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Examining The Effects Of Acute And Chronic Stress On The Interrogative Suggestibility Of Young Adults

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by

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Abstract

High-stress situations, like police interrogations, can hinder an individual's decision-making and critical-thinking ability (Liston et al., 2009), making them more susceptible to suggestive or leading messages during questioning. While research on suggestibility mainly focuses on children and adolescents, young adults may also be vulnerable to suggestion because of their sensitivity to social feedback (Blakemore & Mills, 2014; Redlich & Goodman, 2003). Since the legal consequences of suggestibility for young adults are more severe than for children or adolescents, it is essential to examine the role of stress in young adults' suggestibility. The present study used objective and subjective methods to examine the impact of acute and chronic stress on young adults' suggestibility. Participants (*N* = 128) aged 18 to 26 were randomly assigned to complete either a stressful social task (TSST; Kirschbaum et al., 1993) or a control condition. The Gudjonsson Suggestibility Scale (GSS; Gudjonsson, 1984) and self-report measures were used to assess the participants' suggestibility and experiences with stress. Heart rate and Galvanic Skin Responses (GSR) were also obtained as physiological indices of stress. Although our study did not find significant evidence to support the hypothesized effects of acute and chronic stress on young adults' suggestibility, this research nonetheless highlights the importance of understanding the complex interplay of stress and suggestibility to extend legal recommendations beyond children and adolescents to include young adults in situations where suggestibility is likely to occur.

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Introduction

In the United States, young adults (aged 18 to 24) are more likely to experience police-initiated contact (i.e., traffic stop, arrest) than any other age group (Harrell & Davis, 2020). When police observe suspicious behaviors, they may use interrogative techniques to gather more information and obtain an admission of guilt. Gudjonsson & Clark (1986) defined interrogative suggestibility as "the extent to which, within a closed social interaction, people come to accept messages communicated during formal questioning… and their subsequent behavioral response is affected" (p. 84). Being suggestible can have meaningful and, at times, dire consequences in the legal context. For instance, suggestible individuals may be more likely to falsely confess to a crime they did not commit (Kassin & Gudjonsson, 2004), which can result in severe legal consequences, such as prison.

Interrogative suggestibility research primarily focuses on children, clinical, and forensic populations (Ceci et al., 2000; Eisen et al., 2002; Richardson et al., 1995). Though children and adolescents are more suggestible than adults (Ceci et al., 2000; Quas et al., 1997), young adults are also vulnerable to suggestion (Redlich & Goodman, 2003), as they are in a developmental stage of heightened sensitivity to positive and negative social feedback (Blakemore & Mills, 2014). Therefore, although young adults may be less suggestible than their younger counterparts, they are nonetheless still vulnerable to suggestibility as compared to adults. Importantly, the consequences of young adults' suggestibility may be more dire than those for children and adolescents, who would likely face juvenile court (primarily focused on rehabilitation over punishment; Robinson & Kurlychek, 2019).

Being interrogated produces a highly stressful situation with potentially significant legal consequences. Interrogation can elevate acute stress levels (i.e., reaction to an unexpected situation that dissipates when the event has ceased; Almeida, 2005), negatively impacting an individual's ability to think critically and make informed decisions (Liston et al., 2009), leading them to accept suggestive messages more easily. Little is known about how acute stress affects suggestibility. Yet, the situations in which the consequence of suggestibility are most serious (e.g., interrogations) are likely to induce acute stress (Guyll et al., 2013; Yoo et al., 2020). Within high-stakes legal settings, understanding the impact of stress on young adults' suggestibility is vital.

Furthermore, novel and rapid life transitions (i.e., education, relationships, employment; Rew et al., 2014), which are characteristic of young adulthood, can lead to individual-level differences in underlying levels of chronic stress. Young adults may vary in their stress levels, and the consequences of acute stress may be greater for those already experiencing chronic stress, potentially heightening their risk for suggestibility. Thus, the present study examined the physiological effects of laboratory-induced acute stress on young adults' suggestibility and how these effects varied according to individual levels of self-reported chronic stress.

Suggestibility and Young Adults

Suggestibility is the degree to which social and psychological factors influence memory processing (e.g., encoding, storage, retrieval; Ceci & Bruck, 1993). Interrogative suggestibility (a legal extension of suggestibility) denotes the influence that implicit and explicit suggestions and leading questions have on individuals; this definition will be adopted throughout the paper; Ceci & Bruck, 1993; Gudjonsson & Clark, 1986). Though children are more suggestible than adults (Redlich & Goodman, 2003; Richardson et al., 1995), young adults can be susceptible to suggestion when complying with requests from authority figures and negative feedback (Polczyk & Bomba, 2004; Polczyk, 2005). Though young adults are under-represented in the literature.

Therefore, this study focused on the interrogative suggestibility of young adults aged 18 through 25. Understanding factors contributing to suggestibility in young adults is crucial since suggestibility can result in severe consequences. For example, suggestibility in a legal scenario could contribute to consequences such as being imprisoned for admitting guilt to a crime they did not commit.

In general, suggestibility (or a vulnerability to it) decreases with older age. Children are more vulnerable to suggestion than adolescents (Richardson et al., 1995), and adolescents are more vulnerable to suggestion than adults (Redlich & Goodman, 2003). However, there is limited research on distinctions between the suggestibility of adults at various stages of adulthood (specifically young adults or emerging adults as compared to older adults). Kassin and Kiechel (1996) examined the likelihood of obtaining a confession for a "mock crime" in a sample of young adult college students. Participants performed a reaction-timed typing task on a computer and were explicitly warned not to press the alt-key; otherwise, the program would crash and lose all stored data. When falsely accused of pressing the alt-key, 69% of participants signed an admission of guilt, although only 28% came to believe their "guilt." As an extension of the classic alt-key paradigm, Redlich and Goodman (2003) examined the suggestibility of children (12 to 13 years old), adolescents (15 to 16 years old), and young adults (18 to 26 years old). They found that more suggestible participants (compared to less suggestible) were more likely to comply and admit guilt when falsely accused of hitting the alt-key. Specifically, children were more likely to falsely admit guilt than adolescents and young adults, though over half of the young adult sample (59%) complied with a written statement of guilt. Although accusing someone of losing valuable data is a far cry from accusing someone of a crime, these studies illustrate the prevalence of suggestibility in young adults under minimal stress conditions (a stark difference from those experienced by a suspect held in custody; Kassin & Kiechel, 1996); therefore, understanding stress-related factors that affect the suggestibility of young adults is essential.

Gudjonsson and Clark (1986) proposed a model of suggestibility involving both a cognitive component (i.e., the memory of an event) and a social component (i.e., receiving negative feedback). Both the cognitive component and the social component of suggestibility have been previously examined, particularly in the context of eyewitness memory (Eisen et al., 2002) and compliance-induced confessions (Redlich & Goodman, 2003). Specifically, cognitive aspects of interrogative suggestibility have been defined as the incorporation of misleading information into one's memory that is not due to memory deficit issues (Schooler & Loftus, 1993). On the other hand, social aspects of suggestibility are associated with personality traits such as compliance, eagerness to please, and trust in authority (Gudjonsson, 1995; Ofshe, 1989). Young adults are susceptible to social influences, particularly when receiving negative feedback (McMurtrie et al., 2012; Polczyk, 2005; Polczyk & Bomba, 2004). Although adolescents are more vulnerable to social influences, particularly regarding risk-taking and peer influences (Gardner & Steinberg, 2005; Steinberg & Monahan, 2007), young adults are also susceptible. A study compared the interrogative suggestibility of young adults (aged 18 to 35) and older adults (aged 49 to 88) and found that although older adults were more suggestible than younger adults due to age-related memory deficits (i.e., cognitive suggestibility), younger adults were particularly influenced by negative feedback (i.e., social suggestibility) on the Gudjonsson Suggestibility Scale (GSS). The authors suggested that these results may be due to older adults being more self-confident and less dependent on authority figures (Polczyk & Bomba, 2004). Building upon these findings, Polczyk (2005) evaluated fear of negative evaluation and social desirability in a sample of college students and faculty (aged 18 to 56) and found that social desirability scores and suggestibility were positively correlated. A recent study examined the effects of age and negative feedback in the absence of leading questions in a sample of young, middle, and older adults (groups were separated post-hoc, the young adult group aged 18 to 35). Consistent with prior research, young adults were more likely to change their responses after negative feedback (vs. neutral) than the middle and older adult groups (McMurtrie et al., 2012).

Although limited, literature on young adults’ suggestibility suggests that social influence and desirability may particularly contribute to the suggestibility of this population. To better understand factors that may impact suggestibility in young adults, it is important to consider how stress can influence cognitive and social processes since stress can arise from different sources (e.g., acute and chronic). Therefore, investigating the impact of cumulative stress on young adults' suggestibility is crucial, particularly given the high-stress nature of the legal system where young adults may be most suggestible.

Effects of Stress on Suggestibility

A Cumulative Stress Theory Model proposes that stress accumulates over time, leading to physiological and psychological changes that can hinder an individual's ability to cope with additional stressors (McEwen, 1998). Cumulative stress can be considered a snowball effect, where early stressors are unlikely to have a significant physiological or psychological impact. As stress accumulates (e.g., chronic stress), individuals may find it increasingly difficult to cope with additional acute stressors. In this case, individuals with higher levels of chronic stress may be more suggestible in response to acute stressors (e.g., a laboratory-induced stressor) than those with lower chronic stress levels. Chronic stressors are particularly relevant among young adults, as they may experience a higher degree of stress due to various social, academic, and personal transitions characteristic of this age (Rew et al., 2014).

Given the potential for high-stress interrogations to elicit false confessions, it is vital to understand how stress impacts suggestibility. Research has suggested that stress can significantly impact an individual's cognitive and social processes, which may influence suggestibility (Gudjonsson & Clark, 1986). However, limited research has explored this relationship. Indeed, studies examining this effect have done so in the context of trauma-related stress in memory recollection of child eyewitnesses (Gudjonsson et al., 2020; Vagni et al., 2022) or field studies lacking in experimental design (Morgan et al., 2020). Stress can arise from different sources; therefore, it is crucial to consider both acute and chronic stressors to understand the cumulative effects of stress on suggestibility. Thus, the present study examined the potential impact of cumulative stress on young adults' suggestibility, specifically examining the role of acute and chronic stress.

Acute Stress

Acute (or event-related) stressors are seen as typical day-to-day challenges or can result from a sudden or unexpected experience (Almeida, 2005). Acute stress occurs quickly and typically fades once the situation has passed. The effects of acute stress on suggestibility have yet to be thoroughly studied, particularly in young adults, though limited research suggests high levels of acute stress are positively associated with suggestibility (Morgan et al., 2020).

Studying the ecologically valid effects of stress on suggestibility is challenging due to ethical considerations of Institutional Review Boards' (IRBs) best research practices with human subjects. Research involving forensic (e.g., incarcerated) populations and police interrogation transcripts suggests that stressful interrogation methods are associated with false confessions

(Gudjonsson & Clark, 1986; Gudjonsson & Rutter, 1995). False confessions may be associated with greater suggestibility, though this has been primarily examined with forensic samples of adolescent and adult offenders (Gudjonsson & Singh, 1984; Richardson et al., 1995). A one-of-a-kind study by Morgan and colleagues (2020) directly examined the effects of acute stress on compliance and suggestibility in a sample of special operations U.S. military. They prospectively evaluated intense acute stress exposure in a sample of active-duty personnel enrolled in survival training school—a program designed to simulate realistic survival skills that military personnel might encounter, including experiencing mock captivity and interrogations modeled from terrorist groups. One cohort completed the GSS measure after exposure to the stressful mock interrogation (but while still in "captivity"). They found that mock interrogation stress resulted in a significant increase in suggestibility in adults. Although researchers indicated that this training course elicits high-stress levels, no indices of stress (physiological, hormonal, or self-report) were obtained. Further research is needed to extend these findings to non-military or forensic populations. Additionally, laboratory research is needed, as such studies can experimentally manipulate stress and control for other variables that a field study could not account for.

On the other hand, some empirical research has examined the impact of laboratory-induced stress on interrogations through physiological responses like heart rate, respiration, and functional Magnetic Resonance Imaging (fMRI). Results of these studies suggest that, indeed, interrogation proceedings can cause greater stress activation. For example, a study by Guyll et al. (2013) examined differences in physiological stress between “innocent” and “guilty” young adults (*M* = 19.4 years old, *SD* = 1.6 years old) and whether stress impacted confession rates. Participants were randomly assigned to either an innocent (i.e., working independently on some problems) or guilty (i.e., helping a confederate on some problems) condition. Afterward, they were accused of academic misconduct, interrogated, and pressured to confess. Blood pressure, heart rate, and respiration metrics were measured. Results revealed that “guilty” participants presented greater physiological activity during the accusation and interrogation phase than “innocent” participants (presumably because innocent individuals may perceive the situation as less risky than their guilty counterparts). However, both the accusation and the interrogation periods elicited greater physiological activation indicative of stress compared to a baseline across participants in both conditions. Similarly, in a study conducted by Yoo et al. (2020), the neurological effects of interrogation stress on truthful and deceitful responses were examined using fMRI. The study involved participants aged 19 to 31 who played an online card game during an fMRI session. The objective of the game was to get rid of their cards either truthfully (e.g., innocent condition) or deceptively (e.g., guilty condition) in a limited amount of moves to earn money. An "interrogator" evaluated whether the participant truly discarded the appropriate card or not. However, the "interrogator" was a computerized paradigm programmed to question the innocence or guilt of the participant and make assumptions based on behavioral cues. The results showed that regardless of innocence, higher activation in anxiety-related neural pathways was observed during the “interrogations”. However, the small sample size (*N*=19) limits the generalizability of the results.

These empirical studies provide evidence that interrogations can cause stress, even among innocent subjects, in a laboratory setting, with no actual legal consequences. This supports the long-held belief that interrogations can be stressful. It's important to note that more suggestible individuals are more likely to confess (Kassin & Kiechel, 1996; Redlich & Goodman, 2003), and interrogation settings can increase stress levels (Guyll et al., 2013; Yoo et al., 2020). Therefore, it's essential to explore the connection between stress and suggestibility.

Chronic Stress

Chronic stress persists over an extended period and can severely affect an individual's physical and psychological well-being (McEwen & Stellar, 1993). Unlike acute stress, chronic stress is ongoing, leaving the body and cognitive processes vulnerable to complications and continuously elevated fight-or-flight responses in the sympathetic nervous system (McEwen, 1998). Furthermore, differences in coping mechanisms and resilience indicate that some individuals are more affected by stressors than others (Almeida, 2005). Thus, the impact of additional stressors on an individual may be exacerbated by the cumulative presence of prior stressors. The effect of chronic stress on suggestibility has not been investigated previously, yet it is essential to understand this relationship to understand the cumulative effect that different sources of stress may have on young adults' suggestibility.

Young adults are more likely to experience chronic stress than middle or older adults due to rapid life transitions associated with this age (Turner & Turner, 2005). Economic hardship and relationship stressors are more prevalent among young adults than among middle or older adults (Mirowsky & Ross, 1999). Prior research indicates that ages 18 through 25 are typically unstable in love, work, and views as individuals learn their responsibilities and explore their identities (Arnett, 2000).

Consistent exposure to chronic stress can have serious implications for individuals in adulthood. Research has shown that high exposure to chronic stressors early in life can lead to a cascade of reactivity to novel stressors later on (Wheaton, 1997) and increased suggestibility in adulthood (Morgan et al., 2020). Additionally, individuals who are marginalized, such as individuals from low socioeconomic status, are at greater risk of earlier exposure to chronic stressors and are also more likely to experience greater levels of acute stress compared to their wealthier counterparts (Turner & Turner, 2005). Therefore, it is important to recognize the serious implications of chronic stress and work to mitigate its effects, particularly for those who are most vulnerable to experiencing chronic stressors and are more likely to be involved with the legal system.

Although chronic stress has not been previously investigated, prior research findings highlight young adults' potential to experience chronic stress due to various situations. Additionally, marginalized individuals can be at an increased risk of exposure to chronic stress and legal issues. Therefore, it is crucial to understand the relationship between chronic stress and suggestibility in young adults, particularly in those who may already be experiencing high levels of stress. Studying the impact of long-term stress on susceptibility to suggestion in young adults can provide significant insights into the existing body of literature. It can also open up new avenues to investigate how differences in chronic stress levels over time can impact decision-making during high-pressure situations.

Physiological Measurements of Stress

Studies that rely on self-reporting to measure acute stress face limitations in detecting real-time changes to stress compared to other physiological measures (such as cortisol, heart rate, and electrodermal activity). Research that assesses *perceived* stress via self-report may not accurately capture a participant's *actual* response to stressful stimuli since subjective measures of stress may depend on an individual's current cognitive state (e.g., mood, fatigue) and may, therefore, be biased (Villanueva et al., 2016). On the other hand, research that evaluates stress via cortisol may be more accurate in detecting changes compared to self-report; however, such studies require careful planning and consideration of several factors. Some factors include careful consideration of the protocol for sample collection, such as ensuring there has been a 30-

minute delay between foods, liquids, gum, or nicotine before collecting the sample, taking into account the half-life of cortisol for necessary pre-and post-cortisol collection, and ensuring proper storage at -80F. Participant-dependent variables that may affect hormonal changes must also be considered, such as avoiding medications that affect hormones for at least a 24-hour before collection (including hormonal birth control) and considering a participant's menstrual cycle. Therefore, obtaining biological cortisol samples may not always be feasible and does not provide real-time information on the body's response to acute stressors.

Obtaining physiological responses to stress through changes in skin conductance (i.e., Galvanic Skin Response) and heart rate variability provides a feasible alternative for measuring real-time changes to acute stress in a laboratory. Galvanic Skin Response (GSR) falls under the umbrella term of electrodermal activity (EDA) and occurs when an increase in sweat gland production causes a change in the electrical properties of the skin, allowing us to measure a Skin Conductance Response (SCR; typically due to an aroused state due to an involuntary response to noxious or emotional stimuli; Sharma et al., 2016). Heart rate also changes in response to noxious or emotional stimuli (i.e., increases or decreases), leading to heart rate variability measurements (HRV), consisting of changes in the time intervals between consecutive heartbeats (i.e., Interbeat intervals, IBIs; Shaffer & Ginsberg, 2017). Exposure to arousing stimuli, such as a stressful situation, can cause a shorter interval between consecutive heartbeats, resulting in an increased heart rate. Non-invasive skin sensors can measure micro-level changes in skin conductance and heart rate. These sensors can continuously capture physiological responses during a baseline, stressor, and resting period, allowing for real-time comparisons of individual-level micro changes in response to an acute stressor. Unlike cortisol measures, which may only provide indications of elevated stress over an extended period, skin sensors can provide moment-by-moment insight into stress activation levels. It is important to note that no one method for quantifying stress is better than another, as each method has its unique challenges. However, combining physiological responses of heart rate and skin conductance as a proxy for stress, along with self-reported stress levels, may allow for a more comprehensive understanding of acute stress and its impact on suggestibility.

The Present Study

Suggestibility research thus far is lacking in three specific domains we seek to address in the present study. First, *interrogative suggestibility* research has primarily focused on the cognitive aspect (e.g., memory processing due to stress) of suggestibility, most often in eyewitness testimony, with less empirical research on the social aspect of suggestibility. Second, existing literature has focused on children and adolescents' suggestibility, with a lesser emphasis on young adults' suggestibility. Third, there is almost no empirical research examining the association between stress and suggestibility. Further, extant suggestibility research has been limited methodologically, as most studies have examined the effects of stress on (cognitive) suggestibility through self-report measures, and few studies have experimentally manipulated stress. The present study builds upon the limited existing research by inducing stress in the laboratory using the Trier Social Stress Test (TSST), a widely used and validated laboratory stressor of acute stress, and by assessing stress through real-time physiological changes in heart rate and GSR, in addition to self-report. The present study uses an experimental design, such that participants are randomly assigned to either an acute stress condition or a control (no induced stress) condition to examine the association between stress (including both induced acute and naturally-occurring chronic stress) and social suggestibility among young adults. The current study, therefore, examines the effects of acute and chronic stress on young adults' suggestibility to address gaps in the literature and examine two research questions. To answer each question, we examined acute stress in three different ways: through experimental manipulation, physiological response, and self-reported stress.

1) ***Is there an effect of acute stress on suggestibility?***

In all hypotheses, we predict a positive association between acute stress and suggestibility. However, to evaluate the role of measurement in this relationship, acute stress is evaluated in three distinct ways: a) experimental condition, b) physiological response via heart rate variability and Galvanic Skin Response, and c) self-report of stress.

Hypothesis 1a. Participants in the acute stress condition will be more suggestible than participants in the control condition (as evinced by a higher score on the “yield” suggestibility score).

Hypothesis 1b. Participants who demonstrate a heart rate variability consistent with greater acute stress (i.e., exhibiting increased heart rate from the baseline to the experimental condition – in other words, a positive change score for heart rate) will demonstrate greater suggestibility (as evinced by a higher score on the “yield” suggestibility score) than participants whose heart rate indicates less acute stress (i.e., those who exhibit a negative change score in heart rate).

Hypothesis 1c. Similarly, participants who exhibit a Galvanic Skin Response consistent with greater acute stress (i.e., increased activity from the baseline to the experimental condition – in other words, a positive change score for GSR) will demonstrate greater suggestibility (as evidenced by a higher score on the “yield” suggestibility score) than participants whose change in GSR indicates less acute stress (i.e., those who exhibit a negative change score in GSR).

Hypothesis 1d. Participants who self-report a greater change in stress after the stress manipulation task (compared to the baseline measure of stress) will demonstrate greater suggestibility (as evidenced by a higher score on the "yield" suggestibility score) than participants who self-report no differences in pre-/post-task stress levels.

2) ***Does the effect of acute stress and suggestibility vary depending on participants' level of chronic stress?***

Hypothesis 2a. Chronic stress scores will moderate the relationship between the experimental condition and suggestibility (as evinced by a higher score on the "yield" suggestibility score), such that the positive association between acute stress and suggestibility will be exacerbated for those participants who self-report higher levels of chronic stress.

Hypothesis 2b. Chronic stress scores will moderate the relationship between heart rate consistent with greater acute stress (i.e., exhibiting increased heart rate from the baseline to the experimental condition – in other words, a positive change score for heart rate) and suggestibility (as evinced by a higher score on the "yield" suggestibility score), such that the positive association between change in heart rate and suggestibility will be exacerbated for those participants whose heart rate indicates more acute stress (i.e., those who exhibit a positive change score in heart rate).

Hypothesis 2c. Chronic stress scores will moderate the relationship between Galvanic Skin Responses consistent with greater acute stress (i.e., increased activity from the baseline to the experimental condition –in other words, a positive change score for GSR) and suggestibility (as evidenced by a higher score on the "yield" suggestibility score), such that the positive association between change in GSR and suggestibility will be exacerbated for those participants whose GSR indicates more acute stress (i.e., those who exhibit a positive change score in GSR).

Hypothesis 2d. Chronic stress scores will moderate the relationship between the participants who self-report a greater change in stress after the stress manipulation task (compared to the baseline measure of stress) and greater suggestibility (as evidenced by a higher score on the "yield" suggestibility score), such that the positive association between self-reported change in stress and suggestibility will be exacerbated for those participants who self-report higher levels of chronic stress.

Method

Participants

Young adult college students were recruited from The University of Texas at El Paso's SONA subject pool system. They were invited to participate in a two-hour study that examined the impact of daily stress on the cognitive processing in college students. In order to be eligible to participate, individuals needed to be English-speaking students between ages 18 and 26 years. Additional eligibility criteria included those who were not taking cardiovascular-affecting medication (e.g., hypertensive, antidepressants, and antipsychotic medication), and had a body-mass index (BMI) below 35, as determined by self-reported height and weight during the screening process (as lesser heart rate variability is associated with obesity), given that certain medications and obesity affect normative heart rate patterns (Karason et al., 1999; Shaffer & Ginsberg, 2017). Participants were reminded during the sign-up process (and in the days before their scheduled laboratory session) to refrain from consuming alcohol at least 12 hours prior to their session. Additionally, they were asked to avoid consuming any food, snacks, or caffeine at least two hours before their session, as these factors can have an impact on their heart rate (see Shaffer & Ginsberg, 2017).

A power analysis using G*Power (version 3.1.9.7; Faul et al., 2009) estimated that a minimum sample of 106 participants was necessary to obtain 80% power and a small-to-medium effect size of 0.25. Additional participants (20% of the initial sample) were collected to account for potential missing data, issues with physiological data, and failed manipulation checks. Therefore, N = 128 participants enrolled in and completed the study. Participants were predominantly female (78.1%), Hispanic or Latino/a (90.6%), considered themselves as financially dependent (74.2%), and 20.7 years of age on average (*SD* = 1.96). See Table 1 for participants' demographic information.

Table 1. Participant Demographics.

		Frequency (%)
Sex		
	Male	28 (21.9%)
	Female	100 (78.1%)
Hispanic or Latino/a		
	Yes	116 (90.6%)
	No	12 (9.4%)
Race		
	White/Caucasian	109 (85.2%)
	African American/Black	3 (2.3%)
	Asian	4 (3.1%)
	Native American	2 (1.6%)
	Biracial or multiracial	6 (4.7%)
	Other	4 (3.1%)
	Prefer not to answer	7 (5.5%)
Financially Independent		
	Yes	32 (25%)
	No	95 (74.2%)
Household Income		
	< $15 K/ year	5 (3.9%)
	$15,001 – $25 K/ year	16 (12.5%)
	$25,001 - $35 K/ year	15 (11.7%)
	$35,001 - $50 K/ year	8 (6.3%)
	$50,001 - $75 K/year	21 (16.4%)
	$75,001 - $100 K/ year	12 (9.4%)
	$100,001 - $150 K/ year	6 (4.7%)
	> $150 K/ year	8 (6.3%)
	Prefer not to answer	4 (3.1%)

Note. Percentages not totaling 100% reflect missing data.

Procedures

A trained Research Assistant (RA) or the study's Principal Investigator (PI) obtained written participant informed consent before the start of each laboratory session, in line with the approved The University of Texas at El Paso's Institutional Review Board (UTEP IRB) protocols. A trained RA and the study PI worked with each participant throughout the study, starting with the setup of the physiological equipment at the start of the laboratory session, through completion of the Gudjonsson Suggestibility Scale, and debriefing. All of the session instructions and surveys were completed online on Qualtrics using a tablet.

All participants were set up with the physiological equipment and placed in a private experiment room where they remained by themselves until the end of the laboratory session. A monitor located in front of them presented participants with visual stimuli (e.g., a story, countdown timers), which were controlled by a trained RA from a stimulus computer located in an adjacent room. Meanwhile, the trained RA and PI were positioned in a separate control room where the stimulus computer and ongoing data collection computer were set up. A microphone (in the control room) and speaker (in the experiment room) allowed communication between the rooms throughout the session. Additionally, a camera was placed above the participant's monitor, enabling the research staff to observe them during the assessments. During the consent process, all participants were informed that the camera was on but not recording.

Phase 1. Set-up of physiological measures

After obtaining written consent, the PI, with the help of a trained RA, placed six skin sensors on the participant's body to measure their physiological responses. To measure heart rate, two electrodes were placed on the left and right sides of the collarbone, while two more were placed on the left-hand wrist bone and forearm to serve as the active and reference sites. For GSR readings, two sensors were placed on the tips of the left-hand index and middle fingers. All the sensors and electrodes were connected to a BioSemi signal amplifier and data acquisition system with a sampling rate of 512 Hz. Once the sensors and amplifier were turned on, the signal was visually inspected on both the amplifier and monitor to ensure the proper placement of the sensors. On average, participants wore the sensors for 25 minutes.

Phase 2. Baseline administration

Then, with the help of a trained RA, participants completed a brief survey about potential sources of heart rate variability, such as sleep and recent consumption of alcohol, caffeine, and food (see Measures section). At the same time, the study PI monitored the physiological signal on the control computer in the adjacent room. Following the survey, the participants were instructed to sit quietly while we recorded an initial five-minute session to obtain a baseline heart rate and GSR reading. A 2-to-4-minute baseline session is recommended (Braithwaite et al., n.d.).

Phase 3. Pre-task assessment, stress task, and post-task assessment

After the five-minute baseline reading, the PI asked the participants a series of questions to evaluate their perceived stress level toward an unknown task (see Acute Stress Apprisals in Measures, pre-version). Then, participants were randomly assigned to a control or laboratory-induced stress condition using an online blocked-random assignment generator. Participants were then given instructions for the experimental manipulation task assigned to them.

Control Condition. Participants in the no-stress (control) condition were asked to read a neutral stimulus presented on the screen in front of them. They were instructed that the text would move automatically on the screen and to read the text out loud, clearly, and carefully until asked to stop. They were advised not to worry about not knowing a word or its meaning. And they were reminded that they were not being recorded. Participants read a modified text on the history of trains (“History of rail transport”, 2023; see Appendix A) for 10 minutes. The reading level of the stimuli was rated at a 10^{th} grade Flesch-Kincaid reading level. Additionally, to standardize the stimulus and ensure that all participants were exposed to the same material for 10 minutes, regardless of their individual reading speeds, a slideshow presentation of the stimulus was previously recorded. Approximately three sentences were presented per slide, and each slide was displayed for 30 seconds.

Stress Condition. Participants in the induced stress condition performed a modified Trier Social Stress Test-Online version (TSST-OL; see Kirschbaum et al., 1993; Gunnar et al., 2021), a well-established and validated measure for inducing stress in laboratory settings (Kirschbaum et al., 1993; Allen et al., 2017). Online versions of the TSST have been previously conducted via Zoom and validated to induce stress through salivary cortisol measurements (Gunnar et al., 2021). The online method was chosen to limit participant movement and decrease sources of physiological noise due to movement during the GSR recordings. The speech element of the TSST is designed to induce stress from the social evaluation component and public speaking to a panel, mainly because the "hiring panel" was instructed to suppress any engagement, validation, or emotional responses to the speech. The surprise arithmetic element further increases stress due to the unexpected request to complete a verbal arithmetic task in front of a socially unresponsive panel. Additionally, the serial subtraction subsection of the TSST is the only component that involves negative feedback (requesting participants to start over when they made an arithmetic error); such feedback can also influence social stress. See Appendix B for an outline of the instructions for each component of the TSST.

The TSST task was administered on two computers. Throughout each task component, a three- and four-minute countdown timer was displayed on the original stimulus monitor to assist participants in keeping track of their time, reminding them to continue the task for the entire duration, and increasing their stress levels. A research staff brought a secondary laptop into the room and placed it in front of the participants for the Zoom conference call. A full-screen Zoom meeting room was visible from the start of the task instructions until the end of the serial subtraction task.

During the experiment, the participants were asked to imagine their ideal job and pretend they were being interviewed for it in front of a virtual panel on Zoom. They were given three minutes to privately prepare a four-minute speech to convince the panel that they were the best candidate for the job. At this time, the Zoom room was "empty" while the "hiring panel" waited in a breakout room. After the preparation period, the panelists joined the Zoom room to listen to the speech. Following the speech, the "hiring panel" was moved to a breakout room while the participant was given further instructions. The participants were instructed on a surprise serial subtraction arithmetic task they would perform before the panel for further evaluation. They were instructed to subtract 13 from 1022 out loud, and work backwards for three minutes, without making mistakes. With every mistake, the PI promptly instructed participants to start over. At the end of the three minutes, the PI ended the Zoom call.

The virtual panelists consisted of two adults dressed in formal attire, who were trained to withhold any facial expressions and avoid any interactions with the "interviewee". To standardize the presentation and interactions between the "hiring panel" confederates and participants, the "hiring panel" interactions were pre-recorded. During the recording, confederates were instructed to maintain a blank expression, pretend to take notes periodically and listen to an imaginary speech. To ensure the believability and convincingness of an actual Zoom conference call, a pilot study was conducted on a sample of five participants to evaluate the believability of the recorded Zoom call during the TSST stress manipulation. Following participant feedback, slight adjustments were made to the recording to increase its believability, such as adding Zoom "breakout" rooms between each component of the TSST task for the “hiring panel” to wait while additional instructions were provided to the participant.

After completing their experimental condition tasks, the PI asked the participants questions to evaluate their perceived stress level during the tasks (see Acute Stress Appraisals, post-version). This measure was also used as a manipulation check to ensure stress was induced during the TSST task.

Phase 4. Gudjonsson Suggestibility Scale

Participants proceed with the Gudjonsson Suggestibility Scale (GSS) while continually recording physiological data. The GSS (see Appendix C) measures how much individuals yield to leading questions and how much they might "shift" their responses due to social influence (see Gudjonsson, 1984; Gudjonsson, 1992). All participants completed it immediately following the stress task. Participants were instructed to listen carefully to a short story and informed that they would be asked to report everything they remembered later. Participants recalled everything they remembered once the story was read during an open-ended free recall period. Participant responses were audio recorded during this time. At the end of the session, a trained RA transcribed the audio and scored each recalled idea. The PI then verified the accuracy of the transcription and scoring for all participants. After verification, the audio recordings were deleted. A score of 1 indicated that the idea was accurately recalled, while a score of 0 indicated that there was either no recall or that the recall details were inaccurate. The total number of accurate recalls was summed to obtain a memory recall score out of forty points.

After the free recall, the PI asked participants twenty questions about the story. Fifteen questions are suggestive (i.e., leading questions, affirmative questions, false alternative questions), and five are true questions (i.e., those which contain no misleading information), though only the fifteen leading questions are considered in the “yield” suggestibility score. The fifteen suggestive questions give way to a "yield" score, that is, how much they "gave in" to the suggestive nature of the question. During the study, the PI scored the items in real time. Participants were free to answer each item, but the responses were coded as "Yes," "No," or "Don't know." For each of the fifteen positively answered items, a score of 1 was assigned. Otherwise, a score of 0 was assigned for any answers that included a "No," "Don't know," or provided corrected details from the story. For data analysis, a "yield" summary score was calculated for questions answered "Yes" (out of the fifteen leading questions). After completing the first round of questions, the PI informed the participants that they had made several errors and needed to respond to the questions again as accurately as possible. The PI read all twenty items again and independently scored each with the same guidelines as round 1. For data analysis, any *distinct* changes from the participant’s initial responses were considered a "shift," that is, the extent to which responses were shifted (regardless of correctness) in response to the negative feedback by the PI. For each of the twenty items, response changes from round 1 to round 2 were coded as 1, and retained responses were coded as 0. For data analysis, a “shift” summary score was obtained for each changed response; shift scores range from 0 to 20. This study used yield scores (ranging from 0 to 15) to measure suggestibility to leading or suggestive questions, in which higher scores indicated greater suggestibility. The yield subscale score has been consistently used and validated, with a Cronbach's alpha of 0.84 (Gignac & Powell, 2009).

Phase 5. Questionnaires

After completing the GSS task, the trained RA and study PI removed the equipment used for physiological data collection. Then, participants independently completed a series of computerized surveys on Qualtrics on a tablet. The surveys asked participants to self-report their demographic information, various sources of chronic stress (e.g., financial wellness, racial discrimination), and personality (e.g., psychosocial maturity, resilience)[1]. Overall, participants spent 15 to 20 minutes completing the surveys.

Phase 6. Debriefing session

At the end of the study surveys, but before debriefing, all participants answered a few questions on the tablet regarding their experiences and perceptions of the study. These questions were used as manipulation checks of the control and induced stress conditions (described in Measures). Finally, after completing the surveys, all participants took part in a debriefing session where the study PI informed them about the study's true objective, which was to investigate the impact of stress on suggestibility (as opposed to examining the impact of daily stressors on the cognitive processing in college students, indicated during recruitment), and explained why some people completed a reading task while others completed a speech. Participants were given the opportunity to ask any questions about the study and their participation and were provided with honest answers. After being fully informed of the study's purpose, all participants were given the option to provide written re-consent to the study or withdraw their data without any penalty. No participant chose to withdraw their data. Finally, all participants were thanked for their time and awarded two SONA credits.

Measures

The following measures were administered on Qualtrics. Participants independently completed all surveys on a tablet except for the baseline questionnaire and the Acute Stress Appraisals survey.

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[1] Only the surveys described in the measures section were part of the present study. Other measures were collected in the study, but not part of the hypothesized thesis models.

Demographics

Participants completed demographic questionnaires regarding their age, sex, race/ethnicity, and socioeconomic status (SES). Participant age was calculated from the interview date and their date of birth. Participants self-reported their sex assigned at birth (*Male* and *Female*), their gender identity (*Man, Woman, Non-binary, Prefer to self-describe,* and *Prefer not to answer*), and their race (*African American or Black, Asian, White, Hispanic or Latino, Middle Eastern, American Indian or Alaskan Native, Native Hawaiian or other, Pacific Islander,* and *Other (Describe))*. Participants indicated who they lived with (*My parent(s)/guardian(s), Friend(s) or roommate(s), Spouse or significant other, Alone,* or *Other*) and whether they considered themselves financially independent (*Yes, No,* and *Decline to answer*). Financially dependent participants estimated their combined household's yearly income, whereas financially independent participants estimated their own annual income (or their and their partner's income if shared household expenses*; Less than $15,000 per year*, *$15,001-25,000 per year, $25,001-35,000 per year, $35,001-50,000 per year, $50,001-75,000 per year, $75,001-100,000 per year, $100,001-150,000 per year, Greater than $150,000 per year,* and *Prefer not to answer*). For this study, age, race/ethnicity, and sex were entered as control variables in all analyses.

Factors Affecting Heart Rate Variability

To assess factors that may affect an individual's heart rate, participants completed the following questions at the beginning of the laboratory session (prior to setting up the physiological equipment): "Did you drink alcohol within the last 24 hours? If so, how long ago (in hours)? How many standard drinks?", "How long ago did you last have something to eat?", "Did you drink or consume caffeine today (coffee, tea, energy drink, caffeine pill)? If so, how long ago (in hours)?", "How many hours did you sleep last night?" and "How many hours do you typically sleep each night?". Numeric responses were recorded.

Perceived Acute Stress

The Acute Stress Appraisals measure consists of a pre-and post-task survey (see Appendix D) that measures perceived stress in response to a task. The pre-task version was administered before instructions for the assigned experimental condition were given to the participant, but after a baseline GSR and heart rate reading were obtained. The pre-task version is a 12-item Likert scale that ranges from *Strongly Disagree* (1) to *Strongly Agree* (7) and measures the perceived stressor of a task after it is announced, but before it is performed (e.g., "I am very uncertain how I will perform during the upcoming task"). In-sample reliability was low (α = .58), and mean scores ranged from 1.0 to 7.0. The post-task version was administered once the experimental stress condition concluded but before the GSS task began. The post-task version is a 10-item version on the same scale that assesses the perceived stressor after the task is performed (e.g., "I am very uncertain about how I performed"; see Mendes et al., 2007). In-sample reliability was better at α = .82, and mean scores ranged from 1.0 to 7.0. A mean difference score was calculated to use in analyses ($\Delta_{\text{acute stress}} = M_{\text{post}} - M_{\text{pre}}$) and as a manipulation check. A negative change score indicated greater perceived acute stress before knowing the task, whereas a positive score indicated greater perceived acute stress during the task.

Chronic Stress

Participants completed the Chronic Stress Questionnaire (National Institute of Mental Health Data Archive, 2020; see Appendix E), a 27-item measure that asks individuals about their experiences with long-term sources of stress on a scale of *Not at all* (1) to *Completely true* (5). Higher scores indicate greater experiences with sources of chronic stress. Chronic stressors can range from employment demands, social demands, and life stressors (e.g., "I have had an extremely exhausting schedule for a long time now," "Others are constantly treating me unfairly," "My life situation is deeply frustrating"). A mean summary score for all items was obtained for analyses (*range*: 1.0 - 5.0). The measure had excellent in-sample reliability (α = .93).

Manipulation Checks

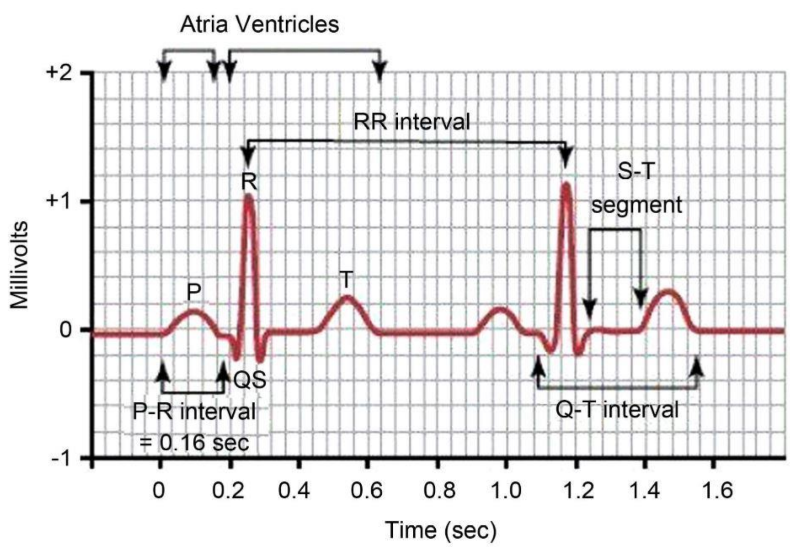
At the end of the laboratory session, participants responded on the tablet to a series of questions that examined their perceptions of the study and the tasks that they had completed as part of a manipulation check. Control group participants answered three questions regarding how much they believed they made mistakes during the recall portion of the Gudjonsson Suggestibility Scale (on a scale from *Not at all* (1) to *Very much* (4)), an open-ended question on what they thought the purpose of the study was, and an open-ended question about anything that stood out or was weird about the study. Stress group participants answered the same three questions, as well as six additional questions pertaining to Zoom, such as how much did they believe people were evaluating their speech, their behavior, and their performance, how much they believed the Zoom interviewers were experts, and how much they believed the Zoom call to be real. These questions were evaluated on a four-point Likert scale from *Not at all* (1) to *Very much* (4). They also answered an additional open-ended question about whether they had any suspicions about the nature of the Zoom call or the evaluation.

Physiological Data Processing

Physiological data was acquired using a BioSemi ActiveTwo system. This system employs an amplifier that delivers a small, constant current of 1 μA while measuring the voltage change between an active site and a relatively inactive (or reference) site (BioSemi, n.d.). The heart rate and Galvanic Skin Response signals were sampled at 512 Hz, and each signal was processed independently using a combination of software to derive their corresponding metrics. Physiological response metrics were obtained for a baseline period of 5 minutes and the experimental condition of 10 minutes, with the use of timed E-prime markers.

Heart Rate

Heart rate metrics were obtained by electrocardiography (ECG), which records the electrical activity of the heart by using electrodes on the skin. This produces a voltage graph for each electrical impulse during a heartbeat (U.S. National Library of Medicine, 2019). Time-domain indices[2] of heart rate variability (HRV) can be calculated by detecting R-peaks in the signal, which quantify the time between two consecutive normal heartbeats (IBIs). This allows for various time-interval HRV metrics to be derived from R-R intervals. Figure 1 provides a representation of a normal heartbeat and its wave components.



Note. The Electrocardiogram Model from Breijo-Marquez (2018) depicts a typical heartbeat pattern. Due to the data acquisition system configuration, R-spikes in our data pointed downward.

Figure 1: Components of Heart Rate

[2] As opposed to frequency-domain indices which estimate the heart rate oscillation patterns into distinct frequency components (i.e., ultra-low-, very-low-, low-, and high-frequency; Shaffer & Ginsberg, 2017).

The heart rate data was preprocessed using the EMSE Data Editor software (version 5.6.1). After isolating the heart rate from the GSR signal, a digital Infinite Impulse Response (IIR)[3] bandpass filter was applied to "smooth" out noise. A bandpass filter allows frequencies between a lower and upper cutoff threshold to pass through Rexy et al., 2019), and it can also eliminate baseline drift that may occur due to participant or sensor movement (Li et al., 2017). The lower-frequency cutoff was set to 0.1 Hz and the upper frequency to 50 Hz, where noise frequency from external electrical activity may lie (Mbachu et al., 2011). Then, an automatic R-spike detection algorithm was applied to detect and mark any downward R-peaks in the signal with the following specified parameters: a peak Full Width at Half Maximum[4] (FWHM) of 0.025mV, exceeded a threshold of at least -0.3mV, and had a refractory period of 0.5ms. The auto-generated R-spike events were visually examined to ensure that most of the R-peaks were identified.

After processing, IBIs were calculated for each stage (e.g., baseline and experimental condition) using R (version 4.2.1), R Studio (version 2013.12.1+402), and the tidyverse package (version 1.3.2). An IBI plot was obtained for each participant, for both the baseline and experimental conditions. The plots were visually inspected for any outliers within each stage. Outliers typically indicated missing or improperly selected R-spikes that were not adequately detected by the algorithm, In the case of outliers (e.g., IBIs below and above the general IBI distribution at each stage), a list of IBI values and corresponding times was obtained. The missing R-spikes were manually marked on EMSE, and the corrected heart rate data was

[3] An IIR filter is a non-linear time-varying filter that uses both the previous and current output samples of a signal to adapt to, and achieve, a desired frequency response selected by the user, effectively smoothing the signal from outside-frequency noise or fluctuations.
[4] This parameter estimates the width (or the spread) of the target peak's wave at the half-amplitude point of .025mV to count as an R-peak.

reprocessed on R to obtain new IBI values for each stage. This process was repeated for each participant until no more outliers were visually detected in the plots. Once finalized, various HRV metrics were calculated and extracted from each participant's IBI files using CMetX Cardiac Metric Software (Allen et al., 2007). Finally, the IBI plots were re-evaluated for significant outliers indicating large variability between missed heartbeats, possibly due to excessive participant movement or artifact noise. A total of 18 participants were excluded due to excessive movement and high variability of IBIs.

Galvanic Skin Response

Galvanic Skin Response data was pre-processed using BrainVision Analyzer 2 (version 2; an electroencephalogram processing software, EEG) to separate heart rate and GSR signals and convert them to an appropriate file format for Matlab and Ledalab import (a Matlab-based software to process and analyze GSR data). Ledalab (version 3.4.9; Benedek & Kaernbach, 2010a) decomposes a skin conductance signal into a tonic and phasic component. The tonic component represents the baseline level of skin conductance in the absence of an environmental event, while the phasic component represents skin conductance response changes due to environmental stimuli. For this project, a Continuous Decomposition Analysis (CDA) approach was preferred over a standard Through-to-Peak (TTP) approach. Unlike TTP methods[5], CDA extracts the phasic (moment-by-moment arousal) underlying EDA information while considering the slowly habituating tonic signal (Benedek & Kaernbach, 2010a; Braithwaite et al., n.d.).

The EDA signal in Ledalab was downsampled from 512 Hz to 16 Hz before CDA processing was performed. This was done following recommended guidelines to conserve

[5] A criticism of through-to-peak methods in EDA is that it fails to account for the continuously habituating tonic Skin Conductance Level (SCL) within an individual, and it may not correctly account for the recovery and decay periods of Skin Conductance Responses (SCR; Braithwaite et al., n.d.).

memory and speed up processing times. Sampling rates between 10 – 20 Hz are appropriate and do not run the risk of losing important aspects of the signal (Benedek & Kaernbach, 2010a). A Gaussian smoothing filter of 200ms (or .2 seconds) was applied to the signal to smooth artifact data in line with CDA processing recommendations (Benedek & Kaernbach, 2010b). A peak threshold of .05μS was set as a significant SCR. A minimum significant peak threshold of .05 or .04μS is typically defined to avoid incorrect measurements caused by movement or noise level artifacts (Boucsein et al., 2012).

Raw and standardized GSR metrics were obtained from Ledalab for each participant's baseline and stress condition periods. The data was evaluated for the following exclusionary criteria (see Braithwaite et al., n.d.): 1) subjects with undetectable electrodermal responses ($<$ .1μS) and 2) standardized measures of skin conductance responses within a specified window (i.e., number of significant SCR, response latency of the first significant SCR, the sum of significant SCR amplitudes) that are three standard deviations from the mean are considered outliers. Three subjects met the latter exclusionary criteria. In total, 21 participants were excluded from physiological data analyses (hypotheses 1b, 1c, 2b, and 2c).

Plan of Analysis

The proposed study aims to examine (1) the effect of acute stress on suggestibility and (2) whether the effect of acute stress on suggestibility varies depending on the level of chronic stress experienced. All statistical analyses will be conducted on IBM Statistical Package for Social Sciences software (IBM SPSS; Version 27). First, we will perform independent-sample t-tests to compare the control and acute stress groups and determine if the stress manipulation was effective, as indicated by significant group differences in their self-reported acute stress, heart rate, and Galvanic Skin Response. Then, multiple linear regression and hierarchical regression models will be utilized to test these hypotheses with each method of evaluating acute stress (i.e., experimental condition, physiological measures of stress, and changes in self-reported stress on pre/post stress task surveys); the analytic approach is discussed within each hypothesis in the "Results" section.

Before conducting statistical analyses, the assumptions for linear regressions will be examined and tested in the following ways: 1) linear relationship between the dependent (yield suggestibility) and independent variables, 2) the residuals are normally distributed, 3) homoscedasticity of variances should be equal across groups, and 4) no multicollinearity between the independent variables. Therefore, a scatterplot of the independent variables and suggestibility will be visually inspected for linearity. The residuals of the dependent variable will be visually examined for non-normality or kurtosis with a histogram. Outliers in the data will be further examined and removed if appropriate. Then, the homogeneity of variances will be tested using Levene's test on SPSS. The homogeneity of variance assumption will be violated if Levene's test yields a $p < 0.05$. If this assumption is violated, an adjusted F statistic, such as Brown-Forsythe, will be conducted so that a significantly adjusted F will reject the null hypothesis. Finally, predictor variables will be tested for multicollinearity issues; variables with high multicollinearity will be omitted or mean-centered.

All statistical models will include age, gender, and race as primary covariates to control for their effects on suggestibility. Models examining physiological predictors (hypotheses 1b and 2b) will also include variables affecting heart rate variability as secondary controls. With the exception of the models testing for the effect of experimental conditions (hypotheses 1a and 2a), change (Δ) scores of pre- and post-assessment will be created to evaluate each hypothesis. A change score of acute stress will be calculated $\Delta_{\text{Acute Stress}} = \text{Pre}_{\text{Acute Stress}} - \text{Post}_{\text{Acute Stress}}$; a positive score indicates higher acute stress at the post-task compared to the pre-task, whereas a negative score indicates higher acute stress at the pre-task compared to the post-task. A heart rate change score will be calculated, $\Delta_{\text{HR}} = \text{HR}_{\text{Manipulation}} - \text{HR}_{\text{Baseline}}$; a positive change indicates an increase in heart rate during the experimental condition. Lastly, a change score of GSR will be calculated using the average phasic activity[6] scores within each response window, $\Delta_{\text{GSR}} = \text{GSR}_{\text{Manipulation}} - \text{GSR}_{\text{Baseline}}$; a positive change indicated an increase in phasic activity during the experimental condition. Additionally, non-dichotomous predictor variables (i.e., chronic stress scores) will be mean-centered for ease of interpretation.

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[6] The phasic activity score is different from the number of significant SCR, as this value considers the average amplitude of significant phasic responses within a response window (i.e., baseline or experimental manipulation), as opposed to the total number of significant SCR within a response window when response windows are not equivalent (Benedek & Kaernbach, 2010a)).

Results

Data Descriptives

Overall, participants in both the control and stress conditions indicated similarly moderate levels of perceived acute stress to an unknown task ($M_{control}$ = 3.29, $SD_{control}$ = .62; M_{Stress} = 3.25, SD_{Stress} = .57). At the end of their experimental manipulation, however, participants in the control condition indicated the task was less stressful after completing it ($M_{control}$ = 3.01, $SD_{control}$ = .72) when compared to participants in the stress condition, who rated their experimental manipulation as more stressful after completing it (M_{Stress} = 4.48, SD_{Stress} = .73). Furthermore, during the GSS task, participants across both conditions only correctly recalled about one-third of the story details, out of 40 possible points (*M* = 15.45, *SD* = 5.08). In terms of "yielding" to suggestive questions during the first round of questions, participants across both conditions had a wide range of scores, ranging from affirmatively answering one leading question, to affirmatively answering almost all fifteen questions. Specifically, participants in both conditions "yielded" 50% of the suggestive questions during the first round ($M_{control}$ = 7, $SD_{control}$ = 3.03; M_{Stress} = 6.84, SD_{Stress} = 2.85). After experiencing negative feedback regarding their performance during the first round, participants "shifted" about one-third of their initial answers to another response (*M* = 6.72, *SD* = 3.32). Interestingly, when examining both groups independently, participants in the control condition had a larger range of responses shifted compared to the stress condition—some shifted no responses, and others shifted almost all of them (compared to a maximum of 12 shifted responses in the stress condition). Lastly, participants across both conditions reported experiencing low-to-moderate levels of chronic stress (*M* = 2.39, *SD* = 0.73); results of an independent-samples t-test indicated that the two groups did not significantly differ in their chronic stress scores, $t(108) = -.573$, $p = .568$. Table 2 presents the descriptive statistics of the main variables included in the study for each experimental group, as well as overall sample descriptives.

Table 2. Descriptive Statistics of Main Variables.

	Overall			Control			Stress		
	Range		*M*	Range		*M*	Range		*M*
	LL	UP	(*SD*)	LL	UP	(*SD*)	LL	UP	(*SD*)
Acute Stress									
Pre	1.75	4.5	3.27 (.59)	1.75	4.5	3.29 (.62)	2	4.33	3.25 (.57)
Post	1.7	6.4	3.74 (1.03)	1.7	4.7	3.01 (.72)	2.9	6.4	4.48 (.73)
Δ	-2.8	3.57	0.47 (1.07)	-2.8	2.03	-0.29 (.79)	-0.02	3.57	1.23 (.72)
GSS									
Free recall	2	27	15.45 (5.08)	2	26	14.41 (5.18)	4	27	16.48 (4.79)
Yield	1	13	6.92 (2.93)	1	12	7 (3.03)	1	13	6.84 (2.85)
Shift	0	18	6.72 (3.32)	0	18	6.98 (3.62)	0	12	6.45 (3.01)
Chronic Stress	1.07	4.48	2.39 (.73)	1.15	4.4	2.41 (.71)	1.07	4.48	2.38 (.75)

Note. N = 128, no missing data was present in the main variables.

Regarding physiological data, an examination of heart rate metrics revealed that during the baseline period, an average of 366.37 IBIs (*SD* = 83.61) were detected, while during the experimental manipulation period, an average of 952.04 IBIs (*SD* = 219.45) were detected. The increased IBI during the stress task suggests that participants experienced greater arousal during the stress task compared to baseline, indicating that the stress successfully induced a stress response in participants. The average duration between IBIs was 781.99 ms (*SD* = 115.90 ms) during the baseline and 706.15 ms (*SD* = 118.84 ms) during the experimental condition. This indicates a shorter distance between R-R spikes during the experimental manipulation than during the baseline period, indicating a faster frequency of heartbeats during the stress condition than during the baseline. The average heart rate during the baseline was 78.89 beats per minute (bpm; *SD* = 11.35 bpm) and 89.54 bpm (*SD* = 14.10 bpm) during the experimental manipulation period. Finally, the mean change in heart rate between the experimental manipulation and the baseline period was 10.65 bpm (*SD* = 8.40 bpm), which further confirms that the experimental manipulation period resulted in a higher heart rate than the baseline period (Table 3 contains heart rate group descriptives). Thus, all heart rate indices demonstrate evidence suggesting that the stress manipulation resulted in greater arousal of participants.

Additionally, examination of GSR metrics indicated that the average number of significant SCRs during the baseline and experimental manipulation period was 119.44 (*SD* = 77.08) and 152.48 (*SD* = 85.04), respectively. After starting the baseline and experimental manipulation task, the first significant SCR occurred on average 4.8 seconds (*SD* = 4.40 seconds) and 2.90 seconds (*SD* = 2.21), respectively. The average amplitude of significant SCR was 8085.60 mµS (*SD* = 8371.61) during the baseline and 9223.37mµS (*SD* = 9223.37) during the experimental condition. Finally, the change in significant SCRs between the experimental manipulation and the baseline was 4.32 (*SD* = 3.93), indicating that, overall, the experimental manipulation period elicited higher phasic responses than the baseline period (see Table 3 for group descriptives).

Table 3. Descriptive Statistics of Physiological Variables.

	Overall			Control			Stress		
	Range		*M*	Range		*M*	Range		*M*
	LL	UP	(*SD*)	LL	UP	(*SD*)	LL	UP	(*SD*)
HR									
IBIs, BL (#)	236	1032	366.37 (83.61)	236	484	355.67 (54.24)	279	1032	379.29 (108.33)

IBIs, man. (#)	455	1363	952.04 (219.45)	455	1070	791.22 (119.17)	896	1363	1146.35 (141.04)
M IBI, BL (ms)	538.99	1165.86	781.99 (115.90)	570.51	1165.86	793.70 (125.24)	538.99	988.26	767.84 (103.04)
M IBI, man. (ms)	481.93	1274.07	706.15 (118.84)	538.16	1274.07	746.30 (128.16)	481.93	825.49	657.62 (85.06)
M HR, BL (bpm)	52.68	111.58	78.89 (11.35)	52.68	105.22	77.88 (11.76)	60.9	111.58	80.11 (10.83)
M HR, man. (bpm)	53.46	133.05	89.55 (14.10)	53.46	112.43	83.52 (12.13)	74.39	133.05	96.83 (12.89)
*SD*NN, BL (ms)	12.63	320.93	63.24 (36.08)	12.63	320.93	64.89 (42.21)	26.72	149.37	61.26 (27.21)
*SD*NN, man. (ms)	41.34	965.49	103.41 (118.73)	46.27	965.49	97.20 (130.58)	41.34	652.98	110.91 (103.48)
Δ HR	-1.81	44.16	10.65 (8.40)	-1.81	13.33	5.63 (3.32)	0	44.16	16.72 (8.69)
GSR									
SCR, BL (#)	32	379	119.44 (77.08)	37	379	115.72 (72.72)	32	337	124.13 (82.82)
SCR, man. (#)	61	658	152.48 (85.04)	61	532	153.74 (66.26)	65	658	150.89 (84.41)
Lat., BL (s)	0.09	16.76	4.81 (4.39)	0.18	16.76	5.20 (4.51)	0.10	15.90	4.32 (4.23)
Lat., man. (s)	0.002	11.46	2.90 (2.21)	0.19	8.33	3.03 (2.20)	0.003	11.46	2.73 (2.23)
Amp., BL (mµS)	62.85	43281.46	8085.60(8371.61)	264.66	33633.68	7346.27	62.85	43281.46	9017.81

						(7171.08)			(9223.37)
Amp, man (mµS)	1012.95	92233.72	9223.37 (9223.37)	1253.70	92233.72	9223.37 (9223.37)	1012.95	87385.51	9223.37 (9223.37)
Phasic BL (mµS)	0.02	26.24	5.45 (5.15)	0.08	21.51	5.02 (4.39)	0.02	26.24	5.98 (5.98)
Phasic man. (mµS)	0.21	32.53	9.77 (6.21)	0.23	32.53	9.50 (5.92)	0.21	27.04	10.12 (6.62)
Δ SCR	-3.07	17.07	4.32 (3.93)	-2.58	17.07	4.47 (3.85)	-3.07	16.17	4.14 (4.07)
ΔSCR, Z	-1.58	3.21	1.54 (.91)	-1.58	2.99	1.54 (.87)	-0.44	3.21	1.53 (.97)

Note. Physiological data sample sizes: Overall = 106, Control= 58, Stress = 48. Response windows: 5-minute baseline and 10-minute manipulation. HR metrics: IBIs = number of IBIs detected within response window, *M* IBIs = mean IBIs, SDNN= standard deviation of IBIs. GSR metrics: values all represent significant SCR within the response window. SCR = number of significant SCR, Lat. = response latency of first significant SCR, Amp. = SCR amplitudes of significant SCR, Phasic = phasic activity score.

The study included secondary control variables that covered possible sources of abnormal heart rate variability. On average, the participants reported having 6.8 hours of sleep the night before the laboratory session (*SD* = 1.49 hours), which was slightly more sleep than their usual sleep duration of 6.77 hours (*SD* = 0.93 hours). Out of 128 participants, 51 reported consuming caffeine within the past 24 hours, with their latest consumption being around 9 hours before their laboratory session (*SD* = 6.7 hours). The most recent meal or snack consumed by the participants was approximately 5.05 hours prior to the laboratory session (*SD* = 5.18 hours). Only two participants reported consuming alcohol within the past 24 hours, with the latest consumption being three standard drinks 17.5 hours before the laboratory session (*SD* = 4.95 hours). Alcohol consumption was, therefore, not considered a covariate in the subsequent analyses (hypotheses 2b and 2c). Table 4 provides an overview of the descriptive statistics by group.

Table 4. Descriptive Statistics for Sources of Heart Rate Variability

		Overall				Control				Stress		
	N	Range		*M*	*n*	Range		*M*	*n*	Range		*M*
		LL	UP	(*SD*)		LL	UP	(*SD*)		LL	UP	(*SD*)
Sleep duration (hours)												
Previous night	128	2.5	11.5	6.81 (1.49)	64	2.5	11.5	6.60 (1.56)	64	3	10	7.02 (1.40)
Typical night	128	5	9	6.77 (.93)	64	5	8.5	6.76 (.85)	64	5	9	6.79 (1.03)
Caffeine consumption												
Past 24 hours	50	.08	24	9.12 (6.70)	28	.08	24	8.39 (6.11)	22	1.2	23.5	10.04 (7.42)
Time since last meal (hours)	127	.08	22	5.06 (5.18)	64	.08	22	4.84 (5.20)	63	.08	19	5.28 (5.18)
Alcohol consumption												
Past 24 hours	2	14	21	17.5 (4.95)	1	21	21	21	1	14	14	14
# standard drinks	2	3	3	3	1	3	3	3	1	3	3	3

Correlations were conducted to examine the relationship between all predictor variables (see Table 5). The results indicate a small yet significant inverse relationship between participant age and Skin Conductance Response (SCR) activity. Specifically, older age was associated with lower significant arousal as evidenced through Skin Conductance Responses ($r = -.205$, $p < .05$). Additionally, a weaker but still significant relationship was present during the experimental manipulation ($r = -.177$, $p < .05$). Skin Conductance Responses (SCRs) observed during the baseline and experimental manipulation were found to have a significant positive correlation with participants' typical sleeping hours ($r = .197$, $p < .05$ and $r = .175$, $p < .05$, respectively). Furthermore, the SCRs were slightly more strongly correlated with the duration of sleep participants reported having the previous night ($r = .259$, $p < .001$ and $r = .288$, $p < .001$, respectively). Mean chronic stress scores were inversely related to typical sleep duration ($r = -.182$, $p < .05$), such that higher chronic stress scores were associated with a decrease in typical sleep duration. Furthermore, a positive relationship between chronic stress scores and pre- and post-acute stress scores was present ($r = .299$, $p < .001$ and $r = .179$, $p < .05$, respectively), such that an increase in chronic stress was associated with an increase of acute stress self-reported before, and after the experimental manipulation task.

Table 5. Pearson Correlations Among All Predictor Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1) Age	1														
(2) Condition	-0.081	1													
(3) Usual sleep	-0.085	0.017	1												
(4) Previous night's sleep	0.011	0.143	**.416***	1											
(5) Caffeine	-0.061	-0.08	0.044	0.06	1										
(6) Last meal	**.208***	0.042	-0.022	0.012	0.038	1									
(7) Sex	-0.004	-0.019	0.016	0.021	0.131	-0.013	1								
(8) Hispanic	0.031	0	0.02	0.051	**.176***	-0.027	0.018	1							
(9) Mean, pre-stress	-0.093	-0.042	0.005	-0.015	0.006	-0.12	-0.028	0.032	1						
(10) Mean, post-stress	-0.023	**.715***	0.001	0.064	-0.162	-0.029	-0.104	-0.052	**.214***	1					

(11) Mean, chronic stress	-0.008	-0.017	-.182*	-0.084	-0.047	0.037	-.203*	0.006	.299**	.179*	1				
(12) SCR, Baseline	-.205*	0.067	.197*	.259**	-0.072	-0.114	-0.069	-0.033	0.118	0.041	0.069	1			
(13) SCR, Manip	-.177*	0.066	.175*	.288**	-0.088	-0.089	-0.073	-0.067	0	0.001	0.071	.762**	1		
(14) Mean HR, Baseline	-0.011	0.098	0.13	0.148	-0.036	-0.014	-0.017	0.188	-0.009	0.085	-0.132	.201*	.199*	1	
(15) Mean HR, Manip	0.022	.472**	0.119	0.118	0.044	0.005	0.001	0.158	0.057	.407**	-0.141	0.084	0.05	.803**	1

Note. * = $p < .05$, ** = $p < .001$. Condition: 0 = control, 1 = stress; Usual sleep and previous night's sleep are coded in hours; Caffeine: 0 = no use in the last 24 hours, 1 = yes; Last meal is coded in hours; Sex: 0 = Female, 1 = Male.

Manipulation Checks

In an examination of the included manipulation check self-reported items, twenty-six participants (out of 64 total in the stress condition) reported "*Not at all*" on at least one of the five manipulation check Zoom-related questions, while four participants (out of the 26) indicated "*Not at all*" on all five items. These four participants were excluded from the analyses involving self-report. Additionally, fourteen participants were excluded since they indicated that they did not believe the Zoom call to be real, which was an important aspect of the study. The total sample for hypotheses 1a, 1d, 2a, and 2d was 110 participants ($n_{control} = 64$, $n_{stress} = 46$). Table 6 provides the frequencies of the manipulation check items. Upon examining excluded and retained participants and key study variables, no significant differences were observed in scores, except for post-acute stress mean scores and overall mean difference scores (see Table 7). This difference was expected as all eighteen excluded participants were in the acute stress condition, rated as more stressful than the control condition.

Table 6. Acute Stress Manipulation Frequencies

Item stem	Frequencies (*n* = 64)			
	Not at all	A little	Somewhat	Very Much
… people on Zoom were evaluating your speech?	8	13	19	24
… people on Zoom were evaluating your behavior?	11	11	19	23
… people on Zoom were judging your performance?	8	7	19	30
… people on Zoom were experts?	14	16	20	14
… the Zoom call was real?	18	20	12	14
Sum of "Not at all" responses per individual				
1 item	13			
2 items	4			
3 items	2			
4 items	3			
5 items	4			

Note. Only participants in the stress condition were asked these questions. Unique "Not at all" responses indicate the frequency of participants who responded "Not at all" to the corresponding number of manipulation check questions out of five items.

Table 7. Statistical Comparison of Excluded and Retained Participants

Variable		*t*	*df*	Mean difference	*S.E.*	*95 % CI*	
						LL	UL
Age		-1.161	126	-.577	.497	-1.56	.406
Sleep							
	Usual	-.765	126	-.181	.237	-.650	.288
	Previous night	-.095	126	-.036	.380	-.788	.716
Caffeine use							
	In 24 hours?	-.945	126	-.118	.125	-.366	.129
	# of hours	.156	48	.389	2.49	-4.618	5.396
Food intake							
	# of hours	-.260	125	-.343	1.321	-2.959	2.272
Acute Stress Appraisals (*Mean*)							
	Pre	1.515	126	.228	.151	-.069	.526
	Post	**-4.002*** **	50.747	-.610	.152	-.916	-.304
	Difference	**-5.067*** **	43.923	-.838	.165	-1.172	-.505

Gudjonsson Suggestibility Scale						
Free recall	.700	126	.906	1.294	-1.655	3.467
Yield	-.035	126	-.026	.748	-1.507	1.454
Shift	.605	126	.513	.847	-1.164	2.190
Chronic Stress (*Mean*)	1.766	126	.325	.184	-.039	.689

Note. The assumption of equality of variances was met for all variables, except acute stress post and difference scores, in which case an adjusted t-statistic is reported. *** = $p < .001$.

Furthermore, prior to conducting statistical data analyses, we first evaluated whether participants perceived the stress condition as more stressful than the control condition, as evidenced by self-reported acute stress, changes in heart rate, and changes in GSR. The results of the independent samples t-test showed significant mean differences between the control and stress conditions for self-reported acute stress change scores ($t(108) = -10.02$, $p < .001$) and heart rate change results ($t(55.12) = -8.125$, $p < .001$). Specifically, participants assigned to the control condition reported their experimental manipulation task as less stressful (i.e., negative mean difference) compared to those in the stress condition who reported positive mean difference scores. Similarly, participants in the stress condition experienced a faster heart rate compared to those in the control condition. However, GSR change scores did not follow this pattern of results ($t(102) = .434$, $p < .667$), indeed, control participants exhibited slightly higher arousal after the experimental manipulation (as evidenced by the mean change scores) compared to induced-stress participants. See Table 8 for more details on the T-statistics.

Table 8. Independent Sample's T-test on Mean Difference Scores

	M Δ Score (*SD*)	*t* (df)	*95% CI* LL	*95% CI* UL
Acute Stress				
Control	-.29 (.80)	t (108) = -10.02, $p < .001$	-1.84	-1.23

Stress	1.24 (.79)			
GSR				
Control	4.47 (3.85)	*t* (102) = .434, *p* < .667	-1.20815	1.88476
Stress	4.14 (4.07)			
Heart Rate				
Control	5.63 (3.32)	*t* (55.12) = -8.125, *p* < .001	-13.89657	-8.39768
Stress	16.78 (8.82)			

Note. $N_{self\text{-}report}$ = 110, $N_{physiological}$ = 107. Mean *Δ* Score represents the change score calculated from experimental manipulation – baseline for each variable. Heart rate statistics are reported using adjusted t-test for equal variances not assumed, Levene's test, *F*(102) = 20.63, *p* < .001.

Effect of Acute Stress on Suggestibility

Four hypotheses were tested to address each research question. First, visual inspection of a histogram indicated that "yield" suggestibility scores were approximately normally distributed, further evidenced by the examination of Quantile-Quantile (QQ) plots. Furthermore, results of Levene's test indicated homogeneity of variances (*F*(1, 126) = .085, p = .772).

The first hypothesis (Hypothesis 1a) investigated the effect of the experimental condition on suggestibility. It was hypothesized that participants in the acute stress condition would be more suggestible than participants in the control condition (as evinced by a higher score on the "yield" suggestibility score). A multiple linear regression was conducted to test this hypothesis. In Step 1 of the model, control variables such as age, sex, and race were included. In Step 2, a dichotomized experimental condition assignment was included, with the control condition as the reference category. Although there were no significant differences in models with and without covariates, the results of the models discussed include the covariates for full transparency. Contrary to our hypothesis, there were no significant differences in "yield" suggestibility scores between the groups, *F*(4,109) = .855, *p* = .494). See Table 9 for detailed model results.

Table 9. Regression Analysis Summary for Experimental Condition Predicting "Yield" Scores

Variable	R^2	*F*	*B*	*SE(B)*	*t*	*p*
Step 1	.029	1.060				.369
Constant			9.050	3.067	2.951	.004
Age			-.093	.149	-.626	.533
Sex			-.366	.713	-.513	.609
Race			-1.532	.997	-1.536	.127
Step 2	.032	.855				.494
Constant			9.408	3.157	2.980	.004
Age			-.104	.151	-.690	.492
Sex			-.401	.719	-.558	.578
Race			-1.534	1.001	-1.533	.128
Condition			-.299	.587	-.509	.612

Note. Predictor coding is as follows: for Sex, 0 = female, 1 = male; for Race, 0 =Hispanic/Latino, 1 = Non-Hispanic/Latino; for Condition, 0 = control, 1 = stress.

The second hypothesis (Hypothesis 1b) investigated the changes in heart rate between the baseline and the experimental condition. It was hypothesized that participants who demonstrate a heart rate variability consistent with greater acute stress (i.e., exhibiting increased heart rate from the baseline to the experimental) would demonstrate greater suggestibility (as evinced by a higher score on the "yield" suggestibility score) than participants whose heart rate indicates less acute stress (i.e., those who exhibit a negative change score in heart rate). A multiple linear regression model was used to examine this hypothesis. Step 1 included primary control variables (age, sex, race). Step 2 included secondary control variables (sleep duration for the previous night, hours since food intake, dichotomized caffeine consumption[7] in the last 24 hours) to examine their effect on heart rate. Step 3 included the mean heart rate change score. Contrary to this hypothesis, the results indicated no relationship between change in heart rate and "yield" suggestibility scores ($F(7,102) = 1.373$, $p = .226$; see Table 10).

[7] Only 39% of the sample reported using caffeine in the last 24 hours; therefore, to retain as much of the sample as possible for power, a dichotomized caffeine use variable was entered instead; "No" caffeine use was the reference category.

Table 10. Regression Summary for Heart Rate Predicting "Yield" Scores

Variable	R^2	*F*	*B*	*SE(B)*	*β*	*t*	*p*
Step 1	0.58	2.022					0.116
Constant			11.376	2.837		4.01	<.001
Age			-0.193	0.135	-0.139	-1.426	0.157
Sex			-0.617	0.631	-0.095	-0.977	0.331
Race			-1.555	0.888	-0.171	-1.752	0.083
Step 2	0.09	1.585					0.160
Constant			11.187	2.948		3.795	<.001
Age			-0.177	0.139	-0.127	-1.273	0.206
Sex			-0.606	0.638	-0.094	-0.95	0.344
Race			-1.596	0.906	-0.175	-1.762	0.081
Sleep the previous night (hrs)			0.277	0.181	0.15	1.535	0.128
Time since food intake (hrs)			-0.048	0.053	-0.091	-0.909	0.366
Caffeine past 24 hours			-0.323	0.572	-0.057	-0.566	0.573
Step 3	0.092	1.373					0.226
Constant			11.135	2.963		3.757	<.001
Age			-0.181	0.14	-0.13	-1.292	0.199
Sex			-0.609	0.64	-0.094	-0.951	0.344
Race			-1.592	0.91	-0.175	-1.749	0.083
Sleep the previous night (hrs)			0.278	0.181	0.15	1.532	0.129
Time since food intake (hrs)			-0.048	0.053	-0.091	-0.906	0.367
Caffeine past 24 hours			-0.357	0.579	-0.063	-0.616	0.539
Δ HR			0.014	0.033	0.042	0.427	0.67

Note. Predictor coding is as follows: for Sex, 0 = female, 1 = male; for Race, 0 =Hispanic/Latino, 1 = Non-Hispanic/Latino; for Condition, 0 = control, 1 = stress.

The third hypothesis (Hypothesis 1c) investigated the changes in GSR between the baseline and the experimental condition. It was hypothesized that participants who exhibited a Galvanic Skin Response consistent with greater acute stress (i.e., increased activity from the baseline to the experimental condition) would demonstrate greater suggestibility (as evidenced by a higher score on the "yield" suggestibility score) than participants whose change in GSR indicates less acute stress (i.e., those who exhibit a negative change score in GSR). A multiple linear regression model was used to examine this hypothesis. Step 1 included primary control variables (age, sex, race). Step 2 included secondary control variables (sleep duration for the previous night, hours since food intake, dichotomized caffeine consumption[8] in the last 24 hours) to examine their effect on heart rate. Step 3 included mean change in SCR. The results also showed no significant relationship between change in SCR and "yield" suggestibility scores ($F(7,102) = 1.477$, $p = .185$; see Table 11).

Table 11. Regression Summary for SCRs Predicting "Yield" Scores

Variable	R^2	*F*	*B*	*SE(B)*	*β*	*t*	*p*
Step 1	0.058	2.022					0.116
Constant			11.376	2.837		4.01	<.001
Age			-0.193	0.135	-0.139	-1.426	0.157
Sex			-0.617	0.631	-0.095	-0.977	0.331
Race			-1.555	0.888	-0.171	-1.752	0.083
Step 2	0.09	1.585					0.160
Constant			11.187	2.948		3.795	<.001
Age			-0.177	0.139	-0.127	-1.273	0.206
Sex			-0.606	0.638	-0.094	-0.95	0.344
Race			-1.596	0.906	-0.175	-1.762	0.081
Sleep the previous night (hrs)			0.277	0.181	0.15	1.535	0.128
Time since food intake (hrs)			-0.048	0.053	-0.091	-0.909	0.366
Caffeine past 24 hours			-0.323	0.572	-0.057	-0.566	0.573
Step 3	0.098	1.477					0.185
Constant			11.488	2.969		3.87	<.001
Age			-0.176	0.139	-0.127	-1.268	0.208
Sex			-0.687	0.644	-0.106	-1.066	0.289
Race			-1.592	0.907	-0.175	-1.756	0.082
Sleep the previous night (hrs)			0.295	0.182	0.16	1.623	0.108
Time since food intake (hrs)			-0.047	0.053	-0.088	-0.885	0.379
Caffeine past 24 hours			-0.339	0.572	-0.06	-0.592	0.555
Δ SCRs			-0.065	0.071	-0.091	-0.917	0.361

Note. Predictor coding is as follows: for Sex, 0 = female, 1 = male; for Race, 0 =Hispanic/Latino, 1 = Non-Hispanic/Latino; for Condition, 0 = control, 1 = stress.

[8] Only 39% of the sample reported using caffeine in the last 24 hours; therefore, to retain as much of the sample as possible for power, a dichotomized caffeine use variable was entered instead; "No" caffeine use was the reference category.

The fourth hypothesis (Hypothesis 1d) investigated the effect of self-reported stress on the "yield" suggestibility score. It was hypothesized that participants who self-reported a greater change in stress after the stress manipulation task (compared to the baseline measure of stress) would demonstrate greater suggestibility (as evidenced by a higher score on the "yield" suggestibility score) than participants who self-report no differences in pre-/post-task stress levels. A multiple linear regression was conducted to test this hypothesis. Control variables such as age, sex, and race were included in Step 1, and acute stress difference scores were mean-centered and entered in Step 2. However, contrary to our hypothesis, the results indicated no significant relationship between self-reported acute stress and "yield" suggestibility scores ($F(4,109) = .793$, $p = .532$). Table 12 provides detailed model results.

Table 12. Regression Analysis Summary for Acute Stress Predicting "Yield" Scores

Variable	R^2	*F*	*B*	*SE(B)*	*t*	*p*
Step 1	.029	1.060				.369
Constant			9.050	3.067	2.951	.004
Age			-.093	.149	-.626	.533
Sex			-.366	.713	-.513	.609
Race			-1.532	.997	-1.536	.127
Step 2	.029	.793				.532
Constant			9.043	3.082	2.934	.004
Age			-.093	.150	-.621	.536
Sex			-.383	.726	-.527	.599
Race			-1.547	1.007	-1.536	.128
Acute Stress			-.038	.266	-.144	.886

Note. Predictor coding is as follows: for sex, 0 = female, 1 = male; for race, 0 = Hispanic/Latino, 1 = non-Hispanic/Latino; for condition, 0 = control, 1 = stress. An acute stress difference score was used for analyses. Positive difference scores indicated higher reported stress in the experimental condition compared to baseline.

Effect of Acute Stress on Suggestibility Dependent on Chronic Stress

An additional four hypotheses were tested again to address the second research question. The first hypothesis (Hypothesis 2a) investigated the effect of the experimental condition and chronic stress scores on suggestibility. It was hypothesized that chronic stress scores would moderate the relationship between the experimental condition and “yield” suggestibility scores, such that the positive association between acute stress and suggestibility would be exacerbated for those participants who self-reported higher levels of chronic stress. A hierarchical linear model was employed to test whether chronic stress scores moderated the relationship. Step 1 involved primary control variables. Step 2 involved the assigned experimental condition and mean-centered chronic scores. Step 3 involved the interaction of experimental condition and mean-centered chronic stress scores. However, the results indicated no significant relationship between the experimental condition, chronic stress scores, and “yield” suggestibility scores (F(6,109) = .577, p = .748; see Table 13 for detailed model results).

Table 13. Hierarchical Model: Chronic Stress as Moderator for Experimental Condition and “Yield” Scores

Variable	R^2	*F*	*B*	*SE(B)*	*t*	*p*
Step 1	.029	1.060				.369
Constant			9.050	3.067	2.951	.004
Age			-.093	.149	-.626	.533
Sex			-.366	.713	-.513	.609
Race			-1.532	.997	-1.536	.127
Step 2	.032	.687				.634
Constant			9.443	3.175	2.974	.004
Age			-.106	.152	-.699	.486
Sex			-.372	.734	-.507	.613
Race			-1.543	1.006	-1.533	.128
Condition			-.305	.590	-.516	.607
Chronic Stress			.091	.414	.219	.827
Step 3	.033	.577				.748
Constant			9.502	3.199	2.970	.004
Age			-.109	.153	-.714	.477
Sex			-.351	.743	-.473	.637
Race			-1.531	1.012	-1.513	.133
Condition			-.293	.595	-.493	.623
Chronic Stress			.376	1.266	.297	.767
Interaction			-.199	.835	-239	.812

Note. Predictor coding is as follows: for sex, 0 = female, 1 = male; for race, 0 = Hispanic/Latino, 1 = non-Hispanic/Latino; for condition, 0 = control, 1 = stress.

The second hypothesis (Hypothesis 2b) investigated the changes in heart rate and chronic stress scores on suggestibility. It was hypothesized that higher chronic stress scores would moderate the relationship between heart rate consistent with greater acute stress (i.e., a positive change score) and “yield” suggestibility scores, such that the positive association between change in heart rate and suggestibility would be exacerbated for those participants whose heart rate indicated more acute stress. A hierarchical linear model assessed whether chronic stress scores moderated the relationship between heart rate change scores and “yield” suggestibility scores. Step 1 included primary control variables. Step 2 included secondary control variables. Step 3 included the mean heart rate change. Finally, step 4 included the interaction between changes in heart rate and mean-centered chronic stress. The results showed no significant relationship between the change in heart rate, chronic stress, and “yield” scores ($F(9,102) = 1.296$, $p = .250$; see Table 14).

Table 14. Hierarchical Model for Heart Rate Change, Chronic Stress, and Suggestibility

Variable	R^2	*F*	*B*	*SE(B)*	*β*	*t*	*p*
Step 1	0.058	2.022					0.116
Constant			11.376	2.837		4.01	<.001
Age			-0.193	0.135	-0.139	-1.426	0.157
Sex			-0.617	0.631	-0.095	-0.977	0.331
Race			-1.555	0.888	-0.171	-1.752	0.083
Step 2	.09	1.585					0.160
Constant			11.187	2.948		3.795	<.001
Age			-0.177	0.139	-0.127	-1.273	0.206
Sex			-0.606	0.638	-0.094	-0.95	0.344
Race			-1.596	0.906	-0.175	-1.762	0.081
Sleep, previous night (hrs)			0.277	0.181	0.15	1.535	0.128
Time since food intake (hrs)			-0.048	0.053	-0.091	-0.909	0.366
Caffeine past 24 hours			-0.323	0.572	-0.057	-0.566	0.573
Step 3	0.101	1.318					0.244
Constant			10.99	2.968		3.703	<.001
Age			-0.176	0.14	-0.127	-1.262	0.21
Sex			-0.477	0.655	-0.074	-0.728	0.469

Race			-1.606	0.911	-0.176	-1.764	0.081
Sleep, previous night (hrs)			0.288	0.182	0.156	1.586	0.116
Time since food intake (hrs)			-0.053	0.053	-0.1	-0.991	0.324
Caffeine past 24 hours			-0.336	0.58	-0.06	-0.579	0.564
Δ HR			0.015	0.033	0.045	0.458	0.648
Chronic Stress			0.385	0.398	0.098	0.968	0.336
Step 4	0.111	1.296					0.250
Constant			10.501	3.003		3.497	<.001
Age			-0.156	0.141	-0.113	-1.106	0.271
Sex			-0.443	0.656	-0.068	-0.676	0.501
Race			-1.579	0.91	-0.173	-1.734	0.086
Sleep, previous night (hrs)			0.273	0.182	0.148	1.5	0.137
Time since food intake (hrs)			-0.052	0.053	-0.099	-0.981	0.329
Caffeine past 24 hours			-0.373	0.581	-0.066	-0.642	0.522
Δ HR			0.023	0.034	0.069	0.68	0.498
Chronic Stress			-0.144	0.641	-0.037	-0.225	0.823
Interaction			0.051	0.049	0.173	1.052	0.296

The third hypothesis (Hypothesis 2c) investigated the changes in Skin Conductance Responses and chronic stress scores on suggestibility. It was hypothesized that chronic stress scores would moderate the relationship between skin conductance consistent with greater acute stress (i.e., a positive change score for GSR) and “yield” suggestibility scores, such that the positive association between change in GSR and suggestibility would be exacerbated for those participants whose GSR indicates more acute stress (i.e., those who exhibit a positive change score in GSR). A hierarchical linear model assessed whether chronic stress scores moderated the relationship between GSR change scores and “yield” suggestibility scores. Step 1 included primary control variables. Step 2 included secondary control variables. Step 3 included the mean GSR change. Finally, step 4 included the interaction between changes in skin conductance (SCRs) and mean-centered chronic stress. The results also did not indicate a significant relationship between change in GSR, chronic stress, and "yield" suggestibility scores (F(9,102) = 1.241, p = .280; see Table 15).

Table 15. Hierarchical Model for GSR Change, Chronic Stress, and Suggestibility

Variable	R^2	F	B	$SE(B)$	β	t	p
Step 1	0.058	2.022					0.116
Constant			11.376	2.837		4.01	<.001
Age			-0.193	0.135	-0.139	-1.426	0.157
Sex			-0.617	0.631	-0.095	-0.977	0.331
Race			-1.555	0.888	-0.171	-1.752	0.083
Step 2	0.09	1.585					0.160
Constant			11.187	2.948		3.795	<.001
Age			-0.177	0.139	-0.127	-1.273	0.206
Sex			-0.606	0.638	-0.094	-0.95	0.344
Race			-1.596	0.906	-0.175	-1.762	0.081
Sleep the previous night (hrs)			0.277	0.181	0.15	1.535	0.128
Time since food intake (hrs)			-0.048	0.053	-0.091	-0.909	0.366
Caffeine past 24 hours			-0.323	0.572	-0.057	-0.566	0.573
Step 3	0.106	1.396					0.208
Constant			11.343	2.975		3.812	<.001
Age			-0.172	0.139	-0.124	-1.237	0.219
Sex			-0.558	0.66	-0.086	-0.846	0.4
Race			-1.606	0.908	-0.177	-1.77	0.08
Sleep the previous night (hrs)			0.304	0.182	0.165	1.669	0.098
Time since food intake (hrs)			-0.051	0.053	-0.097	-0.966	0.337
Caffeine past 24 hours			-0.316	0.573	-0.056	-0.551	0.583
Δ SCRs			-0.063	0.071	-0.087	-0.88	0.381
Chronic Stress			0.365	0.397	0.093	0.921	0.359
Step 4	0.107	1.241					0.280
Constant			11.548	3.055		3.78	<.001
Age			-0.181	0.142	-0.131	-1.27	0.207
Sex			-0.558	0.663	-0.086	-0.841	0.402
Race			-1.634	0.916	-0.18	-1.784	0.078
Sleep the previous night (hrs)			0.315	0.186	0.171	1.693	0.094
Time since food intake (hrs)			-0.056	0.055	-0.106	-1.013	0.314
Caffeine past 24 hours			-0.349	0.585	-0.062	-0.597	0.552
Δ SCRs			-0.063	0.071	-0.088	-0.886	0.378
Chronic Stress			0.237	0.56	0.06	0.423	0.673
Interaction			0.039	0.118	0.048	0.327	0.744

Finally, the fourth hypothesis (Hypothesis 2d) investigated the effect of acute and chronic stressors on suggestibility. It was hypothesized that chronic stress scores would moderate the relationship between the participants who self-report a greater change in stress after the stress manipulation task (compared to the baseline measure of stress) and greater suggestibility (as evidenced by a higher score on the "yield" suggestibility score), such that the positive association between self-reported change in stress and suggestibility would be exacerbated for those participants who self-reported higher levels of chronic stress. A hierarchical linear model assessed whether chronic stress scores moderated the relationship between self-reported acute stress and "yield" suggestibility scores. Step 1 included primary control variables; step 2 included acute stress difference scores and mean-centered chronic stress. Lastly, step 3 included the interaction of acute stress difference scores and mean-centered chronic stress scores. The results indicated no significant relationship change in acute stress, chronic stress, and "yield" suggestibility scores, $F(6,109) = .529$, $p = .785$). See Table 16 for detailed model results.

Table 16. Hierarchical Model Summary for Chronic Stress as Moderator for Acute Stress and "Yield" Scores

Variable	R^2	*F*	*B*	*SE(B)*	*t*	*p*
Step 1	.029	1.060				.369
Constant			9.050	3.067	2.951	.004
Age			-.093	.149	-.626	.533
Sex			-.366	.713	-.513	.609
Race			-1.532	.997	-1.536	.127
Step 2	.030	.636				.672
Constant			9.086	3.099	2.932	.004
Age			-.094	.151	-.628	.532
Sex			-.356	.742	-.481	.632
Race			-1.555	1.013	-1.535	.128
Acute Stress			-.039	.268	-.144	.886
Chronic Stress			.081	.414	.195	.846
Step 3	.030	.529				.785
Constant			9.006	3.160	2.850	.005

Age	-.090	.154	-.588	.558
Sex	-.364	.747	-.487	.627
Race	-1.566	1.020	-1.535	.128
Acute Stress	-.047	.275	-.170	.865
Chronic Stress	.057	.447	.127	.900
Interaction	.059	.398	.148	.883

Note. Predictor coding is as follows: for sex, 0 = female, 1 = male; for race, 0 = Hispanic/Latino, 1 = non-Hispanic/Latino; for condition, 0 = control, 1 = stress. Acute stress reflects a change in acute stress score. Chronic stress reflects a mean-centered variable.

Discussion

Past research indicates suggestibility is more prevalent among children and adolescents due to various developmental and cognitive factors associated with younger age (Ceci et al., 2000; Quas et al., 1997b; Redlich & Goodman, 2003). In a legal context, interrogative suggestibility refers to the tendency to accept leading messages during formal questioning that can affect individuals of all ages (Gudjonsson & Clark, 1986). This can occur in highly stressful situations such as criminal proceedings, plea decisions, and formal questioning. However, research on the relationship between stress and suggestibility, particularly among young adults, is limited. Since interrogative suggestibility is more likely to occur during high-stress situations, and young adults are more likely to face severe legal consequences due to suggestibility, it is essential to investigate this relationship more closely. Therefore, this study examined the effects of acute stress on suggestibility and whether cumulative chronic stressors worsened this influence among young adults.

Is There an Effect of Acute Stress on Suggestibility?

Three methods were used to evaluate the potential effect of acute stress on suggestibility. First, acute stress was experimentally induced in randomly selected participants. Second, real-time physiological proxies of stress were obtained through heart rate and GSR metrics. Third, subjective measures of acute stress were obtained before and after a task. It was hypothesized that experiencing greater levels of acute stress at one time would lead to a greater acceptance of leading questions during a subsequent suggestibility task. Despite successfully inducing acute stress (as evidenced by the direction of the change in heart rate and the direction of acute stress change scores), none of the predictors of acute stress were found to have a significant impact on suggestibility.

Several reasons may explain the results obtained (or lack thereof). First, although the TSST task has been widely used and validated to induce stress (as evidenced by our manipulation checks), the range of stress responses that one can experience from the TSST task is likely to be limited, and it dissipates quickly after the task ends. However, the degree of acute stress required to affect suggestibility is likely to be more severe. Furthermore, group scores on the Gudjonsson Suggestibility "yield" subscale were comparable and not in the direction expected, given that participants in the stress condition did not "yield" to leading questions as much as participants in the control condition. One possible explanation for the similarities in scores comes from Forrest et al. (2002) who found that self-reported acute stress had marginal effects on confession rates on a parallel form of the Gudjonsson Suggestibility Scale. Although the story used in the GSS and the parallel form of GSS are different, all aspects of administration are the same. After the administration of the parallel GSS, the participants completed a third self-report measure of stress. The study found that the parallel GSS induced stress among all participants and significantly affected stress levels among control participants after the GSS; it induced their stress to comparable levels of stress seen among participants in the stress condition. Therefore, it is possible that the stress experienced during the GSS administration reduced the differences between participants in both conditions in our sample.

Second, the academic demands of college may contribute to high baseline levels of acute stress, which could overshadow the effect size estimate of the stress manipulation. This, in turn, could make detecting any additional stress-induced changes in suggestibility more challenging. Unlike other laboratory studies that utilize state- and trait-anxiety measures as indices of pre- and post-acute stress (Gudjonsson, 1988; Gudjonsson & Henry, 2003), this study measured perceived acute stress to a specific task at hand; therefore, extrapolating an index of participant's baseline stress beyond a task would not be appropriate.

It is important to note that acute stress alone may not be the only predictor of suggestibility. Unless the acute stress level is extremely high (Morgan et al., 2020), other factors such as personality traits, cognitive load, social influence, and compliance may affect how a person reacts to acute stress and, ultimately, their suggestibility. Studies have found that more cooperative and agreeable individuals tend to be more susceptible to suggestions (Eisen et al., 2002). Additionally, low self-esteem in uncertain situations, such as receiving negative feedback, has been linked to suggestibility (Eisen et al., 2002; Gudjonsson & Henry, 2003). Compliance, or the tendency to agree with presented information without necessarily accepting it as true, has also been found to strongly predict suggestibility (Gudjonsson & Henry, 2003; Richardson & Kelly, 2004). The present study solely examined the role of stress on suggestibility and did not account for other personality-type factors that may influence both stress and suggestibility. Future research can build upon this study to explore how various personality traits may influence stress and suggestibility. For example, within our sample, participants' "yield" suggestibility scores were positively associated with how many mistakes they believed they made during the first round of the Gudjonsson Suggestibility Scale questions. The relationship could be partly due to cognitive factors associated with memory and comprehension, and it could also be due to individual personality factors, such as internalizing the negative feedback provided. Therefore, it is necessary to explore the relationship between internal and external factors of stress and how they relate to suggestibility.

Does The Effect of Acute Stress and Suggestibility Vary Depending on Levels of Chronic Stress?

In addition to acute stressors, a cumulative effect of stress due to previous or ongoing experiences with chronic stressors may further impact the suggestibility of young adults. Chronic stress stemming from persistent life challenges can negatively impact young adults' cognitive processes and emotional well-being (Kulshreshtha et al., 2023; Yaribeygi et al., 2017). Therefore, it is important to understand how suggestibility may be affected by the interplay between acute and chronic stress in young adults. Four hypotheses were tested to examine the additional influence of participant's self-reported chronic stress scores. Overall, it was hypothesized that chronic stress would moderate the relationship between acute stress and suggestibility. However, the results of each of the four moderation models failed to support these hypotheses, despite initial correlations suggesting a positive association between pre- and post-acute stress scores and self-reported chronic stress levels.

Prior literature posits that young adulthood is a period characterized by exploration, identity formation, and rapid changes across various domains of life (Rew et al., 2014). Therefore, young adults may be particularly susceptible to exposure to chronic stressors more than other age groups (Mirowsky & Ross, 1999; Turner & Turner, 2005). Participants in our sample averaged 2.39 out of five points on the chronic stress scale, indicating low-to-medium experiences of chronic stress. In line with the Cumulative Stress Theory that posits that exposure to acute stressors exacerbates stress in individuals already experiencing high levels of chronic stress (McEwen & Stellar, 1993), it is possible that higher levels of chronic stress could have intensified the effect of acute stress on the suggestibility of participants, even in cases where the acute stress was relatively minor (in comparison to legal situations), such as during the TSST task. Furthermore, sample characteristics such as socioeconomic status and cultural background may help explain (at least in part) a lack of the hypothesized effect. Specifically, our sample comprised predominantly Hispanic (90.6%), financially dependent (74.2%) young adults. Some common sources of chronic stress characteristic of individuals in this age group are financial responsibility, work-related stressors, and significant life event changes (e.g., moving to another city for school, marriage; Rew et al., 2014; Turner & Turner, 2005) that perhaps were not as prevalent in our current sample. Furthermore, there was a lack of variability in chronic stress scores among our sample, which could have further limited any potential effects of chronic stress on the relationship between acute stress and suggestibility. However, it is important to continue exploring the impact of stress on cognitive processes and emotional well-being. Further research can delve into the effects of chronic stress on suggestibility in young adults with diverse backgrounds and varied life experiences to gain a more comprehensive understanding.

Strengths, Limitations, and Future Directions

Although the hypothesized effects lacked statistical support, this study had some notable strengths that are worth highlighting. First, the study employed a multi-method approach to investigate the impact of acute stress beyond self-report measures. Along with experimental manipulation and self-reporting, the study also measured physiological stress responses in real time using heart rate and electrodermal activity as proxies for acute stress. The inclusion of physiological measures makes a unique contribution to the already limited literature on stress and interrogative suggestibility. Additionally, the TSST has been validated to reliably induce acute stress in various methods, such as in-person, as a group, online, and with virtual or imaginary audiences. With some minor modifications and video recording considerations, an online TSST method can be further adapted to include a recorded "hiring panel", increasing the standardization of research methods while further reducing the additional burden of training additional researchers and dealing with limited personnel availability.

Despite these strengths, it is important to recognize several limitations of the study. Even though the experimental manipulation of acute stress was successful, it cannot be assumed that the stress experienced during the TSST task is comparable to the high-stress situations typically encountered in legal settings. Although the TSST is a well-established method for inducing acute stress responses in the laboratory, some legal stressors (e.g., eyewitness identification, plea deals, interrogations) may differ. Future research should explore alternative methods for inducing stress that more closely resemble the stressors encountered in legal settings to enhance the relevance and applicability of the findings.

Another limitation of the study pertains to the measure of suggestibility used. Although the GSS scale is a commonly used measure of interrogative suggestibility, the structured interview format may not fully reflect the dynamic nature of suggestibility observed in real-life situations. Therefore, future studies should explore alternative methods of assessing suggestibility in various legal contexts and not just in formal questioning.

A third limitation of the study pertains to the participant sample. College students may exhibit distinct stress response patterns and experiences of chronic stress that starkly contrast those of young adults who are not students. Therefore, the findings may lack generalizability to non-college student samples of 18–26-year-olds. Additionally, while this study focused on young adults aged 18 through 26, life experiences and stressors may not generalize to non-traditional college students. Therefore, future research can extend to more diverse samples of young adults and non-traditional students to enhance the validity of the results.

Implications

Although the present study did not yield statistically significant results, it contributes to an extremely limited body of research on the impact of stress on the suggestibility of young adults. Even though there is limited literature on interrogative suggestibility beyond adolescence, interrogative suggestibility remains a concern across all age groups, particularly in legal contexts where leading or suggestive questioning can result in detrimental outcomes. While acute stress alone may not significantly predict suggestibility, other factors such as personality traits, cognitive loads, and social influence may play a key role in shaping an individual's susceptibility to suggestion, particularly in contexts where the outcome of being suggestible is of low importance.

However, given the potential ramifications of suggestibility in legal contexts where stress levels are likely to be exacerbated (i.e., interrogations), the results of studies that examine stress and suggestibility can have significant implications for legal practices. Understanding how acute stress influences suggestibility can help extend legal safeguards (currently available to children) to young adults and help reform current interrogation practices aimed at reducing suggestibility. Furthermore, it may be important to recognize the impact of chronic stress and suggestibility, especially on vulnerable young adults who may experience multiple chronic stressors. Although further research is warranted, it may highlight the importance of considering an individual's history with stress, particularly in legal settings where acute stress and suggestibility are likely to occur.

Conclusion

The purpose of this study was to explore how acute stress and self-reported chronic stress affect the interrogative suggestibility of young adults. The study used various methods, including experimental manipulation, self-reports, and physiological stress responses, to obtain both objective and subjective measures of acute stress. This study found no evidence to support the hypothesis that stress affects the suggestibility of young adults. However, this does not indicate that a relationship between stress and suggestibility does not exist; rather, sample characteristics, measures used, or study design could have contributed to a lack of statistical support. Future replication research is needed to confirm this. Despite this, the present study contributes to a scarce body of research that explores the role of stress on suggestibility in young adults. It underscores the importance of considering stress as a critical component of suggestibility in legal contexts among young adults. Further research in this area is crucial to understanding the complex interplay between stress and suggestibility, especially since experiences with the legal system can be very stressful and have detrimental consequences for suggestible young adults.

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Appendix A: Content of Control Condition Stimulus

A train is a group of connected vehicles that travel on tracks and carry people or things. Trains are usually pulled or pushed by engines, but some can move on their own. People and cargo are transported in railroad cars, also called wagons. Trains mostly run on steel tracks with steel wheels, which helps them move efficiently compared to other modes of transportation.

Trains have their origins in wagonways, which were tracks powered by horses or pulled by cables. The invention of the steam locomotive in the United Kingdom in 1804 led to trains spreading worldwide. They allowed for faster and cheaper movement of freight and passengers over land. Later on, rapid transit systems and trams were built in the late 1800s to transport large numbers of people within cities. Diesel and electric trains replaced steam power from the 1920s onwards, especially after World War II. As cars, trucks, highways, and airplanes became more prevalent, trains became less important and many rail lines were closed. Buses also led to the shutdown of rapid transit and tram systems.

Since the 1970s, there has been a push by governments, environmentalists, and train supporters to increase train usage. Trains are seen as more fuel-efficient and emit fewer greenhouse gases compared to other forms of land transport. High-speed rail, introduced in the 1960s, has become a viable option for short to medium distances, competing with cars and planes. Commuter rail has grown in popularity as an alternative to congested highways and as a way to encourage development. Light rail systems have gained significance in the 21st century. Freight trains remain important for transporting bulk commodities like coal and grain, reducing traffic congestion caused by trucks.

While most trains operate on flat tracks with two rails, there are specialized trains with different modes of operation. Monorails run on a single rail, while funiculars and rack railways are designed for steep slopes. Experimental trains like high-speed maglevs, which use magnetic levitation to float above the track, are being developed in the 2020's and offer even higher speeds than even the fastest conventional trains. Trains using alternative fuels such as natural gas and hydrogen are another modern development.

Trains have evolved from wheeled wagons that traveled on stone wagonways. The earliest wagonways were built around 2,200 BCE by Babylon. In the 1500s, wagonways were used to transport materials from mines, and stronger iron rails were introduced in the 1790s. In 1804, British inventor Richard Trevithick created the first steam locomotive, which powered the first steam train. Steam locomotives were initially used mainly in coal mines since coal fuel was easily available. British engineer George Stephenson ran a steam locomotive called Locomotion No. 1 on this railway, carrying over 400 passengers at speeds of up to 13 kilometers per hour, or roughly 8 miles per hour. This success, along with Stephenson's Rocket locomotive in 1829, led to a surge of interest in steam locomotives, known as "Railway Mania".

News of steam locomotives quickly reached the United States, where the first steam railroad opened in 1829. American railroad pioneers began manufacturing their own locomotives designed to handle the sharper curves and rougher tracks of the country's railroads. European countries also took note of the British railroad developments. In the 1830s and 1840s, many European nations constructed their own railroads, following France's first steam train run in late 1829. In the 1850s, trains continued to expand across Europe, with some countries adopting American locomotive designs. However, each European country also developed its own unique designs. By 1900, railroads were developed on every continent except for Antartica. Steam locomotives became larger and more powerful worldwide as technology advanced throughout the rest of the century.

In recent decades, there has been a renewed recognition of the advantages of trains as a mode of transportation. Trains offer significant benefits in terms of energy efficiency and environmental impact compared to other forms of transport. Freight trains, in particular, are much more efficient than trucks and emit fewer greenhouse gases per ton-mile. According to the International Energy Agency, rail requires far less energy and produces significantly fewer emissions per passenger-kilometer than private vehicles and airplanes, making it the most efficient option for passenger transport. Additionally, freight rail is considered the most energy-efficient and environmentally friendly way to transport goods, especially when using intermodal trains that carry double-stack shipping containers. This shift towards rail transport has helped reduce carbon emissions and promote sustainable energy practices. Furthermore, the use of commuter rail has gained popularity as a solution to alleviate traffic congestion on highways in urban areas.

Passenger trains are used to transport people along railroad lines. They can be divided into different types based on their purpose and distance traveled. Long distance trains travel over hundreds or even thousands of miles between cities. The Trans-Siberian Railway in Russia holds the record for the longest passenger train service, covering a distance of 9,289 kilometers (5,772 miles). These trains often take several days to complete their journeys and make stops at many stations along the way. For many rural communities, long distance trains are their only form of public transportation.

Short distance trains, also known as regional trains, have shorter travel times measured in hours or minutes rather than days. They operate more frequently than long distance trains and are often used by commuters traveling within a specific region. Trains specifically designed for commuters are called commuter rail.

High-speed trains are designed to travel at much faster speeds than conventional trains. They usually have their own separate tracks to ensure efficiency. The first high-speed train, the Japanese Shinkansen, was introduced in 1964. In the 21st century, trains like the French TGV and German Intercity Express have become competitive with airplanes for short to medium distances in terms of travel time.

There is also a category of trains known as higher speed trains, which fall between conventional and high-speed trains in terms of speed. They operate at speeds between the two categories. There are different types of trains that serve as rapid transit systems in urban areas. These trains operate more frequently, have shorter distances to cover, and usually have dedicated tracks separate from freight trains. Various systems are used worldwide. Trains that run-in tunnels beneath the ground are called subways, undergrounds, or metros.

Appendix B: Trier Social Stress Test Instructions

Phase 1: Speech Preparation

For this next part, I want you to pretend that you have just been called in to interview for your dream job on Zoom. I want you to take a second now and think to yourself what this dream job is and let me know once you have that in mind. (Pause to let them think)

Now imagine you are applying for your ideal job. You have dreamed about working in this job for as many years as you can remember. You have just seen an advertisement for this perfect job and decided to apply. After submitting your application, you have been invited for an interview. The job pays a very large salary. You are competing against a lot of other candidates, and the final selection will be made based on your ability to convince these two interviewers of how your experiences, abilities, and education make you a better candidate than the others. You will try to convince this panel of interviewers that you are the best candidate for the position.

Your goal is to prepare and deliver a 4-minute speech on Zoom on why you are the best candidate for this position, and why the interviewers should hire you. Remember, you should try to perform better than all of the other participants. These examiners are specially trained to monitor and rate your speech for its believability and convincingness, and they will compare your performance to that of the others who perform this task. You should ensure you use the full 4 minutes allotted for you to convince them.

You will first have 3 minutes to privately prepare a 4-minute speech in your head about why you should be hired for the position, the interviewers have been sent to a breakout room on Zoom while you prepare. You will see a countdown timer on the screen above to help you keep track of the time. The camera above the screen will not be on at this time.

After the 3 minutes, the camera above the screen will be turned on, I will bring the interviewers back to the main Zoom room, and you will deliver this speech to them. They will be muted the entire time as their job is to evaluate your performance, speech, and the believability of your speech. You will have 4 minutes and should plan to use all of that time to truly convince the panel. You will see a countdown timer on the screen to help you keep track of the time.

I will be walking you through each component of the task. As a reminder, please try your best to stay as still as possible, particularly your hands and arms while you are expressing yourself.

For these next 3 minutes, please go ahead and brainstorm what you will say to the panel. I will check in with you at the end of the 3 minutes. Do you have any questions? Let me know when you are ready to start

Phase 2: Speech Delivery

Okay, in a second I will bring the interviewers to the main room where you will now deliver your speech. You will have 4 minutes to deliver the speech and should plan to use all 4 minutes. Remember that the selection will be made based on your ability to convince the interviewers of how your experiences, abilities, and education make you a better candidate than the others. You will try to convince this panel of interviewers that you are the best candidate for the position.

You will see a countdown timer on the screen to help you keep track of the time and to remind you to keep going for the whole 4 minutes. I will check in with you at the end. Let me know when you are ready to start.

Phase 3: Serial Subtraction

Okay, now in addition to the speech, you will now be asked to perform a mental math test, which will give the interviewers additional information about your working memory capacity. The interviewers will still be evaluating your performance. Your task is to subtract 13 from the number 2045 out loud, as quickly and accurately as possible. You will have 3 minutes to complete this task. If you make a mistake, I will ask you to start over from 2045. You will see a countdown timer on the screen to help you keep track of the time. I will check in with you at the end. Let me know when you are ready to start.

Appendix C: Content of the Suggestibility Scale

"Anna Thomson/of South/Croydon/was on holiday/in Spain/when she was held up/outside her hotel/and robbed of her handbag/which contained $50 worth/of travelers cheques/and her passport./She screamed for help/and attempted to put up a fight/by kicking one of the assailants/in the shins./A police car shortly arrived/and the woman was taken to the nearest police station/where she was interviewed by Detective/Sergeant/Delgado./The woman reported that she had been attacked by three men/one of whom she described as oriental looking./The men were said to be slim/and in their early twenties./The police officer was touched by the woman's story/and advised her to contact the British Embassy./Six days later/the police recovered the lady's handbag/but the contents were never found./Three men were subsequently charged/two of whom were convicted/and given prison sentences./Only one/had had previous convictions/for similar offences./The lady returned to Britain/with her husband/Simon/and two friends/but remained frightened of being out on her own."

Questions:	"Yield" answers
I. Did the woman have a husband called Simon? (NS)	Not Scored
2. Did the woman have one or two children? (S)	One/Two/Yes
3. Did the woman's glasses break in the struggle? (S)	Yes
4. Was the woman's name Anna Wilkinson? (S)	Yes
5. Was the woman interviewed by a detective sergeant? (NS)	Not Scored
6. Were the assailants black or white? (S)	Black/White/Yes
7. Was the woman taken to the central police station? (S)	Yes
8. Did the woman's handbag get damaged in the struggle? (S)	Yes
9. Was the woman on holiday in Spain? (NS)	Not Scored
10. Were the assailants convicted six weeks after their arrest? (S)	Yes
11. Did the woman's husband support her during the police interview? (S)	Yes
12. Did the woman hit one of the assailants with her fist or handbag? (S)	First/Handbag/Yes
13. Was the woman from South Croydon? (NS)	Not Scored
14. Did one of the assailants shout at the woman? (S)	Yes
15. Were the assailants tall or short? (S)	Tall/Short/Yes
16. Did the woman's screams frighten the assailants? (S)	Yes
17. Was the police officer's name Delgado? (NS)	Not Scored
18. Did the police give the woman a lift back to her hotel? (S)	Yes
19. Were the assailants armed with knives or guns? (S)	Knives/Guns/Yes
20. Did the woman's clothes get torn in the struggle? (S)	Yes

S = Suggestive questions NS = Non-suggestive questions

Appendix D: Acute Stress Appraisals

Please indicate by circling a number after each statement to indicate how you are feeling right now regarding the task you are about to complete (PRE-TASK)
1 = Strongly Disagree; 2; 3; 4 = Neutral; 5; 6; 7 = Strongly Agree

1. The upcoming task is very demanding.
2. I am very uncertain about how I will perform during the upcoming task.
3. The upcoming task will take a lot of effort to complete.
4. The upcoming task is very stressful.
5. I have the abilities to perform the upcoming task successfully.
6. It is very important to me that I perform well this task.
7. I'm the kind of person who does well in these types of situations.
8. A poor performance on this task would be very distressing for me.
9. I expect to perform well on this task.
10. I view the upcoming task as a positive challenge.
11. I think the upcoming task represents a threat to me.
12. I feel as if I am in complete control of my performance.

Please indicate by circling a number after each statement to indicate how you are feeling right now regarding the task you have just completed. (POST-TASK)
1 = Strongly Disagree; 2; 3; 4 = Neutral; 5; 6; 7 = Strongly Agree

1. The task was very demanding.
2. I am uncertain about how I performed.
3. I exerted a lot of effort during the task.
4. The task was very stressful.
5. I felt that I had the abilities to perform well in the task.
6. It was very important to me that I performed well this task.
7. I believe I performed well on the task.
8. I felt that the task challenged me in a positive way.
9. I felt threatened by the task.
10. I felt in complete control during the task.

Appendix E: Chronic Stress Questionnaire

1 = Not at all 2 = Somewhat Not True 3 = Somewhat True 4 = Mostly True 5 = Completely True

1. I have had an extremely exhausting schedule for a long time now.
2. It just seems as if the demands of my work have been totally overwhelming.
3. It seems everyone around me always wants more and more from me.
4. Others are constantly treating me unfairly.
5. I feel that I never get the acknowledgment I deserve from others.
6. Negative events in my life are a permanent source of frustration for me.
7. People around me always make me feel inadequate.
8. It feels as if I have been constantly on edge.
9. I feel drained by all the daily life challenges I am facing.
10. I don't know how to cope with all the challenges I am facing.
11. I feel demoralized about the way I am handling my personal life.
12. My ongoing responsibilities have caused me lots of stress.
13. I've been told that others treat me poorly.
14. People I'm living with never seem to contribute their fair share.
15. I'm often taken advantage of.
16. Others have told me that my life seems very stressful.
17. I spend most of my day in hostile environments.
18. The demands of my work are overwhelming.
19. My work requires unpleasantly long hours.
20. I live where there is constant threat around me.
21. I feel constantly threatened.
22. My life situation is deeply frustrating.
23. I can never get a good night's sleep because of all of the stressful things in my life.
24. I feel like a burden to others.
25. It seems like I'm constantly experiencing stressful situations.
26. I don't know how to face the constant challenges around me.
27. The permanent stress I experience is taking a toll on my body and physical health.

Appending F: Manipulation Check Questions

Control and Induced Stress Conditions

1. During the story portion of the study, how much did you believe you made errors recalling the story? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
2. What did you think the purpose of the study was? Explain.
3. Anything else that stood out to you or seemed weird about the study? Explain:

Induced Stress Condition Only

4. How much did you believe that the people on the Zoom call were evaluating your speech? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
5. How much did you believe that the people on the Zoom call were evaluating your behavior? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
6. How much did you feel your performance was being judged by the people on the Zoom? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
7. How much did you believe they were experts? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
8. How much did you believe this was a real Zoom call? From 1 = Not at all 2 = A little 3 = Somewhat 4 = Very much
9. Did you have any suspicions about the nature of the Zoom call or the evaluation? a. Yes, explain: b. No

Vita

Claudia Cota graduated from the University of California, San Diego (UCSD) with a Bachelor of Arts in Cognitive Science. Throughout her undergraduate degree, Claudia worked as an undergraduate Research Assistant on diverse projects under the guidance of Drs. Susan F. Tapert and Joanna Jacobus. After completing her undergraduate studies, Claudia continued working with Drs. Tapert and Jacobus as a Research Assistant and Project Coordinator for a nationwide study at UCSD.

In the Fall of 2021, Claudia was admitted to the Legal Psychology Ph.D. program at The University of Texas at El Paso (UTEP) under the mentorship of Dr. April G. Thomas. Claudia's research interests include examining how short- and long-term sources of stress may impact adolescents and young adults' legal decisions and outcomes, such as in custodial interrogations, where true and false confessions may take place.

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