for participants' current levels of exercise engagement will be informative. Experimental or longitudinal studies also may help determine directionality and the extent to which current exercise patterns lead to or stem from exercise motivation and/or relate to psychological needs.

Given the demographic characteristics of our sample, results from this work also are limited in their generalizability. Our university and the present sample comprise a greater number of students who identify as Hispanic and fewer students who identify as other races or ethnicities, compared to college students and samples nationally. This may have important implications for our findings, as both psychological needs and motivation may differ for individuals of different races/ethnicities or cultural backgrounds. Race differences were not observed in the present study across our needs and motivation variables, which is consistent with related theorizing and research on the cross-cultural applicability of self-determination theory (e.g., Ryan & Deci, 2020). However, other theorizing and research do support the existence of cultural differences in such variables (e.g., Nolen, 2020), meaning further investigation is warranted. Our sample also consisted of primarily self-identified women, meaning that the present results may not generalize beyond women. As such, future studies examining how psychological needs relate to exercise motivation among college students of different races and genders will be important for understanding the applicability of the present findings to wider college-student populations and for illuminating ways to motivate college students more broadly. Finally, studies testing whether associations between psychological need fulfillment and exercise motivation could be moderated by race, age, sex, or gender, and why, also could be interesting next steps for this research. For example, it may be useful to further examine the potential for sex or gender differences in associations of various psychological needs with exercise motivation, given previous research showing that males and females are motivated to exercise by different factors (e.g., strength versus appearance, respectively; Egli et al., 2011).

**Implications and Conclusions**

The broad aim of this study was to investigate possible factors related to exercise motivation and intrinsic motivation among college students. We aimed to understand whether needs for fulfillment or happiness in life predict students' motivations for exercise and/or their motivation in general. Our findings align with previous research demonstrating a consistent association between psychological fulfillment and intrinsic motivation while potentially ruling out needs for fulfillment and happiness as predictors of exercise motivation. These results have implications for college students, as well as professionals who work with them. For example, this work provides further evidence for the importance of basic psychological need fulfillment for general intrinsic motivation, which is critical for college students' success. Counselors, coaches, faculty, and other professionals working directly with college students should aim to foster autonomy, competence, and relatedness in the tasks and activities they assign (e.g., offer agency over schedules and activities, encourage mastery in sports and the classroom, provide opportunities for engagement and teamwork to build connections with their peers).

Importantly, the lack of associations of either need for fulfillment or need for happiness with exercise motivation have implications for our understanding of what motivates college students to exercise, particularly by highlighting the need for additional research into this important question. These findings are particularly applicable to research professionals. Specifically, it will be important to identify other personal needs that may be more relevant to exercise motivation, which in turn can inform academic professionals more directly on how to motivate exercise behavior to promote optimal physical and psychological health among college students. Determining predictors of exercise motivation in college

students has the potential to help them remain active and healthy during their college years and beyond.

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The preregistered study plan and hypotheses, a de-identified participant data file, a data codebook, and analytical code/syntax can be found on the Open Science Framework at osf.io/kxesa. The authors report there are no competing interests to declare.

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# OPTIMIZING HUMAN PERFORMANCE AT TSA AIRPORT SCREENING CHECKPOINTS: INTEGRATING PSYCHOLOGY IN SECURITY SYSTEMS

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**Abstract** – In today's persistent threat environment, strengthening the airport security screening checkpoint with its holistic human, social, and technological ecology in mind is an ongoing challenge. Research has focused on technology applications and the design of new or integrated systems, leaving out human-based solutions. A human factors psychology perspective can identify optimization potential without the need to commit to technology development. This paper discusses using human factors principles at airport security screening checkpoints to enhance security. The paper identifies three areas associated with human error at checkpoints. The focus is on how well system components (such as screening tasks) and organizational elements (such as scheduling/shiftwork, training, culture, communication, or procedures) are designed to interface with human physiological and cognitive abilities and limitations. This literature review focuses on the following critical elements in optimizing human performance at TSA airport security screening checkpoints: countering deception, preventing and mitigating fatigue, and fostering Critical Thinking and Effective Communication (CTEC).

*Keywords:* Human factors, security, system optimization, deception, fatigue

The terrorist attacks on the United States on September 11, 2001, occurred as terrorists overcame security screening procedures at Boston, Washington Dulles, and Newark airports (Kean & Hamilton, 2004). Subsequently, the Transportation Security Administration (TSA) was created as a component of the new U.S. Department of Homeland Security that was founded on November 25, 2002, and started operations on March 1, 2003. In today's environment, strengthening airport security screening checkpoints continues to be an important challenge (Janssen, van den Berg & Sharpanskykh, 2020; McFarlane, 2020; Walter, Schmutz & Grote, 2022). With increased demands for more agency funding and investment in technology for air transportation security (Berrick, 2008; Wang et al., 2014), it is also important to identify shortfalls and optimization potential related to human factor psychology. Such an additional focus promises security enhancement, with no need for large budget commitments and technology investment.

As the DHS Office of the Inspector General pointed out in a report titled "TSA needs to improve efforts to retain, hire, and train its Transportation Security Officers (TSO),"

> TSO responsibilities include operating various screening equipment and technology, performing pat-downs of passengers, conducting bag searches, controlling airport terminal entry and exit points, interacting with the public, and understanding and implementing TSA standard operating procedures [...]. In carrying out these screening responsibilities, TSOs must think critically about current threats and risks, and the responses necessary to mitigate

> those threats. (U.S. Department of Homeland Security 2019a, p.1)

However, the report found that training alone is not enough to develop the knowledge, skills, and abilities TSO's need to function optimally in their roles (U.S. Department of Homeland Security 2019a).

Against this challenge, this paper discusses the human factors principles that can be integrated into homeland security processes at airport security screening checkpoints. Human factors is an applied area of psychology that focuses on human-technology interactions (Stone et al., 2018). Human factors researchers use their knowledge of human capabilities to design technologies and systems that are best adapted to human capabilities. Discussing how human factors can be used to enhance the security screening process at airports is a relevant application of knowledge (Chartered Institute of Ergonomics and Human Factors, 2022). This work identified three main challenges at the TSA airport security screening checkpoint: countering deception, preventing and mitigating fatigue, and fostering critical thinking and effective communication (CTEC). The review identifies psychological principles relevant to security screening and TSA operations and suggests solutions to the issues identified.

## Countering Deception at the TSA Screening Checkpoint

The first challenge in the TSA checkpoint system is detecting deception. Common sense would suggest that if detection of deception, and resultant threats related to deception, were countered early in the screening process, the air transportation system would be safer. Travelers carrying banned items such as weapons or dangerous substances would be prevented from entering the principal areas of airport terminals and from boarding flights. To make recommendations to enhance safety, understanding deception and detection is important.

### Deception

Deception is more than just lying. The act of misleading or manipulating someone by false remarks, acts, or behavior with the goal of getting them to believe something untrue is referred to as deception (Galasiński, 2000; Granhag & Hartwig, 2012). It entails purposefully hiding or falsifying information to control people for one's own benefit, escape punishment, or accomplish a certain objective. Detection of deception is an important component of security screening, in order to ensure dangerous individuals or materials do not pass through checkpoints.

Galasiński's (2000) definition of deception is a good starting point for understanding deception. According to Galasiński, deception is defined as an act that is intended to foster in another person a belief or understanding that the deceiver considers false. Depending on the situation and the people involved, deception can take on different forms. However, there are several universal traits that are frequently linked to deceptive behavior. These consist of intentionality, false information, manipulation, motivation, and behavioral inconsistencies. Intent is a deliberate and intentional act of misleading others that constitutes deception. The deliberate effort to offer incorrect information is not accidental. Providing false information is a deceptive behavior that usually entails the dissemination of untrue information, either by blatant lying or by leaving out crucial details. Manipulation is when deceivers may employ a variety of strategies, such as delivering incomplete truths or causing distractions, to influence the perceptions or beliefs of their targets. There is typically a reason for motivation, which can range from self-interest or self-preservation to gaining a particular result or advantage. When it comes to inconsistent behavior, deceptive people may act inconsistently or give inconsistent verbal or body language cues while handling contradictory information.

Depending on the situation and the parties involved, deceit can serve a variety of purposes. Deception is typically used as a tactical strategy to accomplish specific objectives, acquire advantages, safeguard oneself, or control others. These could all be listed under the umbrella of personal gain. One can use deception to obtain personal advantages or benefits, such as financial gain, resource acquisition, or job advancement. In terms of self-preservation, people may use deception when they feel threatened or defenseless, to shield themselves from harm or punishment.

### Indicators of Deception

By exploring empirical studies and theoretical frameworks, we can grasp the indicators that may manifest during deceptions. Two general types of deception indicators are behavioral and physiological (Vrij 2000; Vrij et al., 1996). The cues or symptoms used to determine if someone is being deceitful differ between behavioral and physiological markers of deception. Although both sorts of indicators are frequently investigated in the context of deception detection, they draw their data from various sources. Observable acts, verbal clues, and nonverbal behaviors that can indicate deceit are the focus of behavioral indicators (de Turck & Miller, 1985).

When someone is lying, their communication styles and body language frequently shift, which serves as one of these clues. Several typical behavioral signs of

deception include gaze aversion, speech errors, and nervousness (fidgeting). However, physiological indicators concentrate on alterations in the body's physiological reactions during deceitful behavior. These signs are frequently assessed using a range of physiological sensors and tools. Physiological signs of deception frequently include an increase in respiratory and heart rates, starting to sweat, one's mouth going dry, and a shaky voice.

Furthermore, indicators can be broken down into separate categories, which include those based in psychology and the study of human behavior (Cohn et al., 2007). Advocates of detection suggest that these psychological techniques can be used by many different professionals, such as security guards, counter-terrorism agents, and police interrogators. When psychological techniques are combined with vocal cues and speech patterns, it can lead to a 90% success rate when detecting deception (Adelson, 2004; Ekman & Friesen, 1978). Furthermore, the FACS, or Facial Action Coding System, is the coding system used to evaluate indicators (Cohn et al., 2007; Ekman & Rosenberg, 1997; Ekman & Friesen, 1978).

Psychological indicators refer to observable actions, facial expressions, and gestures displayed by individuals engaged in deception. There are three different theories and approaches regarding psychological indicators (Granhad & Hartwig, 2012). These include the Cognitive Complexity Theory (Spence, 2004; Spence et al., 2001), the Transactive Memory Approach (Driskell et al., 2012b) and the Emotional Deception Model (Gaspar & Schweitzer, 2013). All three of these have pros and cons in deception detection and should be used in certain situations.

The Cognitive Complexity Theory (Spence et al., 2000) is a cognition-based lie detection approach that seeks to understand and explain the cognitive processes underlying an individual's perceptions, problem-solving abilities, and decision-making skills. It argues that lying is a more cognitively demanding task than truth telling (Spence et al., 2001; Verschuere, Spruyt, Meijer, & Otgaar, 2011). It takes more mental power and thought to be able to suppress the pre-potent truth and appear innocent, especially during an in-person interview. People can be trained to use certain techniques that look for cognitive overload, such as asking people to tell their story backwards.

The Transactive Memory Approach requires two or more conspirators and depends on them being able to tell the correct story (Driskell et al., 2012a). Memories from one person may trigger memories of events in another person, leading them to fill in the story for each other. This means that people in continuing relationships develop a specialized division of labor with respect to encoding, storage, and retrieval of information. This approach is only valid when there are two or more suspects in question. Separating the suspects and asking unexpected questions to see if their story is lining up is a technique that can be easily trained for using this approach.

The most useful approach to deception detection, the Emotional Deception Model (EDM: Gaspar & Schweitzer, 2013), describes the three emotions associated with lying, and builds detection based on these emotions. This model is useful because it was developed and tested for use in applied settings, and it narrows the focus of the user to a small set of important emotions with a specific outcome. The three emphasized emotions are fear, guilt, and excitement. The focus of this approach is looking for leakage of these specific emotions. This can be shown through vocal and facial channels, such as elevated tone frequency and microexpressions. When looking for signs of heightened emotions, you can use techniques such as asking unexpected questions or asking individuals to participate in a secondary task during the interview. This could allow the brain to be focused on something else, with the resulting leakage causing individuals' true emotions to be visible through body movements, vocal cues, or microexpressions.

Elaborating on the EDM, the human voice is a potent instrument used for communication, but it may also provide important clues regarding sincerity (Anders Granhag & Vrij 2014; Newman, Pennebaker, Berry & Richards 2003). There are five main vocal indicators that can be used when trying to detect deception (Zuckerman et al., 1979). These include speech patterns, unnecessary pauses, restatement of the questions, avoiding "I" statements, and using the wrong words. During deceptive communication, individuals may exhibit changes in their speech patterns. These alterations can manifest as hesitations, inconsistencies, or shifts in their usual manner of speaking. For instance, a person may suddenly adopt a more formal or overly elaborate style to create a perceived distance from the lie. Deceptive individuals may also often use pauses or hesitation fillers (e.g., "um," "uh," or "you know") as they grapple with fabricating information on the spot. These pauses may be longer or more frequent than during truthful speech, providing potential clues to deception. Furthermore, when asked a direct question, deceptive individuals may rephrase or repeat the question before responding. This tactic serves as a stalling mechanism, allowing them time to construct a response that aligns with their deceptive narrative. People also tend to use first-person pronouns ("I," "me,"

or “my”) when recalling genuine experiences. However, when attempting to deceive, individuals might subconsciously avoid using "I" statements to create psychological distance from the lie, replacing them with third-person pronouns or passive constructions (e.g., "He said," "The document was found"). Finally, deceptive individuals may inadvertently use language that does not accurately convey the intended meaning or align with the context. These linguistic errors can include using incorrect verb tenses, mispronouncing words, or substituting one word for another that has a similar sound but a different meaning.

Despite technological advancements, human screeners remain essential in distinguishing between genuine anomalies in speech and true indications of deception, including in aviation security screening (Ormerod & Dando 2015; Driskell, Driskell, & Salas, E. 2012a). This is particularly important in moving from tactical to strategic detection of deception (Reid, Gozna & Boon 2016).

The EDM also affords the possibility of body/muscular indicators as a supplemental method to behavioral and verbal indicators in deception detection. This supplemental method is critically examined in this section (Ekman & Friesen, 1974). Attending to body/muscular indicators can lead to the successful detection of deception in many situations, increasing safety in situations (Gaspar & Schweitzer, 2013). During deceptive interactions, individuals may exhibit gaze aversion and other eye actions, indicative of deception (Gullipalli et al., 2021). These behaviors can stem from feelings of guilt, discomfort, or anxiety associated with the act of lying. Deceptive individuals may find it challenging to maintain eye contact, as they fear that their lies will be detected through their eyes.

An increase in blinking frequency may also show deception and is another body movement that has been associated with deception (Gullipalli et al., 2021). While it is natural for blinking rates to vary depending on environmental factors, increased blinking during a conversation or when responding to specific questions may indicate heightened stress or cognitive load associated with maintaining a deceptive narrative. Finally, foot and leg movements can reveal indicators of internal emotional states and deception (Vrij et al., 1996). For instance, fidgeting, tapping, or bouncing the legs may signify nervousness or discomfort during deceptive interactions. These subconscious movements can result from the stress of keeping up with a lie. It is important to note that body and muscular indicators should be interpreted in conjunction with other nonverbal cues, and the overall context of the situation. Some individuals may naturally exhibit certain body movements, and cultural norms can also influence nonverbal behavior.

**Detection**

Beyond understanding the elements of deception, it is important to understand if humans can detect the signs discussed above. Spain, Hedge & Blanchard (2017) examined human predictors of screening detection, such as personality traits, abilities, hobbies, and spatial abilities. The work showed that there was faster and more consistent detection with Transportation Security Officers versus Behavioral Detection Officers, but both were highly accurate. “Overall, the results of this analysis showed that visual search performance is strongly affected by behavioral factors, and that spatial ability played a lesser, but significant, role in search performance for TSOs. For BDOs [behavioral detection officers], video game play frequency also explained a significant amount of variance in visual search performance.” (Spain, Hedge & Blanchard, 2017 p.1311).

Non-professional individuals (those without TSA training) were faster at deception detection, however significantly less consistent with their results, than Transportation Security Officers (Biggs et al. 2013). The non-professional searchers completed a detection task with an overall lower accuracy. Furthermore, when comparing the experienced professionals in comparison to the early career professionals, there was a lower accuracy for the experienced professionals. Non-professionals also had a higher false alarm rate, and they took less time to locate the potential target in comparison to the professionals. The recommendation made by Biggs et al. (2013) is to emphasize consistency during professional visual search training and evaluation.

**Deception Research Summary**

It is critical to train screeners (security personnel, law enforcement, etc.) and frequent flyers (passengers who travel often and are familiar with the travel process) to spot deceptive behaviors. This is especially important in fields where deception detection is critical (e.g., the airport). Early threat detection can result in prompt intervention in potentially hazardous circumstances. This can stop crimes, disputes, or security breaches from getting worse. Regular travelers who have been taught to spot deceptive actions can be quite helpful in spotting suspicious people when they are traveling. If they observe someone acting in a suspicious manner, they can notify the appropriate authorities or airline personnel, potentially averting security breaches or incidents.

No single indicator of deception is foolproof, and reliance on a single cue may lead to inaccuracies and misinterpretations. Instead, a comprehensive approach,

combining various indicators and corroborating evidence, holds the key to enhancing the accuracy and reliability of deception detection processes. In conclusion, understanding the subtle intricacies of behavioral, vocal, and body/muscular indicators of deception can contribute to enhanced transportation safety. As humans strive to unravel the enigma of deception, this literature review serves as a foundation for future research endeavors that will enable people to navigate the delicate web of truth and falsehood with greater insight and accuracy.

## Preventing and Mitigating Fatigue at the TSA Screening Checkpoint

The second area of focus for this review is fatigue. While there is no solid body of research specifically on fatigue as it affects Transportation Security Officers (TSOs) at TSA screening checkpoints at airports, the available research on air traffic controllers and fatigue provides transferable insight.

Fatigue significantly impacts air traffic controllers, affecting their physical, mental, and emotional well-being, which in turn compromises their work performance. Cognitive functions such as concentration, dexterity, and intellectual processing are impaired, leading to an increased potential for workplace errors and a compromise in safety (Ferreira et al., 2020). In the high-stakes environment of air traffic control, precision and quick decision-making are imperative, and the balancing act between speed and accuracy becomes crucial. Similarly, the relevance of the speed-accuracy tradeoff at screening checkpoints is important. Accumulating sufficient evidence for decisions enhances accuracy but may slow response times, while faster responses can result in inaccuracies (Donkin et al., 2014). This delicate balance between speed and accuracy is further complicated by the nature of shift work common in these fields, which can disrupt circadian rhythms and sleep quality, exacerbate fatigue, and increase the cognitive workload (Takeyama et al., 2005; Zhang et al., 2021).

Fatigue is typically studied in three components: physical, mental, and emotional (Kop & Kupper, 2016). Physical fatigue, which may stem from sleep deprivation, over-exertion, illness, or inadequate nutrition, can significantly impact job satisfaction. For TSA workers, diminished job satisfaction can hamper performance, which can lead to decreased personal achievements and adverse organizational outcomes. These outcomes can manifest as counterproductive work behavior, increased turnover intentions, and higher incidences of illness (Baeriswyl et al., 2016). These behaviors could result in decreased workplace safety as well as air transport security gaps.

Mental fatigue promotes a decrease in motivation, feelings of exhaustion, lack of energy, and impairs cognitive function and plays a key role in increasing error risk in the workplace. It alters the amount of physical effort people want to invest and is associated with a reduction in the involvement of the prefrontal cognitive control processes (Ferreira et al. 2020).

Working under challenging conditions may precipitate emotional fatigue, which Baeriswyl et al. (2016) described as exhaustion due to the intense physical and mental exertions demanded by high-stress jobs. Such a state typically presents diminished work performance and can potentially lead to burnout, characterized by a diminished sense of personal identity and a reduced capacity to fulfill work responsibilities (Barnes & Van Dyne, 2009).

Fatigue increases tradeoffs, particularly related to speed vs. accuracy. Collecting more evidence before deciding allows one to be more accurate but slower (Donkin et al., 2014). The primary influencer of caution is the threshold amount of evidence required to trigger a response. People will ignore redundant information when they are forced to respond quickly even when information is consistently repeated or reinforced. The primary influencer of the speed-accuracy tradeoff is not the capacity of a processing system, but the amount of evidence required to make a choice. Donkin et al. (2014) reported that participants were capable of strategically ignoring redundant information when being forced to process information quickly: participants did not collect less evidence before making a quick response, rather they found ways to reduce the load of their processing system.

## Preventing and Mitigating Fatigue

There are several ways in which fatigue can be mitigated that are applicable to the security screening environment. Aligning work schedules with an individual's chronotype, which is an individual's preferred times across the 24-hour cycle of activity and rest, has been shown to mitigate the effects of fatigue, reducing mental workload, and enhancing performance (Venesia et al., 2019). Additionally, collaborative efforts among TSOs to align schedules based on chronotype have proven more effective than reliance on technology alone, emphasizing the vital role of human factors in maintaining safety and efficiency (Yamani et al., 2018).

Addressing psychological stress is also crucial, as it influences fatigue, resilient behavior, and workplace safety. Implementing recovery processes and managing stressors can lead to a more positive and resilient safety

culture, ensuring well-being and optimal performance. This has been shown for air traffic controllers (Langan-Fox et al., 2009) and is a finding also relevant for human factors-based TSA airport screening checkpoint optimization efforts.

Ultimately, tackling fatigue in air transportation security demands a comprehensive approach, incorporating schedule adjustments, an understanding of the speed-accuracy tradeoff, collaborative work strategies, and proactive stress management.

## Fostering Critical Thinking and Effective Communication (CTEC) at the TSA Screening Checkpoint

Critical thinking is the cornerstone of a TSO's decision-making process, enabling them to analyze complex situations, anticipate potential threats, and make precise decisions. Effective communication ensures that critical information is accurately conveyed among team members, stakeholders, and passengers, mitigating the risk of human error (Aydiner, 2022).

The integration of critical thinking and effective communication (CTEC) within TSA training programs faces obstacles, as highlighted by a Department of Homeland Security report that underscored the challenges in retention, training, and recruitment, attributing them partly to deficiencies in CTEC competencies among TSA leaders (U.S. Department of Homeland Security, 2019a). Such internal findings indicate a significant gap in current training frameworks and emphasize the need for strategic enhancements. There are several strategies for CTEC enhancement, as summarized in the following.

- Red Teaming Techniques: Red teaming involves creating an internal or external team to simulate the thoughts or behaviors of your adversaries. This practice finds weaknesses in defenses, and can challenge flawed responses (TechTarget, 2024). Adopting red teaming offers a structured approach to challenging assumptions and enhancing decision-making. This technique allows TSA to simulate adversarial scenarios, thereby improving preparedness for real-world threats (United Kingdom Ministry of Defense, 2021; U.S. Army Combined Arms Center, 2021).
- Inquiry-Based Learning: Encouraging TSA personnel to engage in critical questioning fosters a deeper understanding of security scenarios. This approach cultivates adaptive problem-solving, and a mindset geared towards continuous improvement (Paul & Elder, 2000).
- Leveraging FEMA's Communication Training: FEMA's communication training materials provide valuable resources for developing effective communication skills within disaster and emergency contexts, crucial for maintaining clear communication in critical situations (Kirschenbaum & Rapaport, 2017; United States Federal Emergency Management Agency, 2021).

In conclusion, integrating CTEC into TSA's training and operational paradigms is essential for advancing aviation security (Kiltz, 2009). Embedding critical thinking and effective communication at the core of TSA's culture enhances the agency's ability to respond to threats with agility and precision. This endeavor requires concerted effort across training, policy, and operational domains (Aydiner, 2022; Department of Homeland Security, 2019a; United Kingdom Ministry of Defense, 2021; Paul & Elder, 2005; 2000; United States Federal Emergency Management Agency, 2021).

## Conclusion and Summary of Recommendations

Research in the homeland security discipline has focused primarily on technology applications and better design of new or integrated systems to enhance safety, rather than behavioral optimization (Baggett et al., 2017). This paper proposed three areas in which psychology could provide an integrated approach to transportation security (Neffenger & Ades, 2020). Studying the optimization of human performance in the air transportation sector of the homeland security enterprise relates to several core DHS missions including: preventing terrorism, securing critical infrastructure, ensuring resilience to disasters, and growing the homeland security workforce (Siedschlag & Jerković, 2022).

Previous studies focused on airport security screeners' knowledge related to problem-solving during screening tasks (e.g., Swann et al., 2020) but did not address multi-modal screening (such as x-raying combined with behavioral observation in the social setting of the checkpoint and its surroundings). One area where more work can be done is integrating deception detection training into the overall screener training paradigm.

There has been a plethora of research into both visual search tasks and object monitoring tasks as they relate to TSA officers and air traffic controllers, but a literature search showed much less research into the effects of sleep deprivation from shift work on performance. For example, there are differences between TSA officers and nonprofessional searchers. TSA professionals are more accurate than nonprofessionals, but also slower (Biggs et al., 2013; Biggs et al., 2018). Could a better understanding of how fatigue contributes to screener performance be used to modify schedules of

workers, so that screeners can enhance speed of scanning without sacrificing accuracy?

The present work also found that transportation security may be hampered by communication difficulties across the DHS organization, as well as lack of training, especially related to critical thinking and decision-making. A report by the Office of Inspector General of the U.S. Department of Homeland Security, titled "Major Management and Performance Challenges Facing the Department of Homeland Security" (Office of Inspector General, 2022), suggested mismatches between technology and users, and communication/collaboration lapses between multiple agencies thus providing an interesting relevant starting point for integrating human factors psychology knowledge into the air transportation system. How can psychological principles be used by DHS to enhance understanding of decision-making and when/how information is best shared across relevant parties. TSA supports the need for training by calling for research on how to improve operational performance at the screening checkpoint with the human user in mind, thus improving efficiency, effectiveness, and public safety (Kudrick & Greene, 2021).

This review argued for an approach that addresses human performance optimization in the air transportation system by integrating human factors psychology principles into homeland security deterrence and detection tasks, procedures, and training (Biggs et al., 2018). The focus was on how well system components (such as screening tasks) and organizational elements (such as scheduling/shiftwork, training, culture, communication, or procedures) are designed to interface with human physiological and cognitive abilities and limitations.

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# IMPULSIVITY AS AN ENDOPHENOTYPE FOR SCHIZOPHRENIA: A SYSTEMATIC REVIEW

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**Abstract** – Research surrounding the expression of impulsivity in schizophrenia (SCZ) is extensive, as is the investigation of candidate endophenotypes for SCZ. Although much work on SCZ addresses impulsivity and its clinical manifestations, few studies propose impulsivity as an endophenotype for SCZ. This review aims to consider the evidence regarding the relationship between SCZ and impulsivity, ascertain whether implementing impulsivity as an endophenotype for SCZ is appropriate, and review current methods used when studying impulsivity utilizing the standards of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. A literature search was conducted using PubMed, ScienceDirect, and ProQuest. The inclusion criteria required studies to be (a) published after 2010; (b) an empirical study that collected primary data; (c) written in English; (d) published in a scholarly peer-reviewed journal; (e) conducted on Human populations; and (f) include SCZ as a primary outcome measure and discuss endophenotypes or intermediate phenotypes. Following these procedures, seven empirical studies were identified for evaluation. Results provide further evidence for impulsivity as a trait in SCZ and support its conceptualization as an endophenotype. The implications of these findings are threefold: firstly, adopting an endophenotype approach facilitates the understanding of the neurobiological substrates and genetic factors that underlie SCZ, secondly it allows for more lucid associations between genetic variants and impulsivity-related phenotypes, and lastly it recommends considering impulsivity as a construct detached from traditional diagnostic approaches.

Schizophrenia (SCZ) is a complex, chronic, polygenic, and multifactorial psychiatric disorder characterized by three subsets of symptoms: Positive symptoms (e.g., hallucinations and delusions), negative symptoms (e.g., lack of motivation, anhedonia) and cognitive symptoms (e.g., disorganized thinking, poor concentration; Green, 2016; Keefe & Fenton, 2007). Many genetic risk factors influence SCZ's clinical phenotype; in isolation, each of these genetic factors is neither necessary nor sufficient for SCZ to occur (Galindo et al., 2016). A single genetic variant can have multiple effects; genetic variants associated with SCZ risk are not specific to this disorder (i.e., pleiotropy; Meyer-Lindenberg, 2010). SCZ is a multidimensional disease involving close interactions between genetic and environmental risk factors. The interaction between these two factors during brain development can lead to deficits in neuronal synchronization and cellular damage that predispose an individual to develop the disorder (Schmidt & Mirnics, 2015).

Evidence from twin, family, and adoption studies suggests that a predisposition for SCZ is heritable (Ho et al., 2018). This has prompted extensive investigation into genetic variants that may be linked to SCZ. Notably, variations in genes such as *DISC1, CACNA1C, TCF4, and ZNF804A* have been central to these investigations (Bergen & Petryshen, 2012; Calabro et al., 2020; Harrison, 2015; Smeland & Andreassen, 2018). These genes are known for their crucial roles in neural and cortical development, calcium channel signaling, neurotransmission, transcriptional control, and synaptic processes, all of which contribute to the complexity of SCZ susceptibility (Bergen & Petryshen, 2012; Calabro et al., 2020; Harrison, 2015; Smeland & Andreassen, 2018). It is worth mentioning that numerous other risk genes and variations have been associated with SCZ, but an exhaustive list goes beyond the scope of this discussion. Although linkage studies, candidate gene association studies (Arango, 2017; Owen & Cardno, 1999), and genome-wide association studies (GWAS) have

successfully identified variants associated with SCZ (Schizophrenia Working Group of the Psychiatric Genomics, 2014), many of these results are not consistently replicable (Bergen & Petryshen, 2012). Thus, researchers may need to revise approaches by considering the compilation of many variants (i.e., single-nucleotide polymorphisms, SNPs) that might inform us about the pathogenesis of SCZ (Gualtieri, 2020; Harrison, 2015) and adjust current understandings of the phenotype.

There are several reasons to focus on the genetic mechanisms of SCZ. First, a better grasp of the biology of SCZ and the specific genetic variants underlying SCZ could better inform applications of psychiatry (Gejman et al., 2010). Such studies could allow for the development of treatments that target the biological underpinnings of the disorder rather than its symptoms (i.e., clinical manifestation) and allow treating subtypes of SCZ in an individualized way (Ozomaro et al., 2013). Though it is conceivable that further research could enable the provision of specific and tailored treatment to patients (Lally & MacCabe, 2016), the current evidence is insufficient to be applied in this way (possibly due to the heterogeneity of SCZ; Jablensky, 2006). Second, genetic studies could help reduce the stigma and misconceptions surrounding SCZ by helping people understand potential causes (Phelan, 2002). Third, genetic counseling could be improved, especially in heritability and transmissibility to offspring (Costain, Esplen, Toner, Hodgkinson, et al., 2014; Costain, Esplen, Toner, Scherer, et al., 2014). Toward this end, we posit that endophenotype approaches that identify intermediate phenotypes, symptoms, or biomarkers associated with the disorder that are more closely connected to the genetic variation are crucial in decomplexifying genetic mechanisms (Glahn et al., 2014). An endophenotype is a specific and measurable trait that provides a link between the genetic factors of a condition and its observable clinical symptoms (Gottesman & Gould, 2003). Considering consistent issues with poor phenotype measurement in behavior genetics research that makes the subtle, context-dependent effects even harder to identify or replicate, a focus on appropriate endophenotypes is a crucial step in this line of research (Glahn et al., 2014).

The literature on impulsivity in SCZ and related psychiatric disorders is extensive, as are the publications mentioning candidate endophenotypes in SCZ. Nonetheless, very few reviews define impulsivity as an endophenotype for SCZ. Much of the impulsivity literature has focused on themes, including its conceptualization – and the challenges surrounding its definition –, different assessment methods, correlations with substance use, suicidal risk, aggression, and the neural substrates involved (Ouzir, 2013). Although to our knowledge no existing theorists argue against the use of impulsivity as an endophenotype for schizophrenia, there has not been a thorough review to ensure that it does meet these criteria.

Of the articles that review impulsivity as an endophenotype, many do so in conjunction with related disorders such as attention deficit hyperactivity disorder (ADHD; Glahn et al., 2014; Robbins et al., 2012), obsessive-compulsive disorder (OCD; Fineberg et al., 2010; Robbins et al., 2012), substance abuse disorders (Jupp & Dalley, 2014), compulsive eating disorders (Howard et al., 2020), bipolar disorder (BD; Sanches et al., 2014; Wessa et al., 2015), and autism spectrum disorder (ASD; Fineberg et al., 2010). This approach provides relevant information, such as shared phenotypes, but inevitably constricts our understanding of processes specific to SCZ (Robbins et al., 2012). Viewing impulsivity through a transdiagnostic perspective, meaning the examination of impulsivity across a range of psychiatric disorders rather than within a singular disorder, holds promise for identifying common traits among these conditions and for discovering potential pathways to novel therapeutic (Fortgang et al., 2016; Robbins et al., 2012).

**Current Research on Impulsivity and the Genetics of SCZ**

Although genetic studies sometimes report associations between impulsivity and specific gene variants, this information is not typically discussed in the context of a given pathology and its clinical expressions. Indeed, very few recent studies assess those variables in a shared genetic and clinical framework for SCZ. Nonetheless, genetic analyses that measure impulsivity in SCZ report the involvement of distinct variations in SNPs.

Of the few studies connecting SCZ, impulsivity and genetic variation, genetic variants associated with serotonin and calcium channel functioning have been investigated. Genetic variation in the serotonin$_{2a}$ (5-HT2A) receptor, which plays a role in sustained attention (Vollenweider et al., 2007), particularly impulsivity (Quednow et al., 2012), were associated with impulse control assessed with a subset of the Continuous Test Performance (CPT) in patients with SCZ but not in healthy controls (HC; Tsuang et al., 2013). Genetic variation in a calcium channel, the A allele of *CACNA1C* SNP rs11062296 is associated with lower scores on the impulsiveness sub-measure of the PANSS (Positive and Negative Syndrome Scale; Calabro et al., 2020).

The increasing use of whole-genome sequencing has also allowed researchers to adopt reverse genetics, which involves working from the understanding of a gene to trace it back to the protein and understand its role in the cell (Takahashi et al., 1994). Coupled with imaging genetics procedures, using reverse genetics in HC uncovered an association between a risk variant in *AMBRA1* (rs11819869) and impulsivity-related traits (measured by BOLD responses during a Stop Signal Task on motor inhibition; Heinrich et al., 2013). Despite several relevant studies investigating associations between impulsivity and genetics relevant to SCZ, there is a lack of a consistent theoretical understanding of whether impulsivity functions as an endophenotype for SCZ.

**Importance of Endophenotypes in SCZ Research**

One of the main difficulties of genetic research in SCZ lies in the weak correlation between the clinically observable phenotype (SCZ symptoms) and the genotype (Ouzir, 2013). Indeed, some types of SCZ are not associated with the genes studied, and unaffected individuals – especially within families where SCZ is present – may present genetic susceptibility factors without observable clinical expression. Though some studies consider impulsivity, genetics, and SCZ within the same article, they do not incorporate impulsivity as an endophenotype. Novel approaches have been developed to identify subclinical traits (or endophenotypes) in patients and their relatives. Thus, by studying these more elementary and measurable phenotypes, they attempt to decrease the genetic complexity of the disease (Calkins et al., 2007).

Such concepts must satisfy the following criteria in order to meet the definition of endophenotype (or intermediate phenotype): (a) They must be associated with the disease; (b) they must be heritable; (c) they must co-segregate with the illness within families; and (d) they must be independent of the clinical state (Gottesman & Gould, 2003).

**Conceptualization and Measurement of Impulsivity**

Impulsivity is commonly described as following one's inner instincts and reacting to external stimuli without considering the implications and consequences that might result from that action (Moeller et al., 2001). Clinically, the DSM-5 further implies that impulsive decisions can harm individuals and bear on clinical outcomes (American Psychiatric Association, 2013; Congdon & Canli, 2008; Kaladjian et al., 2011). Impulsive behaviors are regularly associated with hazardous decision-making outcomes and adverse response inhibition (Courtney et al., 2012; Moeller et al., 2001), violence and aggression (Perroud et al., 2011; Volavka & Citrome, 2008), suicidal tendencies (Gut-Fayand et al., 2001), and substance abuse (Dervaux et al., 2010; Gut-Fayand et al., 2001).

Within a laboratory setting, impulsivity is typically measured either by means of self-report questionnaires or through experimental tasks (Ouzir, 2013). The former probes participants to rate the extent to which their behavior reflects impulsive tendencies in everyday life (e.g., the BIS-11, UPPS; Patton et al., 1995; Reddy et al., 2014), while the latter evaluates participants' aptitude to inhibit motor responses (e.g., CPT, BART, Go/NoGo, SKIP, Stop-Signal; Chamberlain & Sahakian, 2007; Logan et al., 1997; Moeller et al., 2001). Among the varying forms of impulsivity identified, two main categories emerge: a motor – or action – impulsivity and a cognitive – or choice – impulsivity (Gray et al., 2018). Motor impulsivity is expressed following a spontaneous reaction without prior reflection and motor inhibition, whereas cognitive impulsivity is characterized by a lack of evaluation of a given decision's immediate and long-term (primarily negative) consequences (Caswell et al., 2015; Ouzir, 2013). In this regard, several neurological and psychiatric conditions challenge the notion of impulsivity as an umbrella concept.

SCZ is paired with deficits in response inhibition (Enticott et al., 2008; Kaladjian et al., 2011; Nolan et al., 2011) and high scores of self-reported impulsivity compared to HC (e.g., on the BIS-11; Kaladjian et al., 2011; Nolan et al., 2011). Nonetheless, self-report questionnaires and experimental tasks assessing impulsivity have a very low correlation (Caswell et al., 2015; Enticott et al., 2008; Nolan et al., 2011; Reddy et al., 2014), and these conclusions are not consistently reached in other studies which fail to convey increased self-reported impulsivity levels (Reddy et al., 2014). Both aspects thus maintain the multidimensionality of impulsivity as a trait and support that different subtypes of impulsivity are associated with distinct but shared neural mechanisms (Ho et al., 2018).

**Heritability of Impulsivity**

Impulsivity is heritable, with twin studies estimating a heritability between 38-60%. (Fortgang et al., 2016). Unaffected adult first-degree relatives (FDR) of individuals with SCZ present higher levels of impulsivity on self-report and behavioral tasks (more inclined to immediate rewards on delay-discounting tasks) in comparison to unaffected second-degree relatives (SDR) and adolescents with no family history of SCZ (Ho et al., 2018). FDR's performance during delay-discounting also significantly correlated with alterations in brain regions

correlated with impulsive decision-making in SCZ individuals (Barry et al., 2020). Conversely, SDRs perform similarly to adolescents with no family history of SCZ both on self-report and behavioral tasks. Seven-year-old children of individuals with SCZ also show no difference in performance compared to matched HC (Hemager et al., 2021). The presence of impairments on measures of impulsivity in adult FDRs as opposed to children supports a developmental explanation rather than the outright rejection of impulsivity as an endophenotype and risk marker of SCZ because it potentially implies that such impairments will develop at a later age (Hemager et al., 2021). The heritability and stability of impulsivity are widely supported across the literature (Bevilacqua & Goldman, 2013; Congdon & Canli, 2008; Fortgang et al., 2016; Ho et al., 2018; Pedersen et al., 1988).

The mechanism of the heritability of SCZ and impulsivity can be further understood by identifying the biological differences associated with these phenotypes that may be affected by genetic variation. Impulsivity is associated with differences in the inferior frontal gyrus, dorsolateral prefrontal region, superior medial frontal region, pre-supplementary motor area, subthalamic nucleus, globus pallidus, striatum, and thalamus (Aron et al., 2007; Barkataki et al., 2008; Arce et al., 2006; Nolan et al., 2011; Stuss et al., 2003), which are also implicated in impulsivity in disorders including SCZ (Kaladjian et al., 2011). Because SCZ and impulsivity are highly heritable, highly associated with one another, and share related biological mechanisms, impulsivity is a good candidate endophenotype for SCZ (Barry et al., 2020). Findings from studies on unaffected relatives of SCZ patients similarly endorse impulsive behaviors as an endophenotype for SCZ in children, adolescents, and adults (Ho et al., 2018).

### Impulsivity as a Non-Unitary Construct

The overwhelming majority of studies assessing impulsivity or impulse control in patients with SCZ or schizoaffective disorders allude to the discrepancies in a clear and unique definition of impulsivity and the disparateness of deficits or lack of in those patient populations (Strickland & Johnson, 2021). The divergence between those studies calls for a better delimitation of the concept of impulsivity and more consistent use of self-report and behavioral tasks in patient evaluations.

The variations and discrepancies between the conceptions of impulsivity as an umbrella term versus impulsivity characterized by distinguished subtypes arise from non-consistent methods of neuropsychological test measurements. Despite the growing body of research inquiring into different subtypes of impulsivity, much debate persists concerning the conceptualization and assessment methods of this psychological construct (Strickland & Johnson, 2021). Although impulsivity is one of the most frequently listed diagnostic criteria in the DSM (Johnson et al., 2017; Smith et al., 2007; Whiteside & Lynam, 2001), its multidimensionality is still poorly understood. Considering impulsivity as an entity and a construct not only allows for a dissolution of the ambiguity but also expands the possibilities of studying impulsive behavior subtypes individually and independently from one another.

Although experimental tasks aid in comparing the effects and patterns of one type of impulsive behavior in a population, a failure to consider their respective psychometric properties further fosters confusion about the underlying mechanisms of impulsive behaviors and the reliability and validity of findings in a real-world setting or an alternative population (Enkavi et al., 2019).

The aims of this review are: (a) To review the evidence discussing impulsivity an endophenotypes with SCZ as a primary outcome, (b) evaluate measurement and understanding of the impulsivity construct, and (c) to determine whether the implementation of impulsivity as an endophenotype for SCZ is appropriate. Although much of the literature on SCZ addresses impulsivity and its clinical manifestations, few studies have sought to propose impulsivity as an endophenotype for SCZ. This review thus aims to review the evidence discussing impulsivity as an endophenotype for SCZ to evaluate trends in current research and establish the need for a shift in theoretical framework regarding the genetics of SCZ.

## Methods

The reporting of this systematic review was guided by the standards of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement (Page et al., 2021).

### Eligibility Criteria

The inclusion criteria were (a) publication date after 2010; (b) being an empirical study that collected primary data; (c) written in English; (d) being published in a scholarly peer-reviewed journal; (e) conducted on Human populations; and (f) include SCZ as a primary outcome measure and discuss endophenotypes or intermediate phenotypes. Lastly, studies were excluded from the review if they were unpublished thesis and dissertation studies.

### Information Sources and Search Strategy

A search of the literature was conducted using PubMed, ScienceDirect, and ProQuest (which included

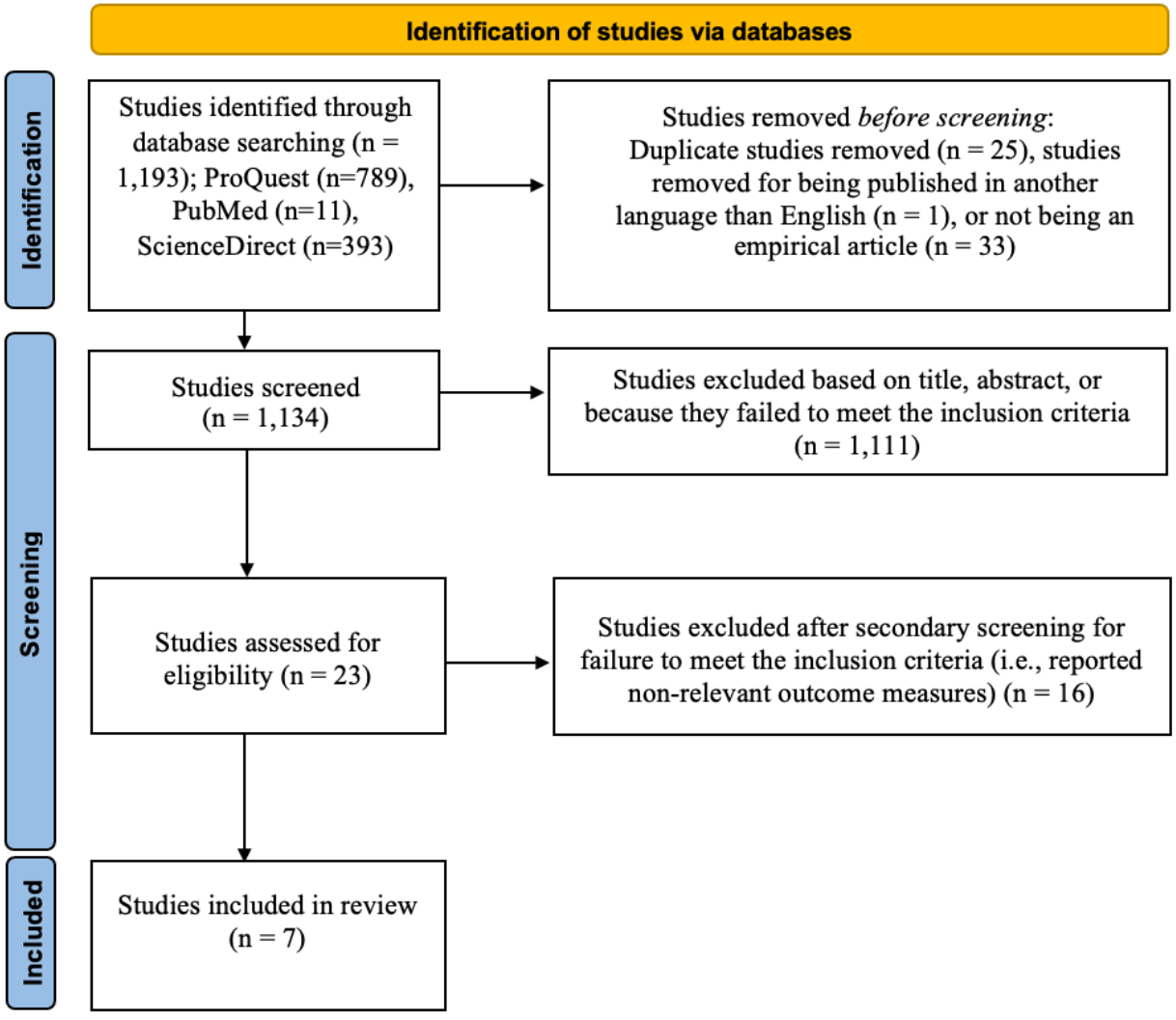
the following databases: APA PsycArticles, APA PsycInfo, and Publicly Available Content Database). Internet searches on those databases were conducted in March 2022 using the following search terms: (Schizophrenia) AND (impulsivity OR impulsive behavior OR impulsive behaviour OR disinhibition) AND (endophenotype OR intermediate phenotype) AND (genetics OR genetic). After an additional hand search, documents that did not fit the desired study type (e.g., poster presentations, conferences, e-posters, or oral communications) were excluded. Moreover, studies that (a) did not include SCZ as a primary outcome measure or (b) did not assess impulsivity or endophenotypes were excluded.

**Study Selection and Data Collection Processes**

Based on the results obtained after the initial search, the title and abstract of each study were screened, and one reviewer further evaluated potentially relevant studies for eligibility. Studies were included if they had a mention of "impulsivity" or related terms and, when possible, included the term "endophenotype" or "intermediate phenotype." The information on study selection and eligibility assessment can be found in the PRISMA flow diagram (Figure 1). Among the 1,193 results obtained through database searching, 59 studies were removed due to duplication ($n$ = 25), publication in another language than English ($n$ = 1), or not being an empirical research article ($n$ = 33). After the title and abstract of each study were examined, 1,111 studies were excluded because of unsuitability for the present review. A secondary screening procedure was done to reassess the relevance of the 23 eligible studies. After reviewing the full text of those articles, 16 were excluded because their focus and outcome measures emphasized impertinent traits or disorders. Following these procedures, seven empirical studies were evaluated in the present review.

**Figure 1**

*PRISMA Flow Diagram of the Studies Selection Process*



## Results

The analysis of the findings from the seven articles included revolves around three core aims: first, an exploration of the various dimensions of impulsivity and their measurement; second, an investigation into methodological variations, primarily related to the assessment of impulsivity; and finally, an evaluation of impulsivity as a potential endophenotype for SCZ within the context of established criteria.

### Study characteristics

Characteristics of the studies included in this review can be found in Table 1.

### Methodological variations

#### *Participants*

The seven studies included in this review include 1,036 participants, with studies ranging in sample size from 60 participants to 420 participants. In total, there were 310 participants with a SCZ or schizoaffective disorder diagnosis, and 200 HCs. One of the aims of this subsection was to state the gender distribution within the selected articles. Most of the studies reviewed enrolled more male participants ($n$ = 573; 55.31%) than female participants ($n$ = 463; 44.69%). Except for Ho and colleagues' study design (2018), which did not include individuals with SCZ, every other study enrolled participants who were medicated, primarily using neuroleptics (Duva et al., 2011; Fortgang et al., 2016; Hoptman et al., 2014; Kaladjian et al., 2011; Nolan et al., 2011; Reddy et al., 2014). Two studies were designed and conducted outside the United States; Fortgang and colleagues (2016) carried out their research in Sweden, and Kaladjian and colleagues (2011) conducted their study in France. Because all the studies reviewed here support the presence of impulsive tendencies in their participants – albeit to different extents –we were unable to identify cross-cultural differences in expression of impulsivity in SCZ cohorts.

#### *Medication*

Of the studies reviewed here, six included patients with SCZ on AP medication (one study on the heritability of impulsivity does not include SCZ patients), and none distinguished between medicated versus non-medicated participants in their analysis. The presence of medication in participants can be responsible for the heterogeneity of results on the incidence of impulsivity in patients with SCZ (Reddy et al., 2014). Some studies show that medication use may reduce impulsive behaviors (Spivak et al., 1997), but others fail to report an association between medication and impulsivity in patients with psychosis (Ahn et al., 2011; Heerey et al., 2007; Shurman et al., 2005).

As displayed in Table 1, most participants take atypical or second-generation antipsychotics (SGAs), including Aripiprazole and Clozapine, two widely prescribed partial dopamine D2/D3 receptor agonists (Casey & Canal, 2017). Both serotonin and dopamine are neurotransmitters known to play a substantial role in impulsive behaviors and risky decision-making (i.e., risk-taking; Reddy et al., 2014; Seo et al., 2008). SGAs also reduce aggression and impulsivity in many patients (Bilder et al., 2002; Jones et al., 2011; van Schalkwyk et al., 2018; Volavka & Citrome, 2011), which prompts the investigation of the effects of dopamine stabilizers on decision making outcomes.

#### *Measures of Impulsivity*

To assess and measure impulsivity, five of the studies used the Barrat Impulsiveness Scale (BIS-11), one of the most widely used self-report questionnaires to evaluate impulsivity (Duva et al., 2011; Fortgang et al., 2016; Kaladjian et al., 2011; Nolan et al., 2011; Reddy et al., 2014). The two other studies gave participants the UPPS, an equivalently widely used self-report scale (Ho et al., 2018; Hoptman et al., 2014). Both Hoptman and colleagues (2014) and Nolan and colleagues (2011) administered additional self-report questionnaires, the Buss Perry Aggression Questionnaire (BPAQ) and the Life History of Aggression (LHA). Hoptman and colleagues (2014) also gave their participants the Impulsive and Premeditated Aggression Scale (IPAS); it is the only study to have used three different self-report measures. Regarding experimental tasks, four studies used the SST and Go/No-go task, reaction time tests that precisely measure response inhibition (Duva et al., 2011; Fortgang et al., 2016; Kaladjian et al., 2011; Nolan et al., 2011). Two studies performed the BART, a paradigm that measures the degree of risk-taking behaviors (Duva et al., 2011; Reddy et al., 2014). Finally, two studies chose to administer the SKIP, TCIP (both modifier versions of the latter test), and the Delay Discounting Task (Duva et al., 2011; Ho et al., 2018).

### Evidence Relating to Endophenotype Criteria

The following section reviews the main findings from our studies in relation to how they apply to the outlined criteria for an endophenotype.

#### *Criterion 1: Association with Illness*

To substantiate the association between impulsivity and SCZ, a consistent pattern of findings has emerged across several studies. Self-report measures consistently indicated heightened impulsivity and aggression scores in individuals with SCZ compared to HC and proband groups (with $p$ values ranging from .01

**Table 1**
*Main Characteristics of the Studies Reviewed (N=7)*

| Study | Participants | Impulsivity measures | Medication | Study Location |
|---|---|---|---|---|
| (Fortgang et al., 2016) | Participants with SCZ (n=64), SCZ Co-twins (n=64), BD*** (n=71), BD Co-twins (n=51), MDD*** (n=44), MDD Co-twins (n=25), Other psychiatric illness (n=5), Other Co-twins (n=2), No consensus diagnosis (n=33), HC (n=61) | BIS-11, SSS, SST | AP medication (n=62) Mood-stabilizers (n=44), Antidepressants (n=71) | Sweden |
| (Hoptman et al., 2014) | Participants with SCZ (n=27), schizoaffective disorder (n=6), HC (n=31) | UPPS, BPAQ*, IPAS*, LHA* | Clozapine (n=6)** Mood-stabilizers (n=12) | USA |
| (Kaladjian et al., 2011) | Participants with SCZ (n=26), HC (n=30) | BIS-11, Go/NoGo | All participants were taking psychotropic medication Atypical AP (n=21) Typical AP (n=5) | France |
| (Reddy et al., 2014) | Participants with SCZ (n=38), BD*** (n=68), HC (n=36) | BIS-11, BART | SCZ participants taking AP medication (n=37) | USA |
| (Duva, Silverstein, & Spiga, 2011) | Participants with SCZ or schizoaffective disorder (n=49), psychosis NOS (n=11) | BIS-11, BART, Laboratory behavioral measures of impulsivity (includes GoStop Impulsivity Task, SKIP*, TIME*, TCIP*) | All participants were taking AP medication. | USA |
| (Nolan et al., 2011) | Participants with SCZ or schizoaffective disorder (n=42), HC (n=42) | BIS-11, BPAQ, LHA, SST* | Treatment with either second-generation neuroleptics (n=28), or with a combination of first- and second-generation neuroleptics (n=11(missing data for n=3)) | USA |
| (Ho et al., 2018) | First-degree relatives of SCZ patients (n=39), second-degree relatives of SCZ patients (n=53), adolescent controls with no SCZ family history (n=118) | UPPS-P, Delay Discounting Task | N/A | USA |

* BPAQ = Buss Perry Aggression Questionnaire, IPAS = Impulsive and Premeditated Aggression Scale, LHA = Life History of Aggression, SKIP = Single Key Impulsivity Paradigm, TIME = Time Estimation Task, TCIP = Two Choice Impulsivity Paradigm, SST = Stop-Signal Task
** Medication was converted to chlorpromazine equivalents. One participant was taking asenapine
*** BD = Bipolar Disorder, MDD = Major Depressive Disorder

to less than .001 and specific statistical values reported in study descriptions below; Duva et al., 2011; Fortgang et al., 2016; Ho et al., 2018; Hoptman et al., 2014; Kaladjian et al., 2011; Nolan et al., 2011; Reddy et al., 2014).

In Nolan and colleagues' study (2011), patients exhibited longer Stop Signal Reaction Time (SSRT) — a behavioral measure of motor inhibition — and increased response variability, with $t(82) = 4.84$, $p < .001$. Risk-taking behaviors were explored in two studies, both indicating heightened impulsivity and risk-aversion in individuals with SCZ (Duva et al., 2011; Reddy et al., 2014). Duva et al. (2011) found a significant main group effect on the TCIP task, revealing that individuals with comorbid psychotic disorders (SCZ, schizoaffective disorder, or psychosis not otherwise specified) and current or past substance abuse demonstrated a heightened propensity for immediate gains compared to HC ($F(2, 57) = 4.60$, $p = 0.01$). In addition, two investigations into the neural basis of impulsivity in SCZ underscore the involvement of prefrontal brain regions, as evidenced by Hoptman (2014) and Kaladjian (2011). Kaladjian and colleagues (2011) unveiled a positive correlation in patients between BIS-11 scores and cerebral activation related to response inhibition, particularly within the right ventrolateral prefrontal cortex ($r = 0.84$, $p < .001$), compared to HC ($r = 0.20$, $p = .293$). Hoptman and colleagues (2014) found that the positive ($d = 1.50$) and negative ($d = 1.21$) urgency subscales were higher in patients than HC (with $p < .001$), whereas lack of premeditation, lack of perseverance and sensation seeking were not (Group×Subscale Interaction, $F(4,60) = 14.86$, $p = 1.05\times10^{-7}$). Further, they identified a robust association between cortical thinning in ventral prefrontal regions and increased impulsivity in SCZ patients. Specifically, they found an association between negative urgency and reduced cortical thickness in the right frontal pole ($r(30) = -0.64$, $p < .001$) and right medial orbitofrontal cortex ($r(30) = -0.36$, $p = .042$). Positive urgency was also negatively correlated with thickness in the left rostral anterior cingulate ($r(30) = -0.38$, $p = .031$) and the right frontal pole ($r(30) = -0.44$, $p = .013$).These results imply a connection between impulsivity and reduced efficiency in processing inhibitory control within the prefrontal brain regions.

### *Criterion 2: Heritability*

Fortgang and colleagues (2016) examined the overlap and genetic loading of impulsivity across SCZ, BD, and major depressive disorder (MDD). Their best fitting models indicate that genetic factors explain between 38%-60% in the variance across various subsets of impulsivity, including self-reported attentional, motor, and non-planning impulsivity, self-reported sensation seeking, and SSRT. SCZ patients exhibited longer SSRTs than HC ($d = 0.78$, $p = .010$), and their co-twins ($d = 0.46$, $p = .004$), aligning with the results observed in Nolan and colleagues' study.

### *Criterion 3: Co-segregation within Families*

Ho et colleagues (2018) contributed to our understanding of heritability by measuring impulsivity in unaffected biological relatives of SCZ patients. They found that on a delay-discounting task, first-degree relatives of SCZ patients exhibited increased impulsivity-related behaviors and displayed a greater preference for immediate rewards compared to adolescents with no SCZ family history ($Q \geq 3.13$, $p \leq .006$) and second-degree relatives ($Q \geq 2.40$, $p \leq .04$). This finding suggested a positive association between impulsivity and SCZ risk, with the severity of impulsivity increasing with closer familial relatedness to the SCZ proband.

### Criterion 4: Independence from Clinical State

Impulsivity is a prevalent trait that is observed in both clinical and non-clinical populations, indicating that it is a widespread human characteristic (Chamorro et al., 2012). An overview of the total mean BIS-11 scores obtained by HC within the studies included in this review demonstrates that even within non-clinical groups, moderate levels of impulsivity are prevalent. Specifically, Kaladjian and colleagues (2011) reported a mean score of 58.9 (SD=8.6), while Reddy and colleagues (2014) reported a score of 42.9 (SD=8.8), and Nolan and colleagues (2011) reported a mean score of 56.00 (SD=9.95). It is worth noting that the BIS-11 scoring scale ranges from 30 to 120, with higher scores showing higher impulsivity. Although these values are significantly lower than those observed in patient groups, they do not negate the presence of impulsivity and emphasize that control groups exhibit impulsivity even in the absence of clinical diagnoses. This finding highlights that impulsivity is an inherent and prevalent characteristic of human behavior that is independent of clinical states.

## Discussion

Although SCZ does not fall under an impulse disorder per DSM classification (American Psychiatric Association, 2013), the studies reviewed here not only provide further evidence for the presence of impulsivity as a trait in SCZ patients but support its conceptualization as an endophenotype. It is also considered an adequate intermediate phenotype in the framework of non-psychiatric populations (i.e., clinically; Chistiakov et al., 2012; Mann et al., 2009). Indeed, even though impulsivity can present stronger associations with psychiatric disorders, it remains a universal trait not

unique to clinical populations (Chamorro et al., 2012). As an endophenotype, impulsivity is thus a marker and a risk factor for SCZ as defined by the DSM-5, and as studies show, it is present throughout the spectrum. A substantial portion of the literature on SCZ has put forward endophenotype candidates that fall under distinct categories, including neuropsychology, electrophysiology, biochemistry, and neuroanatomy (Bryll et al., 2021). As per the outlined criteria for endophenotypes, this review has successfully demonstrated that impulsivity (a) is significantly associated with SCZ; (b) heritable; (c) state-independent (i.e., unaffected individuals present impulsive tendencies albeit to a lesser extent than patients); and (d) co-segregates within families of probands with SCZ. Moreover, although measures of impulsivity do not consistently bear the same outcomes, it is reliably measured (Calkins et al., 2007; Gottesman & Gould, 2003). Allowing for impulsivity to be considered an endophenotype holds many benefits, namely in expanding our understanding of the neurobiological substrates and risk factors (Ho et al., 2018), gene discovery (Bevilacqua & Goldman, 2013), diagnosis and identification of risk genes for SCZ (Radhu et al., 2017), and overall to facilitate clinical management of individuals with SCZ (Congdon & Canli, 2005; Gottesman & Gould, 2003).

**Summary of Methodological Inconsistencies**

The studies reviewed here support that impulsivity, in its multidimensionality, is compatible with an endophenotype definition. To reiterate, endophenotypes encompass heritable, intermediate traits that can serve as indicators for the underlying genetic basis of a complex phenotype or disorder. However, there are some inconsistencies regarding which clinical populations display impulsivity, which specific neural and molecular mechanisms are disrupted, and, how impulsivity is defined and measured (Congdon & Canli, 2005; Dang et al., 2020). These irregularities may be partially due to (a) a problem with the construct of impulsivity; (b) differing neural mechanisms involved depending on the task administered; and (c) a lack of consistency or regulation in the procedures and psychometric properties of a given test. A problem with the construct refers to the mere definition of impulsivity which encompasses many subtypes that may rely on distinct neural networks. In addition, different mechanisms might be implicated depending on the type of assessment performed; for example, the processes associated with self-perception and self-evaluation of impulsivity may differ from those engaged in task performance (Reddy et al., 2014). Lastly, it is suspected that task designs and neuroimaging procedures might contribute to the misalignments of results (Kaladjian et al., 2011). The measures reported in Table 1 illustrate the array of measurement tools used in assessing impulsivity: While some tests or paradigms measure response inhibition (e.g., SST and Go/No-go), other measures gauge the degree of risk-taking behaviors (e.g., BART). Taken together, these tasks all aim to measure impulsivity, yet the mere intricacy of this construct prevents such an overall measurement of impulsivity. Neuropsychological tasks assessing impulsivity do not systematically measure the same construct and traits under the same conditions and test methodologies. Incidentally, there appears to be a tendency in research to apply different methods (e.g., self-report and behavioral measurements) in assessing individual differences and to conflate findings across measurement types despite a weak correlation between both types of measures (Dang et al., 2020). Fortgang and colleagues (2016) highlight this belief by indicating that sensation-seeking and motor response inhibition are, in fact, detached from impulsivity, thus suggesting that phenotypes associated with impulsivity may correspond to utterly different constructs. It is thus primordial to consider impulsivity from a Research Domain Criteria (RDoC) standpoint in complement to traditional DSM-ICD diagnostic approaches (Fortgang et al., 2016; Lilienfeld & Treadway, 2016).

**Toward a Better Phenotype Conceptualization**

In studies investigating genetics and SCZ, there remains a tendency to use DSM criteria as a set phenotype, which inevitably results in heterogeneous findings that are not easily replicable (Braff et al., 2007; Congdon & Canli, 2005). Considering DSM criteria as an accurate and comprehensive representation of one's traits can be problematic on several levels. DSM criteria are, by definition, established as nosological guidelines that categorize a fixed group of heterogeneous symptoms for clinical purposes (Jablensky, 2010; Kendell & Jablensky, 2003). This implies that the DSM has the inherent limitations of a categorical classification system, meaning that these categories are based on syndromic groups and, thus, only on clinical criteria (Frances & Egger, 1999; Ginsburg et al., 1996; Kendell & Jablensky, 2003). The principles that prevail in the establishment of such atheoretical classifications are validity and reliability (Carson, 1991; Kendell & Jablensky, 2003). In the absence of diagnostic biomarkers that can act as external validators, the validity of the DSM (or other diagnostic tools) is hard to establish and leads to the reduction of validity to questions of reliability (Kupfer & Regier, 2011; Weickert et al., 2013).

The heterogeneity of SCZ has led to the emergence of multiple models that account for hypothetical processes (Arslan, 2018; Owen & Cardno, 1999; Smeland & Andreassen, 2018). Yet even with an abundance of genetic and clinical evidence, those different models do not reach a consensus (Peralta & Cuesta, 2001; Pickard, 2011). Relying on such categorical classifications hinders the singularity and individuality of clinical presentations (Congdon & Canli, 2005; Heckers et al., 2013). Resorting to heterogeneous symptom criteria thus also entails relying on corresponding heterogeneous genetic processes, which inevitably precludes the identification of phenotypes closer to the influence of genetic variants (Braff et al., 2007; Congdon & Canli, 2005; Gottesman & Gould, 2003). Hence, adopting an endophenotype approach that is amenable to quantitative genetic data constitutes a way to overcome this obstacle (Braff & Light, 2005; Gur et al., 2007; Hyman, 2000). Endophenotypes in their ability to identify subclinical traits and measurable phenotypes not only decrease the genetic complexity of SCZ but allow for more lucid associations between genetic variants and impulsivity-related phenotypes (De Geus & Boomsma, 2001; Gottesman & Gould, 2003; Turetsky et al., 2007).

## Conclusion

Reviews comparing different neuropsychiatric disorders such as ASD, ADHD, BD, SCZ, and impulsive behavior disorders find that these conditions all share impairments in serotonin regulation, specifically in shared domains such as executive functioning, public behavior, and sensory gating (Broberg et al., 2010; Patrick & Ames, 2015). Thus, if impulsivity has been proposed as an endophenotype for those disorders (Fortgang et al., 2016; Nigg et al., 2017; Sharp, 2016; Yen et al., 2013; Yi-Ling et al., 2017; Zhou et al., 2018), we support that further investigations on SCZ alone should be carried out. Lastly, though this review supports that impulsivity should be considered an endophenotype for SCZ, it also emphasizes the need for future research – specifically genetic studies – to rely on endophenotype approaches as their central methodology.

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# SOCIAL PSYCHOLOGICAL ANALYSIS: FACTORS CONTRIBUTING TO CANCEL CULTURE

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**Abstract** – The prevalence of cancel culture in today's society has captured the attention of the general public, the media, and even researchers. The current paper describes three relatively recent (and, arguably, controversial) examples of cancel culture and then identifies and describes three group-related social psychological factors—social contagion, group polarization, groupthink—that may contribute to cancel culture via social media. Using the empirical social psychological literature, these group-related factors are defined and discussed in the context of cancel culture. By describing and applying three group-related social psychological factors, the paper reveals how social psychological science can help explain people's tendency to banish or "cancel" individuals accused of violating moral norms.

*Keywords:* assessing creativity, torrance, drawings

In 2021, singer-songwriter and film director—Sia—debuted the movie *Music* which cast a neurotypical actress in the role of a nonverbal autistic teenager. A mass of viewers—over 55,000—signed a petition to have the film officially condemned by the industry, in hopes of removing its two Golden Globe nominations (Sparks, 2021). The action taken by viewers was, in large part, because Sia failed to cast a neurodivergent individual in the role of the nonverbal autistic teenager, thereby excluding disabled and neurodiverse actors from their own narratives.

In 2022, a respected and accomplished professor of organic chemistry—Dr. Maitland Jones Jr—was denied a contract at New York University, because a swath of students signed a petition against him (Saul, 2022). The students, who used a GroupMe chat to unite their frustrations about the organic chemistry course, blamed Dr. Jones for their poor test scores, claiming his expectations were unreasonable and unachievable. Although Dr. Jones defended his standards, his contract was nevertheless terminated.

Finally, in early 2023, newspapers across the nation—including well-renowned and highly read papers such as The Boston Globe, The Washington Post, and The Los Angeles Times—stopped printing the *Dilbert* comic strip because the creator—Scott Adams—made denigrating comments about Black people. Specifically, as part of a YouTube livestream, Mr. Adams described Black people as "a hate group" and espoused the belief that it "makes no sense to help Black Americans if you're White." Mr. Adams feigned ignorance to the racist nature of his remarks and Tweeted "An obvious question for those who canceled me is do they disagree with my point. So far I have not seen it. I only see disagreement with my use of hyperbole" (Adams, 2023).

The examples reported previously demonstrate the idea of cancel culture, which is broadly defined as strategies to socially isolate and ostracize people accused of offensive comments or actions (Norris, 2023). Specifically, cancel culture reflects the public shaming of individuals for their unacceptable comments or actions in hopes that they experience personal and/or professional consequences (Tandoc et al., 2022). Cancel culture's recent proliferation may be due, in large part, to the rapid transmission of information via social media, which makes cancel culture feel distinctive and controversial. In fact, Vogels et al. from the Pew Research Center (2021) recently revealed that 58% of U.S. adults believe that calling attention to individuals' words or deeds on social media is an effective method for holding them accountable, whereas 38% believe that such action has the capacity to punish people unnecessarily. Given disparate perceptions of the effectiveness of cancel culture online, it is important to understand the conditions that may foster or exacerbate its use. The current paper uses the empirical social psychological

literature to identify and explain three group-related factors (i.e., social contagion, group polarization, groupthink) that may contribute to the proliferation of cancel culture via social media.

**Social Contagion**

The first social psychological phenomenon that may contribute to cancel culture is social contagion. According to the American Psychology Association (2023), social contagion is defined as the spread of attitudes, emotions, and behaviors across groups of people. Arguably, cancel culture operates and persists through the mechanism of social contagion, which is exacerbated via social media. In fact, Tandoc et al. (2022) argue that the anonymity often provided to social media users allows them to easily participate in cancel culture—spreading ideas—without social barriers. Relatedly, Brady et al. (2020) argue that social contagion of ideas is magnified on social media due to the rapid spread of inherently social and emotional content. Thus, the spread of ideas on social media platforms can help explain how social contagion contributes to cancel culture.

Social contagion often occurs when information is rich with moral and emotional language—something common in arguments associated with cancel culture. For example, Barrios-O'Neill (2021) investigated the role of emotional language in the social contagion of messages from leading non-governmental organizations on Twitter. In the study, Barrios-O'Neill examined exactly 1000 of the most recent Twitter posts from each of ten environmental agencies working to educate the public about threats to biodiversity, such as overexploitation and climate change. The results revealed that the use of negative emotional language in these posts significantly boosted social contagion (e.g., #stopkillingsharks; Barrios-O'Neill, 2021), demonstrating how information that is rich with emotional content can spread.

In an additional study examining the role of moral emotions in the spread of ideas on social media, Brady et al. (2017) analyzed 563,312 tweets (on the social media platform Twitter) reflecting three polarizing political and moral topics: gun control, climate change, and same-sex marriage. Results revealed that the use of moral-emotional words in tweets increased the spread of the words by approximately 20% (Brady et al.). Such results demonstrate that the use of moral-emotional language in social media posts can increase the social contagion of ideas online.

The research by Barrios-O'Neill (2021) and Brady et al. (2017) are excellent examples of how ideas conveyed online using moral and emotional language, especially negative emotional language, contributes to the spread of those ideas (i.e., social contagion). Because cancel culture tends to reflect topics of moral significance, such as racism, sexual violence, ableism, and sexism, this evidence explains how such information is rapidly propagated and perpetuated online.

**Group Polarization**

Group polarization reflects the idea that, in groups, individuals tend to report more extreme opinions, responses, or decisions than if they reported their opinions, responses, or decisions individually (Myers & Lamm, 1976). That is, on average, when individuals are in groups of like-minded others, they tend to report more polarized attitudes—such as a shift to more extreme attitudes—than when not in groups. Whyte (1989) explains that group polarization occurs because groups of like-minded people experience pressure to maintain uniformity in their ideas and have little need to challenge or critically examine information for which everyone already agrees. Consequently, extreme versions of ideas can emerge and be sustained.

Arguably, group polarization can flourish on social networking sites just as it does for groups that form offline or in person. In a demonstration of group polarization online, Strandberg et al. (2019) assigned like-minded individuals to in-person or online discussion groups about the status of the Swedish language in Finland (a national language spoken by only 5.4% of the population). Results revealed that group polarization was just as likely to occur in free discussions online as it was for free discussions in person. Such results demonstrate how group polarization occurs in online discussions with like-minded individuals and, therefore, may have implications for the proliferation of cancel culture online.

Interestingly, some researchers have argued that social media promotes and favors polarizing spaces thus decreasing users' ability to access diverse content (Iandoli et al., 2021). Specifically, Iandoli et al. (2021) conducted a systematic review of the literature, which included summarizing results from 121 research papers, examining the presence of group polarization on social media and other online discussion-based platforms. Results of the systematic review revealed various mechanisms promoting group polarization online. For example, social media was thought to create environments where users consume and share information that reinforces their opinions. Additionally, Iandoli et al.'s review revealed that social media allows—oftentimes encourages—individuals to find socially similar others, which can promote the creation of groups that possess homogeneous beliefs. After reviewing the literature, Iandoli et al. boldly stated that communications via social media can intentionally contribute to group polarization (Iandoli et al., 2020). If social media supports the

emergence of polarizing echo-chambers that do, in fact, reduce users' exposure to diverse information, such lack of information diversity may promote cancel culture. Specifically, group polarization may be one mechanism whereby individuals experience social pressure—from like-minded individuals—to ostracize targets accused of offensive words or deeds. Because cancel culture is often centered on moral or ethical topics, it is understandable how the polarization of individuals' attitudes can heighten their moral convictions and fuel their desire to see violators punished.

**Groupthink (and the Illusion of Morality)**

A third social psychological phenomenon that may contribute to cancel culture is groupthink. Groupthink is described as a way of thinking whereby members of a cohesive group strive to form united beliefs at the expense of exploring alternative ideas (Janis, 1982). Although groupthink emerges due to a variety of factors, understanding the function of group illusions, specifically that of the illusion of morality, is particularly relevant to cancel culture.

The illusion of morality describes the idea that individuals experience certainty in their moral convictions on various issues (Forsyth, 2020). Because cancel culture often involves seeking consequences (e.g., financial and/or social) for violators of moral norms, individuals engaged in canceling a violator of a moral norm may experience heightened certainty—experience an illusion of their morality—in the rightness of their moral perspective. In fact, Stern (2016) argues that individuals experience a desire to be in groups that feel empowered by and superior in their moral convictions (i.e., righteousness indignation). Such an illusion of morality may contribute to cancel culture by creating an illusion of moral superiority that is derived from groupthink.

In a demonstration of the illusion of morality contributing to groupthink, Forysth (2020) analyzed the media posts from groups of individuals highly resistant to quarantining—termed anti-quarantine groups—during the COVID-19 pandemic. Forysth's analysis revealed that anti-quarantine groups may have believed that their arguments were morally superior to opposing arguments. Specifically, anti-quarantine groups asserted moral claims associated with people's rights to engage in behaviors such as traveling freely, which were violated by safer-at-home policies. Counterarguments—even when morally-laden (e.g., public health ideas related to the preservation of life) had little impact on their convictions. Forsyth attributes these behaviors not only to the illusion of morality, but to other factors of groupthink such as cohesion and isolation, that were extremely prevalent during the COVID-19 pandemic. When the illusion of morality—contributing to groupthink—is applied to cancel culture, it is clear how experiencing heightened conviction for a moral stance, without an openness to critically examine alternative ideas, unites people to take action.

**Conclusion**

In sum, three group-related social psychological phenomena—social contagion, group polarization, and groupthink—appear to contribute to cancel culture online. If the factors that contribute to cancel culture are identified and understood, it is possible that more reasoned responses—those driven by less emotion and less social influence—may emerge in response to perceived wrongdoing online.

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