# Suspicious Minds: The Link Between Stress and Perceptions of Agency

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A thesis

Submitted to the Victoria University of Wellington in

fulfilment of the requirements for the degree of

Master of Science

Te Herenga Waka – Victoria University of Wellington

2020

## Abstract

How do we perceive other minds? Research shows that people intuitively think about other minds in terms of two dimensions: agency (the capacity to think and act) and experience (the capacity to sense and feel). Perceiving a mind in another entity can alter how people interact it because mind perception implies moral status. There is evidence that stress alters the treatment of others, including contributing to dehumanization (the failure to perceive a humanlike mind in another person), but the effect of stress on mind perception is unknown. Based on previous research about the effects of stress on psychological phenomena related to the dimensions of agency and experience, I hypothesized that stress increases perceptions of agency and reduces perceptions of experience. To test these hypotheses, I conducted four studies combining two different measures of mind perception and two different methodological approaches. The results were inconsistent from one study to the next, but a tentative pattern emerged when taking all studies together. Participants who reported high levels of pre-existing stress tended to perceive more agency across a range of different entities, while inducing stress in the laboratory caused participants to attribute agency more readily to inanimate human faces. These results were weak and inconsistent, but they suggest that stress might increase perceptions of agency. The results for experience were inconclusive. I discuss some possible implications of my findings for mind perception and morality.

Acknowledgements

*Ehara taku toa, he takitahi, he toa takitini.*

For Tyler,

With thanks

To my supervisors (David Carmel and Gina Grimshaw),

Collaborators (Christine Looser and Hugh Rabagliati),

Friends and family.

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Suspicious Minds: The Link Between Stress and Perceptions of Agency

Think about the last time you had a stressful day. Were you quick to blame others for any problems that were occurring? Did you fail to consider the feelings of those around you? Stress seems to change the way we understand others' thoughts and feelings; that is, how we perceive other minds. In this thesis, I present four studies testing the hypothesis that stress affects mind perception.

## 1.1. What is mind perception?

Mind perception is the attribution of a mind to another entity (Gray et al., 2012). In other words, mind perception is about whether people think a particular entity has a mind or not (Waytz, Gray, et al., 2010). Beyond the mere detections of other minds, mind perception also involves judgments about the degree and kind of an entity's mental capacities (e.g., the extent to which it is capable of thinking or feeling, Hackel et al., 2014).

Mind perception can be distinguished from theory of mind, which is the attribution of specific mental content to other minds (e.g., attributing a specific belief or emotion to another entity; Premack & Woodruff, 1978)[1]. On these definitions, mind perception can be considered a prerequisite for theory of mind. Before you can understand exactly what someone is thinking or feeling, you must perceive that they have a mind at all (Gray et al., 2012).

## 1.2. Who has a mind?

You know that you have a mind (*cogito, ergo sum*; Descartes, 1637). Intuitively, it seems obvious that other people have minds too. But those around you could be zombies: creatures who look and behave exactly like normal human beings, but lack conscious experience (Chalmers,

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[1] Mind perception should be similarly distinguished from mentalizing (Frith & Frith, 2003) and perspective-taking (Galinsky & Moskowitz, 2000).

1996; Kirk, 2019). Few people, if any, think zombies actually exist. But they help illustrate a certain philosophical problem of other minds. Because we do not have access to other minds, we cannot be sure they exist (Avramides, 2019). Therefore, the existence of other minds is independent of our perception of them (Arico et al., 2014; Huebner et al., 2010; Knobe & Prinz, 2008; Malle, 2006).

Research on mind perception is about how people perceive other minds, not the existence of other minds. From this perspective, a mind is real to the perceiver when it is perceived. This idea is best demonstrated by Alan Turing's (1950) famous thought experiment. In the Turing Test, you converse via text messaging with two different entities: a human and a computer programmed to act like a human. Your task is to decide which entity is which. Turing thought that if the computer can trick you into thinking it has a mind, then it has one (Oppy & Dowe, 2019)[2].

We perform the Turing Test every day when we decide which things have minds and which do not (Wegner & Gray, 2016). But what do we mean when we say something has a mind? Do we perceive minds on a single dimension from no mind (a rock) to full mind (a human)? Or, do we perceive minds along multiple dimensions?

**1.3. Two dimensions of mind perception**

For centuries, philosophers argued for a one-dimensional view of mind perception. Saint Augustine presented a version of this argument in the 'great chain of being' from rocks up

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[2] If you are curious what people do when the Turing Test is turned against them, see McCoy and Ullman (2018). Imagine you and a smart robot are before a Judge who cannot see you. The Judge will guess which of you is human. You each must choose one word based on which the Judge will guess who is human. What word would you choose? Most people choose 'love'. However, when acting as judges, most people select 'poop' over other words as the one given by a human. This shows that people reason poorly about others' beliefs when distinguishing between the minds of humans and robots.

through plants, animals, people, angels, and, finally, God (Lovejoy, 1936; Nee, 2005). More recently, Daniel Dennett (1996) echoed this one-dimensional view in his book *Kinds of Minds*.

Empirical research challenges this philosophical assumption that mind perception exists on one dimension. Gray et al. (2007) conducted a large-scale web survey asking participants to compare 13 different characters on each of 18 different mental capacities. The characters included humans, animals, a robot, a dead person, and God. One question, for example, asked whether a 5-year-old girl or chimpanzee was more capable of feeling pain. Gray et al. (2007) calculated the average ratings for each mental capacity across characters. Submitting these means to factor analysis revealed that the mental capacities could be grouped into two independent factors, which Gray et al. (2007) labelled 'agency' and 'experience'.

The agency factor included the capacities for self-control, morality, memory, emotion recognition, planning, communication, and thought. The unifying theme of these capacities is thinking and doing. The concept of agency appears to underlie perceptions of competence, intelligence, and action. Entities show their agency when they act and accomplish goals (Wegner & Gray, 2016).

The experience factor included a different set of capacities: hunger, fear, pain, pleasure, rage, desire, personality, consciousness, pride, embarrassment, and joy. The unifying theme of these capacities is sensing and feeling. Experience seems to capture 'what it is like' to have a mind – what philosophers talk about when they talk about consciousness (Dennett, 2018; Nagel, 1974).

Entities are attributed each of the two dimensions in varying degrees (Figure 1). An entity can be high on both dimensions (e.g., adult humans), high on agency and low on experience (e.g., robots, Google), low on agency and high on experience (e.g., children, animals), or low on both dimensions (e.g., the dead, inanimate objects; Gray et al., 2007; Gray et al., 2008, 2011). In sum, when people think about other minds, it is in terms of their capacity to 'think', to 'feel', or both (Waytz, Gray, et al., 2010)

**Figure 1**

*A Map of Mind Perception*

Redacted

*Note*. From Gray, H. M., Gray, K., & Wegner, D. M. (2007).

Other work on mind perception in experimental philosophy has revealed a similar two-dimensional structure. Knobe and Prinz (2008) distinguish between the ascription of phenomenal (e.g., pain, sadness, joy) versus non-phenomenal mental states (e.g., beliefs, intentions, knowledge; see also Huebner, 2010; Robbins & Jack, 2006; Sytsma & Machery, 2010 for similar distinctions). As has social-psychological research on perceptions of humanness, distinguishing between human nature (the capacity for emotionality) and human uniqueness (the capacity for rationality; Haslam, 2006; Haslam et al., 2008; Loughnan & Haslam, 2007); stereotypes, distinguishing between warmth (corresponding to experience) and competence (corresponding to agency; Fiske et al., 2002, 2007; Harris & Fiske, 2006); and empathy, distinguishing between cognitive and emotional empathy (Davis, 2007; Decety, 2011; Shamay-Tsoory et al., 2009).

**1.4. Why does mind perception matter?**

Philosophers, psychologists, lawyers, and laypeople agree that mind is required for moral status (Aristotle, 340 BC/2001; Monroe et al., 2014; Nahmias et al., 2014; O'Connor, 2000; Rosati, 2016). But there is disagreement over the exact mental requirements for moral rights versus moral responsibility. Kant (1788/2001; see also Hume, 1751) argued that rationality is required for rights and responsibility. Bentham (1879/1999; see also Singer, 1990) disagreed, emphasizing the importance of pain for moral rights. "The question is not, Can they reason? nor, Can they talk? but, Can they suffer?"

Gray et al.'s (2007) survey revealed critical links between the dimensions of mind perception and the attribution of moral rights and responsibility (see also Bastian et al., 2011 for similar findings). Perceptions of agency were correlated with judgements of responsibility, whereas perceptions of experience were correlated with ascriptions of rights (Gray et al., 2007; see also Gray, Waytz, et al., 2012; Gray, Young, et al., 2012; Gray & Schein, 2012; Schein et al., 2015; Schein & Gray, 2018). In philosophical parlance (Aristotle, 340 BC/2001), agency qualifies entities as moral agents (those who are capable of doing good or evil), while experience qualifies entities as moral patients (those who are capable of having good and evil done to them; Figure 2).

**Figure 2**

*Two dimensions of mind and two moral types*

Redacted

*Note*. Adapted from Gray, K., Young, L., & Waytz, A. (2012).

Just as perceiving someone's mind gives them moral status, failing to perceive their mind strips away their moral status. Indeed, denying others' mental capacities is the essence of dehumanization (Haslam, 2006; Haslam et al., 2008; Loughnan & Haslam, 2007). People can dehumanize others by denying them agency or experience. Those denied agency are objectified (Fredrickson & Roberts, 1997; Gray, Knobe, et al., 2011), or seen as subservient (Fiske et al., 2007) or animalistic (Haslam, 2006; Loughnan & Haslam, 2007). Those denied experience are seen as robotic, cold, and cruel (Haslam, 2006; Loughnan & Haslam, 2007), encouraging active harm towards them (Fiske et al., 2007).

### 1.5. A possible role for stress in mind perception

There are three basic research questions about the inferences people make about other minds. First, do people think a particular entity has a mind? Second, what is the state of that mind? Third, what are the behavioural consequences of perceiving a mind in another entity? Most research has focused on the second question – about the perception of mental states, or theory of mind. In 2010, Waytz et al. reviewed a then-emerging trend as researchers expanded their attention to the first and third questions – about the causes and consequences of mind perception.

Ten years later, we still do not have a good understanding of the factors affecting mind perception. I opened this thesis with the anecdotal observation that stress seems to affect mind perception. Although there is a lot of evidence that stress contributes to dehumanization (Bar-On, 2000; Bar-Tal, 1990, 1990, 1998, 2007), the effect of stress on mind perception is unknown. However, previous research about the effect of stress on psychological constructs related to agency (intentionality) and experience (empathy) suggests opposing hypotheses for the two dimensions.

But first, what do we mean when we talk about stress? There are many different definitions of stress, perhaps because it is difficult to define (stress definitions was reviewed in detail by Selye, 1976; see also Fink, 2009). “Everybody knows what stress is and nobody knows what it is” (Selye, 1973, p. 692). A working definition of stress in this thesis is a cognitive perception of uncontrollability and/or unpredictability expressed through a physiological and behavioural response (Koolhaas et al., 2011; see also Henry, 1992; Kim & Diamond, 2002; Mason, 1968a, 1968b; Salvador, 2005). Stressful situations are conditions where a person is aroused and made anxious by an uncontrollable aversive challenge (e.g., being stuck in heavy traffic on a highway, a hostile employer, unpaid bills; Fink, 2016).

#### 1.5.1. Intentionality

Rosset (2008; see also Rosset, 2007) asked participants to decide whether a series of ambiguous actions (e.g., "He set the house on fire") were done on purpose or by accident under speeded conditions. Each action was described in a sentence, presented consecutively for either 2400 ms (speeded condition) or 5000 ms (unspeeded condition). Participants were randomly assigned to either condition. Those in the speeded condition were more likely to judge ambiguous actions as purposeful than in the unspeeded condition. There was even a significant difference for control sentences describing actions that are always accidental (e.g., "He poked himself in the eye"), with more 'on purpose' judgements in the speeded condition.

Similarly, Kelemen and Rosset (2009) asked participants to judge the correctness of purpose-based (teleological) explanations of various natural phenomena (e.g., "the sun radiates heat because warmth nurtures life") under speeded conditions. Participants were randomly assigned to one of three conditions: fast speeded, moderately speeded, or unspeeded. In the speeded conditions, sentences describing each explanation were presented consecutively for either 3200 ms (fast) or 5000 ms (moderate). In the unspeeded condition, participants read the sentences in their own time. Participants in the speeded condition were more likely to endorse teleological explanations of natural phenomena than in the moderate or unspeeded conditions.

More recently, Kubota et al. (2014) asked participants to judge whether a series of everyday behaviours were caused by situational (the context in which the behaviour occurs) or dispositional factors (the individual's personality characteristics) following a cold-pressor stress manipulation. Participants were randomly assigned to either submerge their arm in ice-cold (stress condition) or lukewarm water (control condition). Then, participants read a series of scenarios describing both behavioural (e.g., "Tom left the restaurant in a hurry without tipping the waitress") and situational information (e.g., "Tom's baby was screaming") in sequentially presented sentences. Stressed participants were more likely to make dispositional attributions than controls.

In a follow-up study, Kubota et al. (2014) asked an online sample to judge whether the cause of a range of criminal behaviours was situational or dispositional. Each behaviour was described in a vignette (e.g., "A 13-year-old boy in the slums of Chicago robs an 87-year-old man of $2.27"). Then, participants rated their current level of stress. Self-reported stress was correlated with increased dispositional attributions. (As a measure of chronic stress, participants also rated how stressed they felt in the last month, but this did not correlate with attributions.)

In sum, people are more likely to interpret others' actions as intentional when placed under cognitive load due to time constraints (Rosset, 2008). Cognitive load also causes people to explain natural phenomena as instances of intentional action from an agent (an organism or the Earth construed as a Gaia-like entity; Kelemen & Rosset, 2009; see also Lovelock, 1990). Finally, stress increases intentional attributions of others' behaviour (Kubota et al., 2014).

Stress is cognitively demanding, and cognitively demanding tasks are often used to induce stress (e.g., Delaney & Brodie, 2000; Huerta-Franco et al., 2012; Scholey et al., 2009). Taken together, then, these findings indicate that stress makes people more likely to perceive others as acting intentionally. But, before you can attribute intentions to another entity, you must perceive that they are capable of intentionality (i.e., agency). Therefore, previous findings that stress increases attributions of intentions could be explained by increased perceptions of agency. This has not been directly investigated. In this thesis, I test the hypothesis that stress increases perceptions of agency.

### 1.5.2. Empathy

Most research about the effects of stress on empathy focuses on problems associated with chronic stress in healthcare professionals. Studies show that empathy is blunted by stressors such as high workload, exposure to patient suffering or death, and ethical conflicts (Newton, 2013; Shanafelt et al., 2005, 2009; West, 2012).

Recently, Buruck et al. (2014) asked participants to rate others' observed pain following a stress manipulation. Participants were randomly assigned to either a stress or control condition. Those in the stress condition completed the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). The TSST involves developing a speech on a preselected topic, performing the speech, and doing a mental arithmetic task. The tasks are performed in front of trained 'evaluators'. Additionally, participants' behaviour is recorded via a camera and microphone. Participants in the control condition completed the Placebo-TSST, which involves preparing and reciting a text about a holiday and doing a mental arithmetic task designed to be easier than the TSST. The tasks are performed in an empty room without evaluators or recording.

Following the stress manipulation, participants were presented with a series of pictures of right hands and feet in painful situations (e.g., a person cutting their finger with a pair of scissors). They rated the intensity of the pain they thought the other person would experience in each situation. Stressed participants rated the pictures as less painful than controls.

In sum, the findings from Buruck et al. (2014) and prior research (Newton, 2013; Shanafelt et al., 2005, 2009; West, 2012) suggest that stress reduces empathy. "Empathy in the broadest sense refers to the reactions of one individual to the observed experiences of another" (Davis, 1983, p. 113; see also Davis, 2006). Before you can empathize with what another entity is experiencing, you must perceive that they are capable of experience. Therefore, previous findings that stress reduces empathy could be explained by reduced perceptions of experience. This has not been directly investigated. In this thesis, I test the hypothesis that stress reduces perceptions of experience.

### 1.7. The current research

The effect of stress on mind perception is unknown. In this thesis, I aim to fill this gap in the literature. I reviewed previous research about the effects of stress on psychological constructs related to agency (intentionality) and experience (empathy). Based on this review, I formulated two hypotheses: (1) stress increases perceptions of agency and (2) reduces perceptions of experience.

To test these hypotheses, I conducted four studies using two different measures of mind perception (mind survey and morph task) and two different methodological approaches (correlational and experimental). This gave me four possible combinations of measures and methods (Figure 3). All studies were planned in advance and run in parallel (see Appendices A-D for preregistration documents). Below, I briefly describe each measure and method.

**Figure 3**

*A 2x2 grid of the current studies*

| | |
|---|---|
| **Study 1**<br>*Mind survey*<br>*Correlational* | **Study 2**<br>*Mind survey*<br>*Experimental* |
| **Study 3**<br>*Morph task*<br>*Correlational* | **Study 4**<br>*Morph task*<br>*Experimental* |

#### 1.7.1. Measures

In Studies 1 and 2, I measured mind perception using the mind survey. The mind survey was created by Gray et al. (2011) to directly measure perceptions of the dimensions of agency and experience identified in Gray et al. (2007). Participants rate how much they perceive various characters to possess different mental capacities (0 = *not at all* to 6 = *very much*)[3]. Characters include an adult woman, adult man, a baby human, a deceased human, a dog, God, a robot, a tree, and Superman. Mental capacities include both agency-related capacities (exercise self-control, have memories, and act morally) and experience-related capacities (feel fear, pleasure, and hunger). The characters and capacities in the mind survey are adapted from Gray et al. (2007).

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[3] The mind survey involves absolute ratings of mental capacities rather than relative ratings as in Gray et al. (2007).

I chose to use the mind survey because it is most common measure of mind perception (e.g., Bigman & Gray, 2018; Buck et al., 2017; Cooley et al., 2017; Gray, Knickman, et al., 2011; Gray, Knobe, et al., 2011; Gray, Waytz, et al., 2012; Gray & Wegner, 2010a, 2010b, 2012). It is sensible to use a well-established measure of a construct (mind perception) when investigating a hypothesis about that construct (the influence of stress).

In Studies 3 and 4, I measured using a modified version of the morph task (Looser & Wheatley, 2010). The morph task consists of a series of 10 morphing continua between pictures of doll faces at one end and well-matched photographs of human faces at the other. Participants scroll through each morph continuum in 2% increments (50 images per morph) to select the image where the face first looks capable of either formulating a plan (related to agency) or feeling pain (related to experience). The capacities were adapted from Gray et al. (2007).

The morph task is a relatively novel measure of mind perception, having only been used in two previous studies (Hackel et al., 2014; Looser & Wheatley, 2010). I chose to use the morph task because it has higher measurement resolution (50-point continuum) than the mind survey (7-point Likert), so it might be more sensitive. Including two different measures of mind perception also gave me an opportunity increase the generalizability of my results.

**1.7.2. Methods**

Studies 1 and 3 were online surveys comprising self-report measures of stress followed by either the mind survey (Study 1) or morph task (Study 3). These studies allowed me to search for associations between stress and mind perception in large samples.

Studies 2 and 4 were lab experiments comprising a between-subjects stress manipulation followed by either the mind survey (Study 2) or morph task (Study 4). These studies allowed me to test the causal relationships between stress and mind perception.

# 2. Study 1

## 2.1. Introduction

Study 1 was an online survey comprising two self-report measures of stress (Section 2.2.2), followed by the mind survey (Gray et al., 2011). Based on my hypotheses, I predicted that scores of self-reported stress should correlate positively with scores of perceived agency and negatively with scores of perceived experience on the mind survey.

I fielded the survey on Amazon's Mechanical Turk (MTurk), an online labour market. MTurk is a popular platform for online psychological studies (Buhrmester et al., 2018) because it allows researchers to collect large amounts of data quickly and cheaply (Buhrmester et al., 2011; Stewart et al., 2015). Crucially, there is a lot of evidence that MTurk data are equivalent or superior in quality to data obtained in the lab (Behrend et al., 2011; Casler et al., 2013; Kees et al., 2017; Paolacci & Chandler, 2014). This has been demonstrated across various study designs and data-types (Chandler & Shapiro, 2016; Goodman et al., 2013; Horton et al., 2011; W. Mason & Suri, 2012; Shapiro et al., 2013). These features make MTurk a useful tool for investigating a novel trend within the research time-frame (McDuffie, 2019).

## 2.2. Method

### 2.2.1. Participants

Because this is the first study to correlate stress with mind perception, I had no prior effect size to use in estimating the required sample size. I therefore based my sample size on previous studies correlating other psychological constructs with mind perception. Such studies include sample sizes from 100-845 (Buck et al., 2017; Gray et al., 2011; Schroeder et al., 2017). I therefore aimed for a sample size of 300.

Three hundred and eleven participants completed the study on MTurk. I excluded 91 participants for failing response validity checks (Section 2.2.3). This left a final sample of 220 (122 female; age: $M = 36.01$, $SD = 11.08$, range 18-76). To help ensure data quality (Hauser et al., 2018), I restricted my sample to English-speaking countries (Aotearoa/New Zealand, Australia, Canada, the United Kingdom, & the United States. Unfortunately, I neglected to record the number of participants from each country). All participants provided informed consent and received $1 NZD for participating. The School of Psychology Human Ethics Committee of Victoria University of Wellington approved this study.

**2.2.2. Measures**

I adapted each of the measures to be presented through Qualtrics (Provo, UT), an online survey software. I did not have access to information about participants' computer or display specifications. It is unlikely that differences in these specifications between participants impacted responding because this study had no special presentation requirements.

I used Cronbach's (1951) alpha to assess the internal consistency of each measure because it is the most common index of scale reliability (Cho & Kim, 2014; Raykov & Marcoulides, 2017). To interpret the size of Cronbach's alpha, I used the following rules of thumb: > .9 – Excellent; > .8 – Good; > .7 – Acceptable; > .6 – Questionable; > .5 – Poor; and < .5 – Unacceptable (George, 2011).

#### 2.2.2.1 Depression, Anxiety, and Stress Scale 21 (DASS-21)

I used the 7-item stress subscale from the DASS-21 (Henry & Crawford, 2005) to measure state stress[4]. Participant's rate the extent to which each item (e.g., *I found it hard to wind down*) applied to them over the past week on a 4-point scale from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). (For full measure, see Appendix E.) The DASS-21 stress subscale is scored by summing the ratings of all items, then multiplying this score by two. Possible scores range from 0-42, with higher scores indicating greater state stress (Lovibond & Lovibond, 1996). Previous research has shown the DASS-21 stress subscale to have good to excellent internal consistency ($\alpha$ = .87-.90; Henry & Crawford, 2005; Norton, 2007). In the current sample, the stress subscale showed good internal consistency ($\alpha$ = .89).

#### 2.2.2.2. State-Trait Anxiety Inventory (STAI)

Based on common practice (e.g., Arora, Sevdalis, et al., 2010; Arora, Tierney, et al., 2010; Jones et al., 2015; Valsamakis et al., 2017), I used the STAI (Spielberger et al., 1983) to get commensurate measures of state and trait stress[5]. The STAI comprises two 20-item subscales (40 items total): state (STAI-S) and trait (STAI-T). On the STAI-S, participants rate the extent to which each item (e.g., *I am tense*) describes how they are currently feeling on a 4-point scale from 1 (*Not at all*) to 4 (*Very much*). On the STAI-T, participants rate the extent to which each item (e.g., *I feel nervous and restless*) describes how they generally feel on a 4-point scale from 1 (*Almost never*) to 4 (*Almost always*). (For full measure, see Appendix F.) The STAI subscales are

[4] Although I only analysed data from the stress subscale, participants completed the whole DASS-21 in all studies. My preregistered hypotheses focused only on the stress scale, so the other scales are not reported here.

[5] Because this is the first research about the effect of stress on mind perception, I wanted to examine both state and trait aspects of stress. I did not have specific hypotheses for the effects of state versus trait stress.

scored by first reverse-coding relevant items (e.g., *I feel calm*), then summing the ratings of all items for each subscale. Possible scores thus range from 20-80 on each subscale. Higher scores indicate greater state or trait stress. Previous research has shown the STAI to have excellent internal consistency (α = .9; Spielberger et al., 1983). In the current sample, the STAI-S and STAI-T both showed excellent internal consistency (α = .96 for both subscales).

#### 2.2.2.3. Mind survey

I used the mind survey (Gray et al., 2011; see also Buck et al., 2017; Gray, Knickman, et al., 2011; Gray, Knobe, et al., 2011) to measure perceptions of agency and experience. Participants rate the extent to which they perceive each of nine characters to be capable of six mental capacities on a 7-point scale from 0 (not at all) to 6 (very much). The characters include an adult woman, an adult man, a deceased human, a dog, God, a human infant, a robot, Superman, and a tree. Each character is introduced with a line-drawing and brief description (e.g., "Sharon Harvey, 38, works at an advertising agency in Chicago"; Figure 4). The mental capacities include capacities related to agency (exercising self-control, remembering, and formulating a plan) and capacities related to experience (feeling fear, pleasure, and hunger). For example, one question asks, "How capable of feeling fear do you think Sharon Harvey (adult woman) is?" (Figure 5). The mind survey is scored by separately averaging all the agency and experience capacities for each character. This creates an agency score and an experience score for each character. These scores are averaged across characters for each dimension, creating an overall agency score and an overall experience score. Previous research has shown the mind survey to have excellent internal consistency (α = .95; Gray, Knickman, et al., 2011). In the current sample, the mind survey showed acceptable to good internal consistency (agency: α = .74; experience: α = .75; overall: α = .84).

### 2.2.3. Response validity indicators

Based on recommendation in the literature and MTurk forums, I included multiple validity indicators to remove likely 'bots' (computer programs that automatically complete tasks), 'spammers' (people who do not care about the quality of their work), and other invalid responders (Aust et al., 2013; Chmielewski & Kucker, 2019; Kennedy et al., 2020; Mason & Suri, 2012; Wood et al., 2017; see also Dreyfuss, 2018; Stokel-Walker, 2018)[6].

I used two common validity checks (response consistency and recall; Abbey & Meloy, 2017). Additionally, I designed a novel check (monotonic increase) to address a possible weakness of the response consistency check.

#### 2.2.3.1. Memory check

After completing the mind survey, participants were presented with three multiple-choice questions designed to test their memory of the survey. The questions were: (1) *Which character was a dog?* (possible choices: *Charlie*, *Nicholas*, or *Kismet*); (2) *Which of the following was not included in the questionnaire?* (*A tree*, *a robot*, or *a car*); and (3) *Which of the following mental capacities was included in the questionnaire?* (*Fear, embarrassment,* or *communication*)[7].

The logic behind this check is that attentive participants should generally recall information from the mind survey accurately. I therefore assumed that participants who failed to accurately recall information were inattentive. Even attentive participants make occasional mistakes, however, so I set the exclusion threshold at two incorrect responses.

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[6] I also used MTurk's 'qualifications' system to block duplicate or suspicious IP addresses and to verify participant country location.
[7] The correct answers were, respectively: *Charlie*, *a car*, and *communication*.

Nineteen participants met or exceeded the threshold and were excluded from the sample. The average number of incorrect responses among excluded participants was 2.42 (*SD* = .51), and .17 (*SD* = .38) among included participants. This suggests that the current sample was generally attentive.

**2.2.3.2. Response consistency check**

During the mind survey, one item was randomly repeated for each capacity (6 repeated items total) to assess response consistency. (Repeated items were not included in the main analyses.) The logic behind this check is that attentive participants should generally respond similarly to identical repeated items. I therefore assumed that participants who responded inconsistently to repeated items were inattentive.

I quantified response consistency by calculating difference scores between ratings on the first and second presentations of each repeated item. I converted all difference scores to absolute values. Then, I averaged the difference scores across all six repeated items for each participant to produce an overall difference score from 0-6. I set the exclusion threshold at 2.5.

No participants exceeded this threshold. Only four participants approached the threshold, with overall difference scores ranging from 2-2.17. Across participants, the mean overall difference score was low at .32 (*SD* = .44). This finding provides converging evidence that the sample was generally attentive. Possibly, however, invalid respondents inadvertently beat my response consistency check by responding identically to all items. I designed the next validity check to address this blind spot.

**2.2.3.3. Monotonic increase check**

I screened the mind survey data to ensure that agency scores increased monotonically from the tree to the dog to the woman and man. The logic behind this check is that attentive participants should attribute more agency to an adult human than a dog, and more agency to a dog than a tree. This logic was based on common sense and previous research (Buck et al., 2017; H. M. Gray et al., 2007; K. Gray et al., 2008, 2011). I therefore assumed that participants who deviated from this pattern were inattentive.

I calculated the difference between agency scores for adult human (collapsing woman and man[8]) over dog, and dog over tree. Difference scores of zero indicated that human and dog, and dog and tree, were attributed equal agency. Negative difference scores indicated that the dog was attributed more agency than the human, and the tree more than the dog. I set the exclusion threshold at one difference score equal to or less than zero.

Eighty-nine participants met or exceeded this threshold. The average difference score among excluded participants was -.39 ($SD$ = .46). Notably, the current check uniquely excluded 72 participants (the other 17 were also excluded by the memory check). In other words, most of the participants excluded by the current check were not excluded by either of my other two checks. This suggests that some of these participants might have been attending to mind survey properly. But the fact that these participants did not attribute more agency to a human than a dog, or to a dog than a tree, indicates idiosyncrasies in their interpretation of the task. These idiosyncrasies may have influenced my overall results, making them difficult to interpret.

**2.2.4. Procedure**

Participants completed a captcha, followed by the DASS-S, STAI-S, and STAI-T. The stress measures were presented separately in randomized order. Then, participants completed the

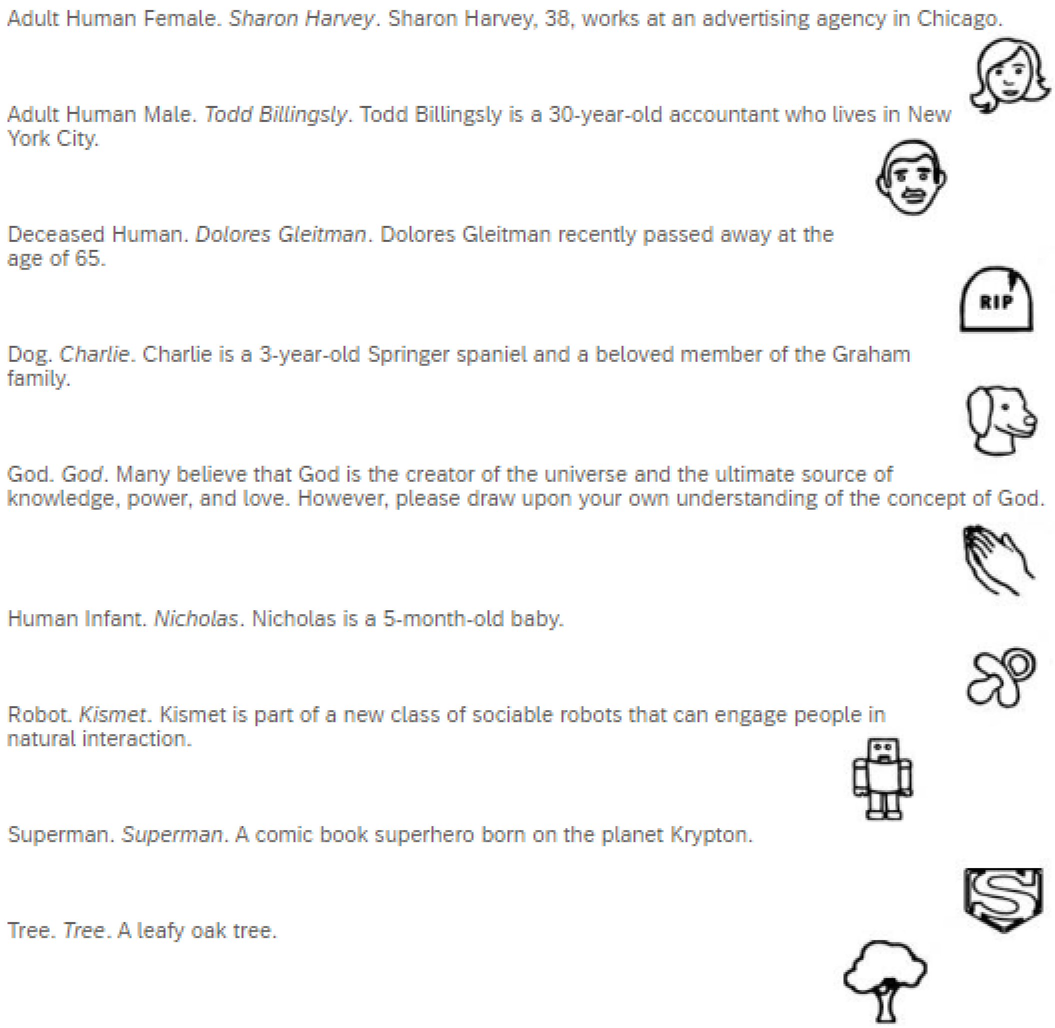
[8] There was a strong positive correlation between agency scores for the woman and man, $r = .91$, $p < .001$.

mind survey, followed by the recall questions. Finally, participants were debriefed and remunerated.

I consulted Kurt Gray (personal communication, 10 April 2019) about how to present the mind survey. First, participants were introduced to the characters (Figure 4). Then, the items were presented. Items were blocked by capacity (6 blocks total). Each block contained 9 items (1 item per character). The blocks were presented in randomized order, and items were presented one at a time in randomized order within each block (Figure 5).

**Figure 4**

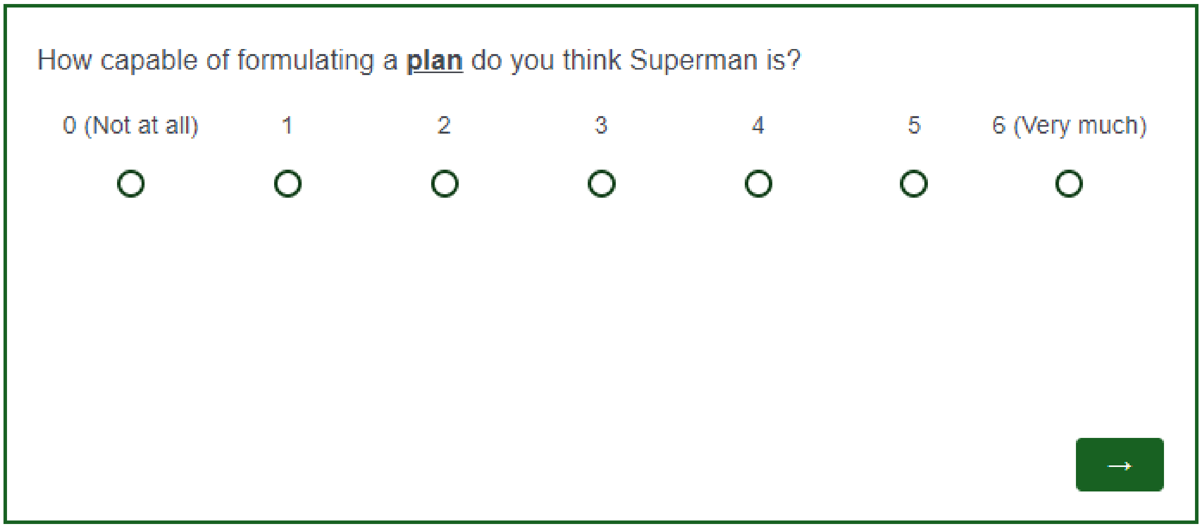
*Meet the mind survey characters*




*Note*. Screenshot from Study 1.

**Figure 5**

*A sample question from the mind survey*




*Note*. Screenshot from Study 1.

## 2.3. Results

### 2.3.1. Descriptive statistics

To characterize the current sample's level of self-reported stress, I calculated means and standard deviations for each stress measure (Table 1). I also calculated agency and experience scores for each character from the mind survey (Table 2).

**Table 1**

*Means (and Standard Deviations) on Stress Measures in Study 1*

| Stress measure | Possible range | *M* (*SD*) |
|---|---|---|
| DASS-S | 0-42 | 12.56 (5.00) |
| STAI-S | 0-80 | 38.27 (13.23) |
| STAI-T | 0-80 | 44.62 (13.54) |

**Table 2**

*Mean Character Scores (and Standard Deviations) on Agency and Experience in Study 1*

| Character | Agency | Experience |
|---|---|---|
| Woman | 5.37 (.76) | 5.59 (.77) |
| Man | 5.29 (.82) | 5.58 (.74) |
| Corpse | 0.21 (.65) | 2.02 (.49) |
| Dog | 2.70 (1.12) | 5.21 (.93) |
| God | 4.73 (2.08) | 2.19 (1.68) |
| Baby | 1.42 (.97) | 4.96 (1.03) |
| Robot | 3.23 (1.79) | 0.27 (.67) |
| Superman | 4.66 (2.04) | 3.67 (1.97) |
| Tree | .38 (.77) | .75 (1.97) |

**2.3.2. Pre-registered analyses**

To test my hypotheses that stress increases perceptions of agency and reduces perceptions of experience, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall agency and experience scores (mind survey). If my hypotheses are correct, then stress scores should correlate positively with overall agency scores and negatively with overall experience scores.

As predicted, DASS-S, STAI-S, and STAI-T scores all correlated positively with overall agency scores (Table 3). However, DASS-S and STAI-T scores also correlated positively with overall *experience* scores, opposite to my prediction for experience. STAI-S scores did not correlate with overall experience scores. These results indicate that participants with high self-reported stress tended to perceive both more agency and experience across mind survey characters.

I used one-tailed significance tests for the agency correlations, as planned, because they were in the same direction as my one-tailed hypothesis for agency. However, because the experience correlations were in the opposite direction of my one-tailed hypothesis, I used two-tailed significant tests for these correlations.

**Table 3**

*Correlations of Stress Measures with Overall Agency and Experience Scores in Study 1*

| Stress measure | Agency | Experience |
|---|---|---|
| DASS-S | $.16^{\dagger\dagger}$ (.008) | $.13^{*}$ (.050) |
| STAI-S | $.17^{\dagger\dagger}$ (.007) | .12 (.073) |
| STAI-T | $.17^{\dagger\dagger}$ (.006) | $.15^{*}$ (.023) |

$^{*}p < .05$, two-tailed. $^{\dagger}p < .05$, one-tailed. $^{\dagger\dagger}p < .01$, one-tailed.

Although all the reported correlations ($r$ = .12-.17) are small according to Cohen's (1988) conventions, the agency correlations are consistently stronger (.16-.17) than the experience correlations (.12-.15).

In sum, the above results are consistent with my hypothesis that stress increases perceptions of agency but not with my hypothesis that stress reduces perceptions of experience. In fact, the results for experience were in the opposite direction to my prediction.

### 2.3.3. Exploratory analyses

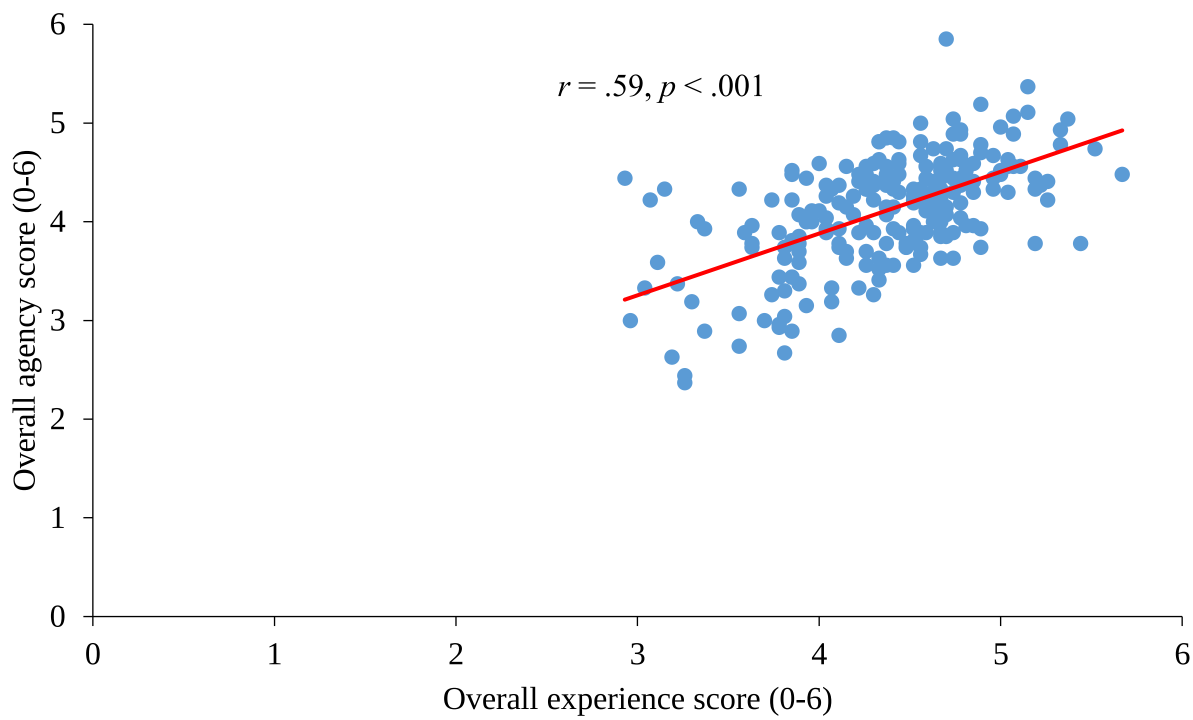
#### 2.3.3.1. Correlating overall agency and experience scores

So far, I have found that scores of self-reported stress correlate positively with both overall agency and experience scores. Because the correlations for agency and experience are in the same direction, it is possible that the mind survey measures perceptions of one underlying construct rather than two dimensions. In such a case, overall agency and experience scores should be correlated.

Indeed, there was a strong positive correlation between overall agency and experience scores, $r = .59$, $p < .001$ (Figure 6). This result indicates that perceptions of agency increased across mind survey characters as perceptions of experience increased (and vice-versa).

**Figure 6**

*Correlation Between Overall Agency and Experience Scores in Study 1*




*Note*. Each dot represents an individual participant. The red line is a best-fit trend-line. The correlation between overall agency and experience scores was statistically significant and strongly positive.

**2.3.3.2. Correlating self-reported stress scores with overall mind scores**

Because overall agency and experience scores were strongly correlated, I averaged ratings of all the mind survey items (across both dimensions) across all characters to produce an overall score of perceived mind (Buck et al., 2017; Gray et al., 2011). As I did for overall agency and experience scores, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall mind scores. This increased the statistical power of my tests. Because the correlations for agency and experience were positive (Section 4.1), I expected scores of self-reported stress to correlate positively with overall mind scores.

Because these were exploratory tests without pre-planned hypotheses, I applied Bonferroni correction for multiple comparisons (Armstrong, 2014; Mcdonald, 2009; Streiner & Norman, 2011). I had two measures of state stress (DASS-S and STAI-S), so I used an adjusted alpha of .05/2 = .025 for correlations with each of these measures. I only had one measure of trait stress (STAI-T), so no correction was required.

As expected, DASS-S, STAI-S, and STAI-T scores all correlated positively with overall mind scores (Table 4). This result indicates that participants with high self-reported stress tended to perceive more mind across mind survey characters.

**Table 4**

*Correlations of Stress Measures with Overall Mind Scores in Study 1*

| Stress measure | Mind |
|---|---|
| DASS-S | $.165^{\dagger}$ (.014) |
| STAI-S | $.162^{\dagger}$ (.016) |
| STAI-T | $.181^{**}$ (.007) |

$^{\dagger}p < .025$. $^{*}p < .05$, two-tailed. $^{**}p < .01$, two-tailed.

#### 2.3.3.3. Grouping characters by agency, experience, and mind

So far, I have found that scores of self-reported stress correlate positively with overall agency, experience, and mind scores. It is unclear, however, whether stress correlates with these measures of mind perception for each individual character, or whether the overall correlations are driven by a subset of the characters.

One approach to testing this possibility is to correlate scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with agency, experience, and mind scores for each character. However, this leads to a large number of correlations (81 total) and extremely conservative Bonferroni-corrected alphas (state stress: $\alpha = .003$; trait stress: $\alpha = .006$).

Here, I report a different approach. I used principal components analysis (PCA), a data reduction technique, to group the mind survey characters according to their scores for agency, experience, and mind, respectively (Curtin & Schulz, 1998; R. A. Johnson & Wichern, 2007; Jolliffe & Cadima, 2016; Ringnér, 2008). This allowed me to run fewer correlations based on these groups.

Additionally, I dropped the STAI-S as redundant with the DASS-S so that I did not have to correct for multiple measures of state stress. I chose to drop the STAI-S rather than the DASS-S because many of the STAI-S items are redundant with the STAI-T.

***2.3.3.3.1. Grouping characters by agency scores***

First, I grouped mind survey characters by their agency scores using PCA with varimax rotation. A rule of thumb in PCA is to use .32 as a cut-off for significant item loadings (Stevens, 2012; Tabachnick et al., 2019; Yong & Pearce, 2013). However, because my sample size of 300 was relatively small for PCA, I used a more conservative cut-off of .42. I dropped items that cross-loaded positively on multiple components at .42 or higher (Costello & Osborne, 2005).

The rotated solution accounted for all nine characters, explained 62% of score variance, and yielded three components (Table 5). Component one (eigenvalue = 1.88; variance = 24%) included three characters: woman, man, and dog. Component two (eigenvalue = 1.68; variance =

21%) included four characters: baby, tree, dog, and corpse. Finally, component three (eigenvalue = 1.31; variance = 17%) included three characters: Superman, God, and robot. Because dog cross-loaded on components one and two, I dropped it from analysis.

I labelled component one ‘adult human’ because it comprised the woman and man. In previous research (e.g., Gray et al., 2007; Gray et al., 2008, 2011), adult humans are typically perceived as high in both agency and experience. Additionally, I labelled component two ‘non-agentic’ because it comprised characters typically perceived as low in agency (baby, tree, and corpse). Finally, I labelled component three ‘agentic’ because it comprised characters typically perceived as high in agency (Superman, God, and robot).

**Table 5**

*Component Loadings of Characters for Agency in Study 1*

| Character | Adult human | Non-agentic | Agentic |
|---|---|---|---|
| Woman | **.95** | -.07 | -.11 |
| Man | **.95** | -.06 | -.08 |
| Baby | .10 | **.77** | -.06 |
| Tree | -.15 | **.72** | .17 |
| Dog [a] | **.51** | **.61** | .15 |
| Corpse | -.11 | **.60** | -.12 |
| Superman | .06 | .03 | **.76** |
| God | -.09 | -.06 | **.69** |
| Robot | -.08 | .03 | **.64** |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

[a] Dog was dropped due to cross-loading.

In sum, the above results indicate that, in terms of perceived agency, participants tended to group the mind survey characters into adult humans, agentic entities, and non-agentic entities.

***2.3.3.3.2. Correlating stress with group agency scores***

To investigate the relationship between stress and perceptions of agency in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with agency scores for each group (adult human, agentic, and non-agentic). I calculated group agency scores by averaging the agency scores across the characters within each group. Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. I had three groups, so I used an adjusted alpha of .05/3 = .017 for correlations with each group.

Both DASS-S and STAI-T scores correlated positively with the agency score for the agentic group (Table 6). Neither DASS-S nor STAI-T scores correlated with the agency score for the adult human or the non-agentic group. These results indicate that participants with high self-reported stress tended to perceive more agency in agentic characters, but not in non-agentic characters. Interestingly, participants did not perceive more agency in adult humans (high in both agency and experience). This could be due to a ceiling effect, but this seems unlikely because the correlations for adult humans are numerically negative.

**Table 6**

*Correlations of Stress Measures with Agency Groups in Study 1*

| Stress measure | Adult human | Non-agentic | Agentic |
|---|---|---|---|
| DASS-S | -.101 (.134) | .117 (.082) | .165$^{*}$ (.014) |
| STAI-T | -.062 (.357) | .070 (.305) | .188$^{*}$ (.005) |

$^{*}p < .017$, two-tailed.

In sum, the above results indicate that the correlation between scores of self-reported stress and overall agency scores was driven by increased perceptions of agency specifically in agentic characters.

#### *2.3.3.3.3. Grouping characters by experience scores*

Next, I grouped mind survey characters by their experience scores using PCA (varimax rotation). The rotated solution accounted for all nine characters, explained 89% of score variance, and yielded two components (Table 7). Component one (eigenvalue = 2.92; variance = 36%) included five characters: man, woman, dog, baby, and robot. Component two (eigenvalue = 1.34; variance = 53%) included five characters: God, tree, Superman, and corpse. Notably, robot cross-loaded *negatively* on component one, suggesting that it was an anti-member of this group.

I labelled component one ‘experiential’ because it comprised characters typically perceived as high in experience (adult humans, dogs, babies; Gray et al., 2007; Gray et al., 2008, 2011). Additionally, I labelled component two ‘non-experiential’ because it comprised characters typically perceived as low in experience (God, tree, robot, Superman, and corpse). This group is similar to the agentic group identified for agency (Table 5).

**Table 7**

*Component Loadings of Characters for Experience in Study 1*

| Character | Experiential | Non-experiential |
|---|---|---|
| Man | **.91** | -.05 |
| Woman | **.89** | -.14 |
| Dog | **.82** | .17 |
| Baby | **.74** | .16 |
| God | -.02 | **.61** |
| Tree | -.10 | **.58** |
| Robot | **- .48** | **.55** |
| Superman | .32 | **.52** |
| Corpse | .27 | **.42** |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

In sum, the above results indicate that, in terms of perceived experience, participants tended to group the mind survey characters into experiential versus non-experiential entities.

#### *2.3.3.3.4. Correlating stress with group experience scores*

To investigate the relationship between stress and perceptions of experience in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with experience scores for each group (experiential and non-experiential). I calculated group experience scores as I did for agency. Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. I had two groups, so I used an adjusted alpha of .05/2 = .025 for correlations with each group.

Both DASS-S and STAI-T scores correlated positively with the experience score for the non-experiential group. Neither DASS-S nor STAI-T scores correlated with the experience score for the experiential group (Table 8). This could be due to a ceiling effect. These results indicate that participants with high self-reported stress tended to perceive more experience in non-experiential characters, but not in experiential characters.

**Table 8**

*Correlations of Stress Measures with Experience Groups in Study 1*

| Stress measure | Experiential | Non-experiential |
|---|---|---|
| DASS-S | -.028 (.679) | .206$^{**}$ (.002) |
| STAI-T | .068 (.316) | .153$^{*}$ (.023) |

$^{*}p < .025$, two-tailed. $^{**}p < .005$, two-tailed.

In sum, results indicate that the correlation between scores of self-reported stress and overall experience scores was driven by increased perceptions of experience specifically in non-experiential characters. It is interesting that this finding is not complementary to my finding for agency (increased perceptions of agency in agentic characters; Section 2.3.3.3.2). Taken together, my findings indicate that participants with high self-reported stress tended to perceive both more agency and experience in agentic characters (high agency, low experience).

***2.3.3.3.5. Grouping characters by mind scores***

Finally, I used PCA (varimax rotation) to group characters according to their mind scores. The rotated solution accounted for all nine characters, explained 61% of score variance, and yielded three components (Table 9). Component one (eigenvalue = 2.28; variance = 28%) included four characters: man, woman, dog, and baby. Factor two (eigenvalue = 1.54; variance = 17%) included four characters: dog, tree, corpse, and baby. Finally, the third factor (eigenvalue = 1.07; variance = 16%) included three characters: Superman, God, and robot. Because baby and dog cross-loaded on components one and two, I dropped both characters from analysis.

I labelled component one ‘adult human’ because it comprised the woman and man. In previous research (e.g., Gray et al., 2007; Gray et al., 2008, 2011), adult humans are typically perceived as high in both agency and experience. Additionally, I labelled component two ‘mindless’ because it comprised characters typically perceived as low in both agency and experience (tree and corpse). Finally, I labelled component three ‘agentic’ because it comprised characters typically perceived as high in agency and low in experience (Superman, God, and robot). These groups are similar to those identified for agency (Table 5).

**Table 9**

*Component Loadings of Characters for Mind in Study 1*

| Character | Adult human | Mindless | Agentic |
|---|---|---|---|
| Man | **.94** | -.08 | -.07 |
| Woman | **.94** | -.11 | -.08 |
| Dog [a] | **.67** | **.46** | .15 |
| Tree | -.17 | **.72** | .16 |
| Corpse | .02 | **.62** | -.06 |
| Baby [b] | **.46** | **.59** | .07 |
| Superman | .20 | -.01 | **.76** |
| God | -.04 | -.03 | **.73** |
| Robot | -.21 | .21 | **.54** |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

[a] Dog was dropped due to cross-loading. [b] Baby was dropped due to cross-loading.

In sum, results indicate that, in terms of perceived mind, participants tended to group the mind survey characters into adult humans, mindless entities, and agentic entities.

***2.3.3.3.6. Correlating stress with group mind scores***

To investigate the relationship between stress and perceptions of mind in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with mind scores for each group (adult human, mindless, and agentic). I calculated group mind scores as I did for agency and experience. Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. I had three groups, so I used an adjusted alpha of .05/3 = .017 for correlations with each group.

Both DASS-S and STAI-T scores correlated positively with the mind score for the agentic group (Table 10). DASS-S scores also correlated positively with the mind score for the mindless group. STAI-T scores did not correlate with the mind score for the mindless group. Neither DASS-S nor STAI-T scores correlated with the mind score for the adult human group.

These results indicate that participants with high self-reported stress tended to perceive more mind in agentic characters and mindless characters. However, the correlations for the agentic group were more consistent than for the mindless group.

**Table 10**

*Correlations of Stress Measures with Mind Group Scores in Study 1*

| Stress measure | Adult human | Mindless | Agentic |
|---|---|---|---|
| DASS-S | -.068 (.314) | .178* (.008) | .194* (.004) |
| STAI-T | .012 (.860) | .080 (.238) | .196* (.004) |

* $p < .017$, two-tailed. ** $p < .01$, two-tailed.

In sum, results indicate that the correlation between scores of self-reported stress and overall mind scores was driven by increased perceptions of mind specifically in agentic and mindless entities. Taken together, my findings indicate that participants with high self-reported stress tended to perceive more agency, experience, and mind in agentic entities.

## 2.4. Discussion

I hypothesized that stress increases perceptions of agency and reduces perceptions of experience. If my hypotheses are correct, then self-reported stress should correlate positively with perceptions of agency and negatively with perceptions of experience. The findings of the current study are consistent with my first prediction, but not with my second predictions. Self-reported stress correlated with increased perceptions of both agency and experience across mind survey characters. The correlations were small for both dimensions, but consistently stronger for agency than experience.

Exploratory analyses revealed that stress correlated with increased mind perception particularly in agentic entities (e.g., Superman, God, and robots) and mindless entities (e.g., trees and dead people). These findings are consistent with Buck et al. (2017), who found that paranoia correlated with increased mind perception in dead people, trees, robots, and Superman.

Because the correlations for agency and experience were in the same direction, it is possible that the mind survey measured one underlying dimension of perceived mind. However, this is unlikely. If participants did not distinguish between agency and experience, then stress should have correlated similarly with both dimensions. Instead, I found that stress correlated more strongly with perceptions of agency than experience. This suggests that participants distinguished between the dimensions at least to some extent.

Although the correlations for agency and experience were in the same direction, it is still possible that stress may have influenced perceptions of agency and experience in opposite directions as hypothesized. Agency and experience were highly correlated, indicating that perceptions of agency and experience tended to increase in parallel. Because stress correlated more strongly with agency than experience, this suggests that stress may have influenced perceptions of agency more strongly than experience. Thus, it is possible that the stronger positive trend for agency overwhelmed the predicted negative trend for experience so that it became positive too. This could explain my pattern of results.

Initially, this explanation may seem to conflict with Gray et al.'s (2007) finding that agency and experience are independent (i.e., orthogonal) in factor analysis. But this orthogonality only indicates that each dimension can account for an independent portion of the variance in responding on the mind survey (Rummel, 1970). It does not mean that the dimensions are psychologically independent. In fact, orthogonal factors are often correlated, as in my case (Costello & Osborne, 2005; Yong & Pearce, 2013).

The current allowed me to search for associations between stress and mind perception in a large sample. In Study 2, I tested my causal hypotheses directly by experimentally inducing stress. Additionally, Study 2 gave me an opportunity to check whether the current study's unexpected findings would replicate.

# 3. Study 2

## 3.1. Introduction

Study 2 was a lab experiment with a between-subjects manipulation of stress, followed by the mind survey. Based on my original hypotheses, I predicted that stressed participants should produce higher agency scores and lower experience scores on the mind survey compared with controls. Alternatively, if the current study produces similar results to Study 1, then stressed participants should produce higher scores of both agency and experience.

I manipulated stress using an adapted version of the Trier Social Stress Test (TSST; Kirschbaum et al., 1992, 1993). The TSST is the most common and gold-standard method for laboratory stress induction (A. P. Allen et al., 2014, 2017; Domes & Frings, 2020; Kudielka et al., 2007). In the classic TSST protocol, participants prepare a speech, and then perform the speech as well as a mental arithmetic task in front of a panel of judges. The mental arithmetic task involves serial subtraction in large increments (e.g., counting backwards from 2023 in steps of 17).

The TSST induces robust and reliable subjective and physiological stress responses, including increases in cortisol levels, heart rate, electrodermal activity, and self-reported stress (Allen et al., 2014, 2017; Kirschbaum et al., 1993; Kudielka et al., 2007). Meta-analysis indicates that the TSST is effective because it combines elements of uncontrollability (a context of forced failure where participants cannot succeed or avoid negative consequences despite best efforts) and social-evaluative threat (real or potential negative judgement of an important aspect of the self by others; Dickerson & Kemeny, 2004).

I used a modified version of the TSST's serial subtraction (counting) task. I chose this task because it is quicker and easier to administer than the full TSST, but still involves both uncontrollability and social evaluation (via scripted feedback and monitoring from an 'evaluator'). I inferred stress response to the task from physiological responses (heart rate and skin conductance level) and subjective mood reports (stress, anger, worry, sadness, happiness). I measured the stress response as the change in physiological activity and subjective mood from an initial rest period to the counting task. Previous research at Te Herenga Waka has validated that the counting task effectively induces a stress response (Moody, 2016; Robinson et al., 2019).

It was important to ensure that participants completed the mind survey before the stress response recovered. Numerous studies indicate the TSST raises heart rate throughout stress exposure, but heart rate returns to pre-stress levels within about five minutes (Buske-Kirschbaum et al., 2002; Childs et al., 2006; Jezova et al., 2004). Similarly, increases in skin conductance peak immediately post-stress (Het et al., 2009; Jezova et al., 2004; Rohrmann et al., 1999). Pilot data indicated that, on average, participants ($n$ = 12) take 4.82 minutes ($SD$ = 1.27) to complete the mind survey, within the expected duration of the stress response[9].

## 3.2. Method

### 3.2.1. Participants

Because this is the first study to test the effect of a stress manipulation on mind perception, I had no prior effect size to use in estimating the required sample size. A power analysis using G*Power (Faul et al., 2007) indicated 51 participants per condition to have a 0.8 probability of detecting a moderate effect ($d$ = 0.5) at an alpha of .05. I therefore aimed for sample size of 102.

[9] Salivary cortisol levels usually peak around 10-20 minutes after cessation of stress exposure (Het et al., 2009; Petrowski et al., 2010; Rohleder et al., 2001), but I did not measure cortisol in either of my lab experiments.

One-hundred and six participants completed the study. Three participants in the stress condition exercised their right to withdraw from the experiment. I excluded one other participant for failing to follow experiment instructions (completing the mind survey before the stress manipulation). The remaining 102 participants (78 women, 23 men, 1 non-binary; mean age = 20.74, *SD* = 3.73, range = 18-38 years old) included 83 undergraduate students from Te Herenga Waka (67 women, 16 men; mean age = 19.7, *SD* = 2.41) and 19 members of the broader Wellington community (11 women, 7 men, 1 non-binary; mean age = 25.26, *SD* = 4.99). All participants had normal or corrected-to-normal vision, spoke English fluently, and reported that they were not currently receiving treatment for anxiety or depression.

Participants were randomly assigned to either a stress condition ($n$ = 52; $M_{age}$ = 21.13, $SD_{age}$ = 4.229) or control condition ($n$ = 50; $M_{age}$ = 20.32, $SD_{age}$ = 3.12). The conditions did not differ in terms of gender distribution, $\chi^2$ = 1.005, $p$ = .605, or age, $t$ = 1.104, $p$ = .272. All participants provided written, informed consent to participate in the study. Students received course credit for participation. Community participants received a movie or supermarket voucher worth $15 NZD. The School of Psychology Human Ethics Committee of Te Herenga Waka approved this study.

### 3.2.2. Self-report measures

Participants completed the DASS-S, STAI-S, STAI-T, and mind survey, as in Study 1. Because I was less concerned with data-quality in the current lab sample, I did not include any response validity indicators.

The DASS-S showed acceptable internal consistency in the current sample (α = .79). The STAI showed good to excellent internal consistency (STAI-S: α = .89; STAI-T: α = .92; STAI:

.94). The mind survey showed acceptable to good internal consistency (agency: $\alpha = .72$; experience: $\alpha = .75$; overall: $\alpha = .84$).

I adapted each of the measures to be presented through Qualtrics. Participants completed the measures on a Dell Precision 3630 Tower Workstation.

**3.2.3. Counting task procedure**

Participants in the stress group completed the TSST-adapted counting task (Moody, 2016). I (experimenter) told participants they would complete a mental arithmetic task to assess their working memory ability and verbal intelligence. I also told them their performance would be video-recorded for future assessment (all participants gave consent to be recorded) and they would be monitored during the task by an evaluator. I described the evaluator as a psychologist trained to assess verbal and non-verbal behaviour (to increase the social-evaluative aspect of the task).

I pretended to set up a camera and then left the room. The evaluator (a mature, male research assistant) entered the room. The evaluator maintained a neutral, professional demeanour throughout the task, and spoke from scripted lines (Appendix G). He told the participant to count backwards from 2023 in steps of 17 aloud, as quickly and accurately as possible. As they counted, he timed them using a stopwatch, made notes on a clipboard, and enforced a restart after every error. He also pressed participants to count faster, particularly those skilled at the task, to maximise feelings of uncontrollability. The evaluator ended the task after five minutes.

The control group completed a similar but easier task (Moody, 2016). Participants were left alone (no evaluator or camera) to count forwards from zero in steps of five, aloud. After five minutes, I re-entered the room to stop the task. This task was designed to match the TSST-adapted counting task in movement and speech but to be low in stress (controllable and not socially-evaluated).

### 3.2.4. Manipulation checks

#### 3.2.4.1. Physiological responses

To measure heart rate, I recorded electrocardiogram (ECG) using three disposable adhesive Ag-AgCl foam ECG electrodes (Kendall Meditrace, Tyco Healthcare), placed according to a Lead II system (Figure 7). ECG was amplified using an ML408 Dual Bio Amp/Stimulator (ADInstruments, Australia).

I recorded skin conductance levels, a measure of sympathetic nervous system activation, using MLT116F GSR electrodes attached to the medial phalanges of the index and ring fingers of the right hand. Electrodermal activity was amplified using an ML116 GSR Amp (ADInstruments, Australia).

##### *3.2.4.1.1. Physiological data recording and reduction*

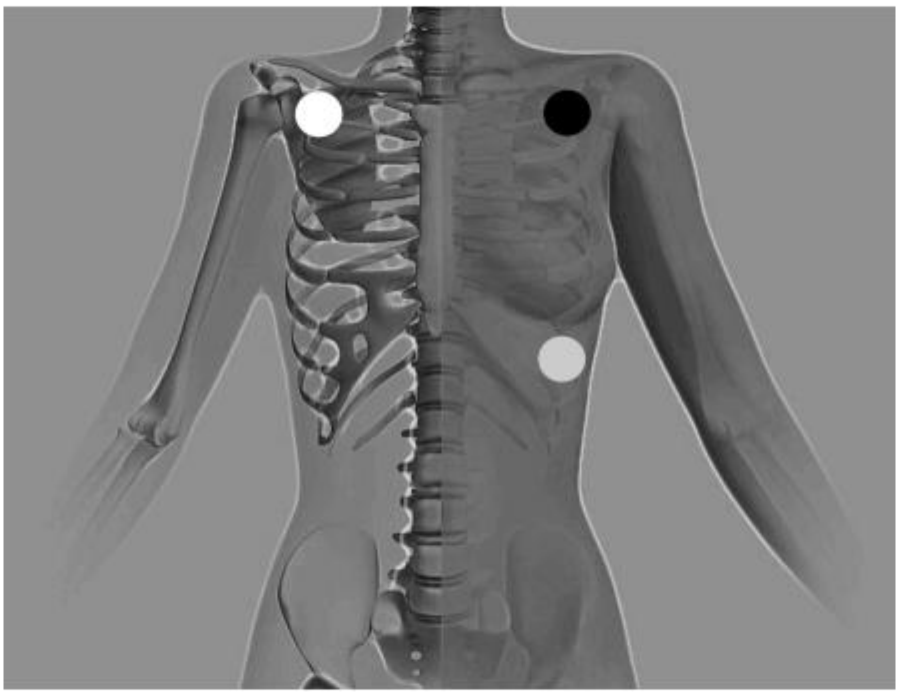
The amplified analogue signals were converted to digital using a PowerLab 16/30 amplifier, sampled at a rate of 1 kHz. Samples were recorded and processed by LabChart Pro 8.0 software (ADInstruments, Australia) on a Dell Optiplex 9020 computer, running Windows 7 Enterprise operating system.

I filtered the ECG data offline (band-pass filter: 840 Hz). I identified artefacts by visual inspection and excluded data points within a time-window spanning two R-wave spikes either side of the artefact from both heart rate and skin conductance data. Heart rate was then calculated using the inter-beat interval (time between R-wave spikes), converted to beats per minute, and averaged across the rest period and counting period for each participant.

I averaged skin conductance (recorded in micro-Siemens) across the rest period and counting period for each participant, a procedure used commonly in electrodermal research (e.g., Wagner & Abaied, 2016). Because electrodermal data showed no skew or kurtosis, I used raw averages in analyses.

**Figure 7**

*Electrocardiogram (ECG) electrode placement in Study 2*



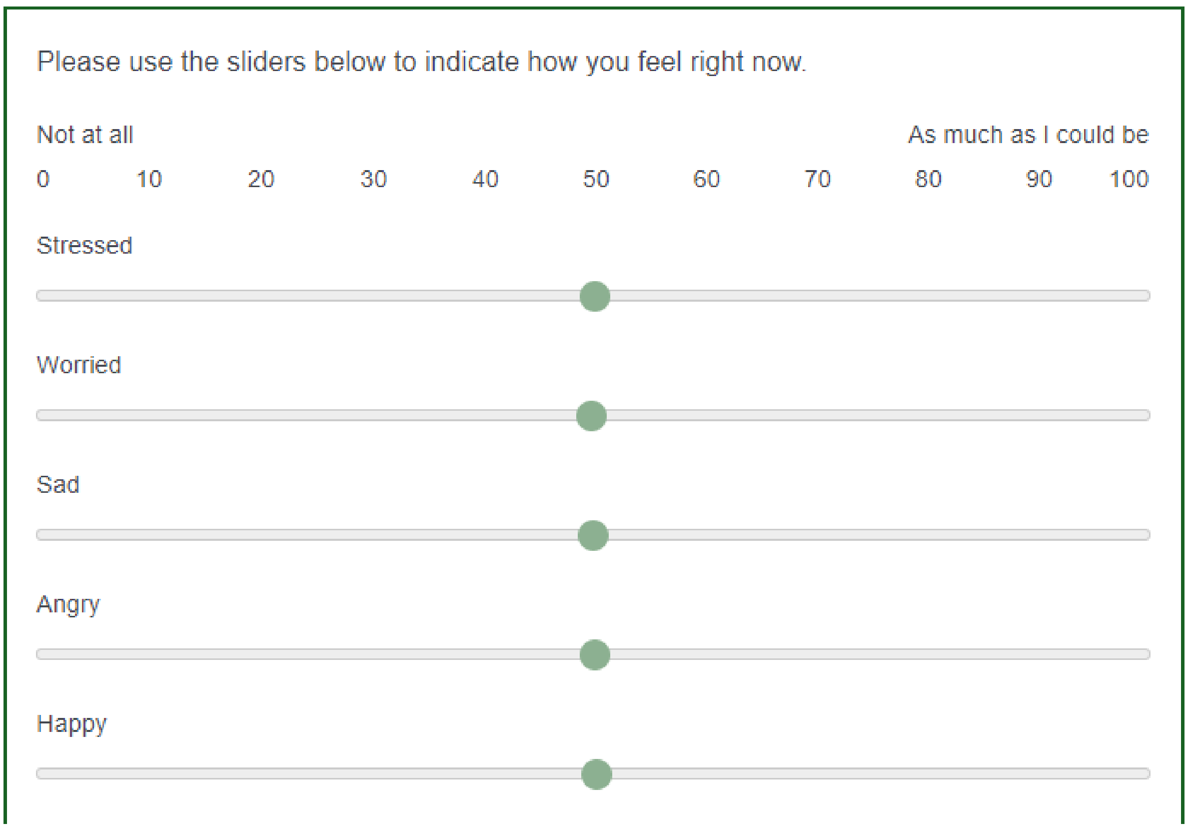
*Note.* White: negative electrode; grey: positive electrode; black: ground electrode.

**3.2.4.2. Self-report ratings**

I measured changes in subjective mood over the session using visual analogue scales. I measured five aspects of current mood (stress, anger, worry, sadness, happiness) on 100-point sliders from 0 (not at all) to 100 (as much as I could be; Figure 8). The sliders were initially centred between the two endpoints and the moods were rated in randomized order. This simple scale discriminates stress levels similarly as well as a questionnaire and has good construct validity (Lesage et al., 2012).

**Figure 8**

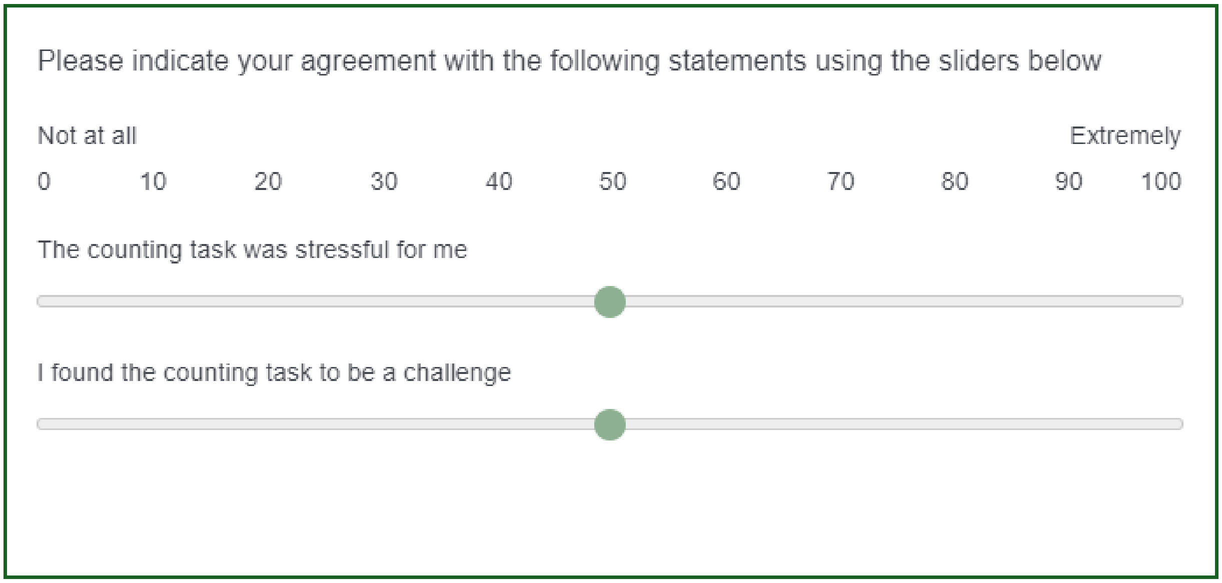
*Mood ratings in Study 2*




I also collected two ratings of task experience (the counting task was stressful for me; I found the counting task to be a challenge) on 100-point sliders from 0 (not at all) to 100 (extremely so), presented in fixed order (Figure 9). These rating statements have been used in previous research to assess the TSST's efficacy (e.g., Kirschbaum et al., 1999).

**Figure 9**

*Task ratings in Study 2*




### 3.2.5. Mood elevation task

At the end of the experimental session, I presented participants with one of two YouTube videos depicting nature scenes to restore mood to baseline levels. One video depicted a forest and the other depicted a beach. Both videos were five minutes long and presented without audio. I alternated the two videos between participants. Previous research has found that nature scenes are effective at augmenting mood after negative mood inductions (Arbuthnott et al., 2015).

Participants were presented with a series of items assessing how the videos made them feel. Specifically, participants rated the videos on spirituality, familiarity, attractiveness, and willingness to visit. Participants also rated the videos on valence and arousal. These rating data were collected for a separate study, so I will not discuss them in this thesis.

### 3.2.6. Procedure

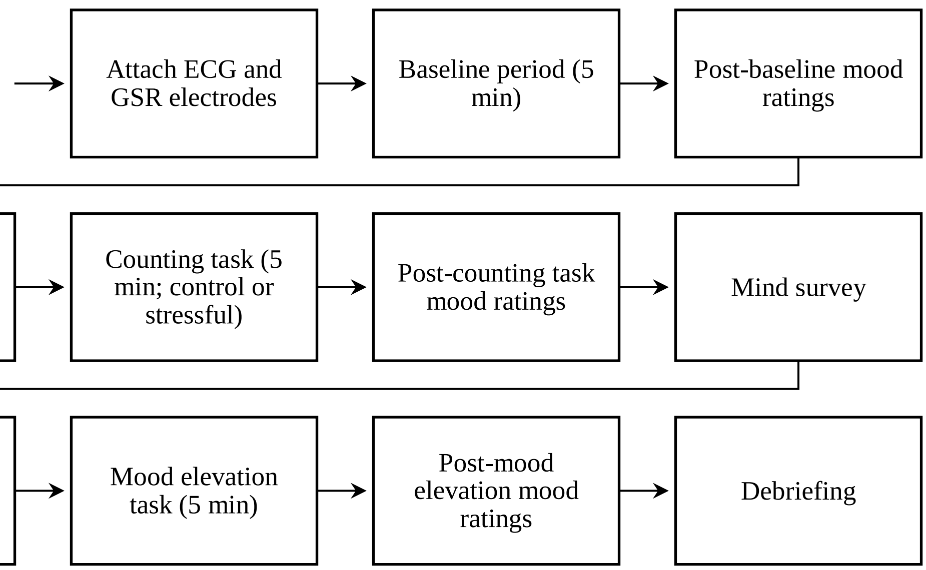
I ran participants individually in sessions lasting about one hour each (Figure 10). First, I attached the GSR electrodes to the participant's fingers. Then, I instructed the participant on how to attach the ECG electrodes. For privacy reasons, I was not permitted to attach the ECG electrodes to the participant's torso. Participants attached the electrodes alone in the room. I verified the correct placement of the electrodes by asking the participant to point with a finger over the top of their clothes to indicate the location of each electrodes.

Participants then rested seated alone in the room for five minutes while baseline physiological measurements were recorded. After the rest period, participants completed a set of mood ratings to measure baseline mood. They also completed the DASS-S, STAI-S, and STAI-T to measure pre-existing stress.

Procedure then diverged for the two groups. The stress group completed the TSST-adapted counting task and the control group completed the low-stress counting task. All participants then completed a set of mood ratings as a manipulation check. They also completed the mind survey and task ratings. Finally, participants completed the mood elevation task, followed by a set of mood ratings to check the task's efficacy.

**Figure 10**

*Study 2 Procedure Timeline*




## 3.3. Results

### 3.3.1. Descriptive statistics

To characterize the current sample's level of self-reported stress, I calculated means and standard deviations for each stress measure (Table 11). I also calculated agency and experience scores for each mind survey character (Table 12).

**Table 11**

*Means (and Standard Deviations) on Stress Measures in Study 2*

| Stress measure | Possible range | *M* (*SD*) |
|---|---|---|
| DASS-S | 0-42 | 13.36 (3.81) |
| STAI-S | 0-80 | 37.49 (3.81) |
| STAI-T | 0-80 | 45.12 (10.36) |

**Table 12**

*Mean Character Scores (and Standard Deviations) on Agency and Experience in Study 2*

| Character | Agency | Experience |
|---|---|---|
| Woman | 5.06 (.85) | 5.49 (.82) |
| Man | 5.00 (.89) | 5.43 (.89) |
| Corpse | .48 (1.07) | 2.19 (.81) |
| Dog | 2.89 (1.13) | 5.33 (.79) |
| God | 3.72 (2.29) | 2.07 (1.68) |
| Baby | 1.69 (.92) | 5.07 (1.01) |
| Robot | 3.55 (1.78) | .57 (.89) |
| Superman | 4.50 (1.69) | 4.18 (1.72) |
| Tree | .83 (1.16) | 1.24 (1.19) |

### 3.3.2. Manipulation checks

To check if my stress manipulation was successful, I compared changes in heart rate (HR), skin conductance level (SCL), and stress ratings over time (resting, counting, and mood elevation) between conditions (control and stress). I expected participants in the stress condition (the stress group) to show greater increases in HR, SCL, and stress ratings from resting to counting compared with participants in the control condition (control group). (See Table 13 for group means at resting and counting[10].)

[10] I did not record HR or SCL during mood elevation

**Table 13**

*Group Means (with Standard Deviations) for Physiological Measures Over Time in Study 2*

| | Control | | Stress | |
|---|---|---|---|---|
| Measure | Resting | Counting | Resting | Counting |
| HR [a] | 83.26 (11.47) | 88.45 (10.84) | 83.39 (11.19) | 98.04 (15.79) |
| SCL [b] | 2.77 (2.63) | 14.74 (7.49) | 2.67 (3.93) | 18.12 (8.67) |

[a] In beats per minute (bpm). [b] In micro-Siemens (µS).

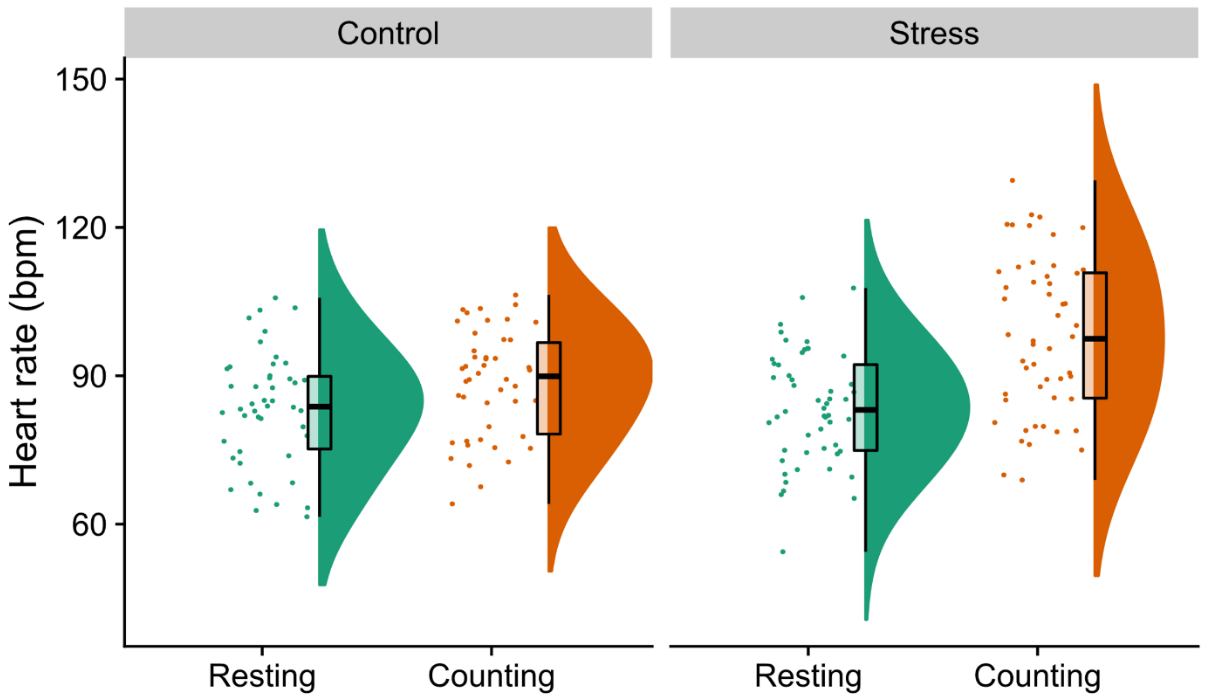
#### 3.3.2.1. Physiological response

I compared changes in HR from resting to counting between groups using a 2 (time: resting and counting) x 2 (group: control and stress) mixed-model analysis of variance (ANOVA). I found main effects of both time, $F(1, 96) = 85.034$, $p < .001$, $\eta_p^2 = .470$, and group, $F(1, 96) = 4.446$, $p = .038$, $\eta_p^2 = .044$. However, these findings were qualified by a significant interaction between time and group, $F(1, 96) = 4.446$, $p = .038$, $\eta_p^2 = .168$.

I unpacked the time x group interaction using a pair of independent t tests. First, I compared HR between groups at rest. Groups did not differ in HR during resting, $t(96) = .057$, $p = .955$, $d = 0.01$. Then, compared the difference in HR from resting to counting between groups. The stress group showed a greater increase in HR than the control group, $t(96) = 4.399$, $p < .001$, $d = 0.91$ (Figure 11).

**Figure 11**

*Mean Heart Rate (HR) as a Function of Time (Resting vs Counting) and Group (Control vs Stress) in Study 2*



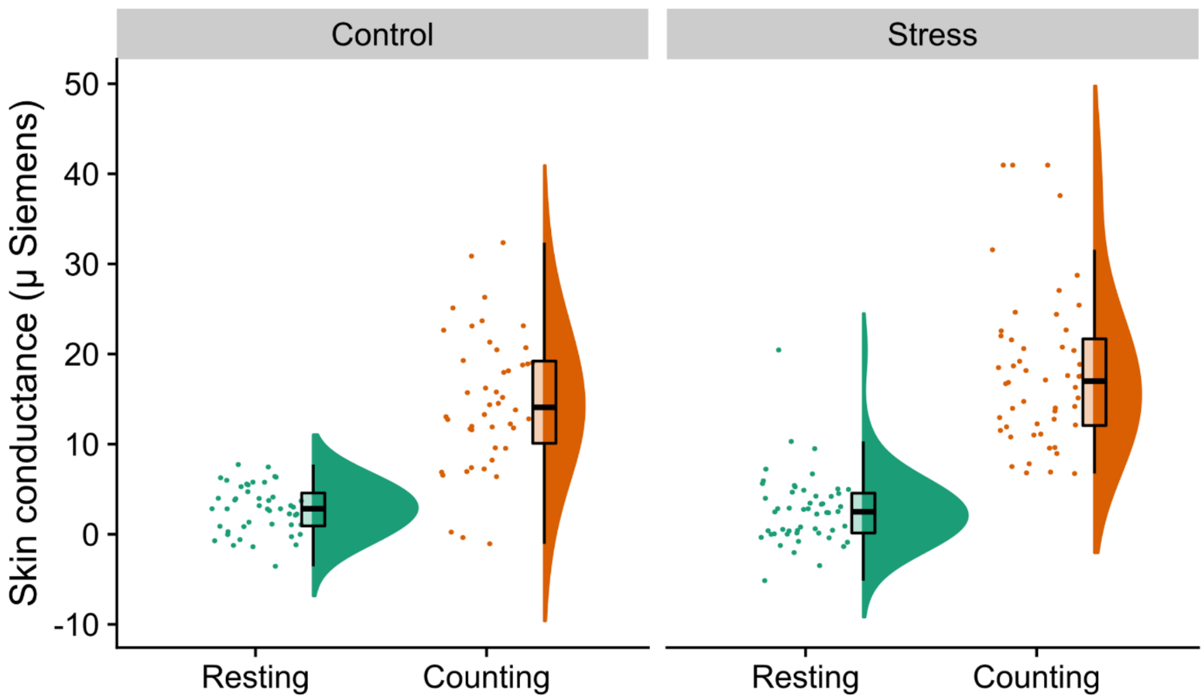

*Note*. This raincloud plot combines a split-half violin, raw jittered data-points, and a boxplot (Allen et al., 2019).

As I did for HR, I compared changes in SCL from resting to counting between groups using a 2 (time) x 2 (group) mixed-model ANOVA. I found a main effect of time, $F(1, 96) = 362.20$, $p < .001$ $\eta_p^2 = .79$, but not of group, $F(1, 96) = 2.49$, $p = .118$ $\eta_p^2 = .03$. However, these findings were qualified by a significant interaction between time and group, $F(1, 96) = 148.117$, $p = .017$, $\eta_p^2 = .06$.

I unpacked this time x group interaction using the same pair of t tests as I did for HR. SCL did not differ between groups during resting, $t(96) = .158$, $p = .875$, $d = 0.03$. The stress group showed a greater increase in SCL from resting to counting than the control group, $t(96) = 2.418$, $p = .017$, $d = 0.49$ (Figure 12).

**Figure 12**

*Mean Skin Conductance Level (SCL) as a Function of Time (Resting vs Counting) and Group (Control vs Stress) in Study 2*




#### 3.3.2.1. Subjective response

I compared changes in mood ratings (stress, anger, worry, sadness, happiness) over time between groups using a 3 (time: resting, counting, mood elevation) x 2 (group: control vs stress) mixed-model multivariate analysis of variance (MANOVA). I found main effects of both time, $F(10, 90) = 14.42$, $p < .001$, $\eta_p^2 = .62$, and group, $F(5, 95) = 3.13$, $p = .012$, $\eta_p^2 = .14$. However, these findings were qualified by a significant interaction between time and group, $F(10, 90) = 6.34$, $p < .001$, $\eta_p^2 = .41$.

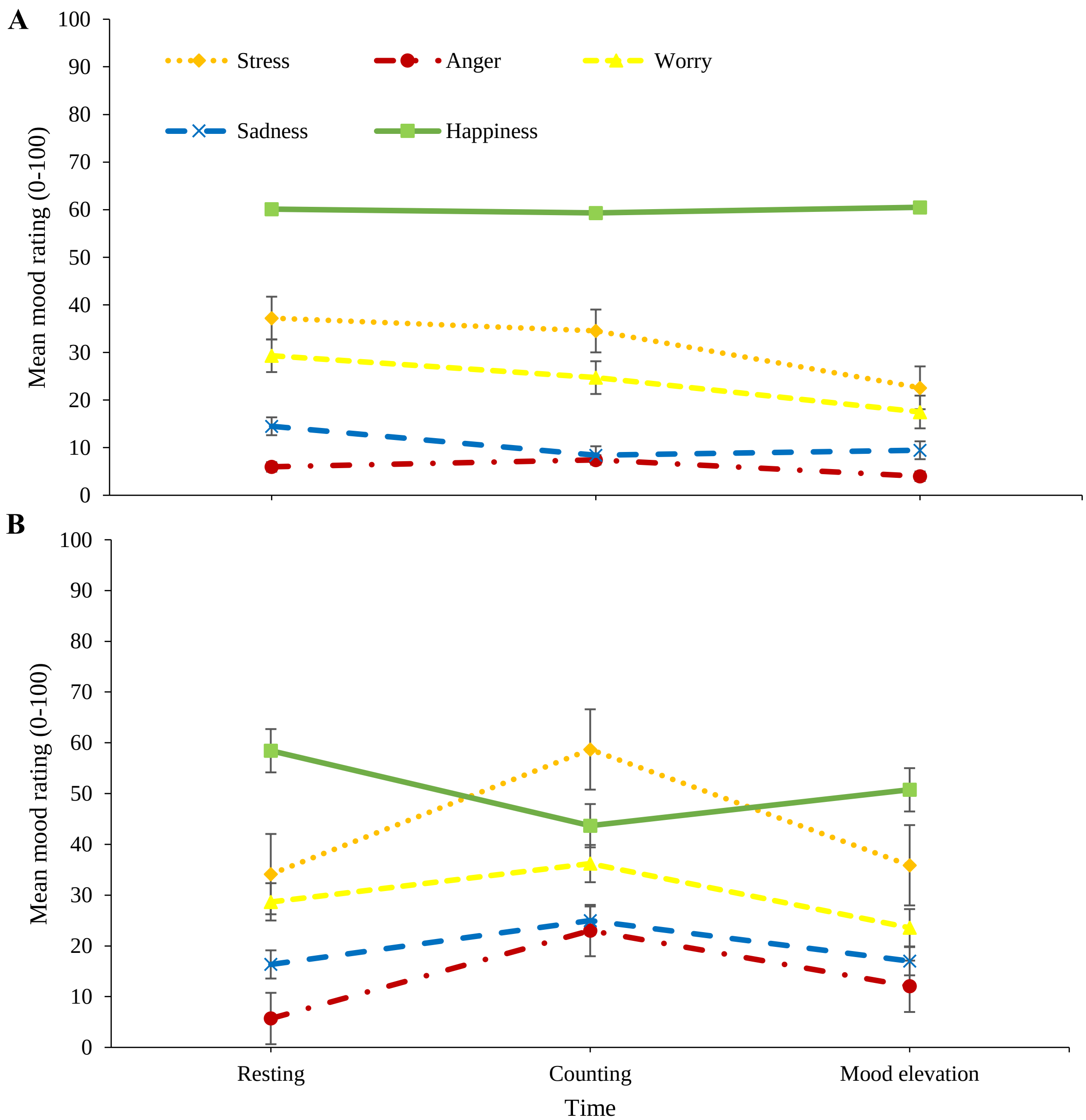
The time x group interaction was significant for all five mood ratings: stress, $F(2, 198) = 19.78$, $p < .001$, $\eta_p^2 = .78$; anger, $F(2, 198) = 10.96$, $p < .001$, $\eta_p^2 = .10$; worry, $F(2, 198) = 3.82$, $p = .024$, $\eta_p^2 = .04$; sadness, $F(2, 198) = 6.9$, $p = .001$, $\eta_p^2 = .07$; and happiness, $F(2, 198) = 9.81$, $p < .001$ $\eta_p^2 = .09$.

To unpack these interactions, I used paired t tests to compare each mood rating between resting and counting, and between counting and mood elevation, within each group. In the control group (Figure 13, Panel A), ratings of stress, anger, and worry did not change from resting to counting (stress: $t(49) = .929$, $p = .357$, $d = .09$; anger: $t(49) = 1.050$, $p = .299$, $d = .12$; worry: $t(49) = 1.461$, $p = .150$, $d = .18$) and then decreased from counting to mood elevation (stress: $t(49) = 5.156$, $p < .001$, $d = .44$; anger: $t(49) = 3.038$, $p = .004$, $d = .33$; worry: $t(49) = 3.089$, $p = .003$, $d = .29$). Sadness ratings decreased from resting to counting, $t(49) = 3.669$, $p = .001$, $d = .38$, and then did not change from counting to mood elevation, $t(49) = .501$, $p = .618$, $d = .07$. Happiness ratings did not change from resting to counting, $t(49) = .364$, $p = .717$, $d = .04$, or from counting to mood elevation, $t(49) = .485$, $p = .630$, $d = .06$.

In the stress group (Figure 13, Panel B), ratings of stress, anger, worry, and sadness increased from resting to counting (stress: $t(51) = 7.823$, $p < .001$, $d = .89$; anger: $t(51) = 4.717$, $p < .001$, $d = .82$; worry: $t(51) = 2.146$, $p = .037$, $d = .26$; sadness: $t(51) = 2.339$, $p < .001$, $d = .33$), and then decreased from counting to mood elevation (stress: $t(50) = 7.365$, $p < .001$, $d = .78$; anger: $t(50) = 4.591$, $p < .001$, $d = .45$; worry: $t(50) = 3.979$, $p < .001$, $d = .44$; sadness: $t(50) = 2.276$, $p = .027$, $d = .27$). Happiness ratings decreased from resting to counting, $t(51) = 6.173$, $p < .001$, $d = .66$, and then increased from counting to mood elevation, $t(50) = 3.252$, $p = .002$, $d = .29$.

**Figure 13**

*Changes in Mood Ratings as a Function of Time and Group in Study 2*

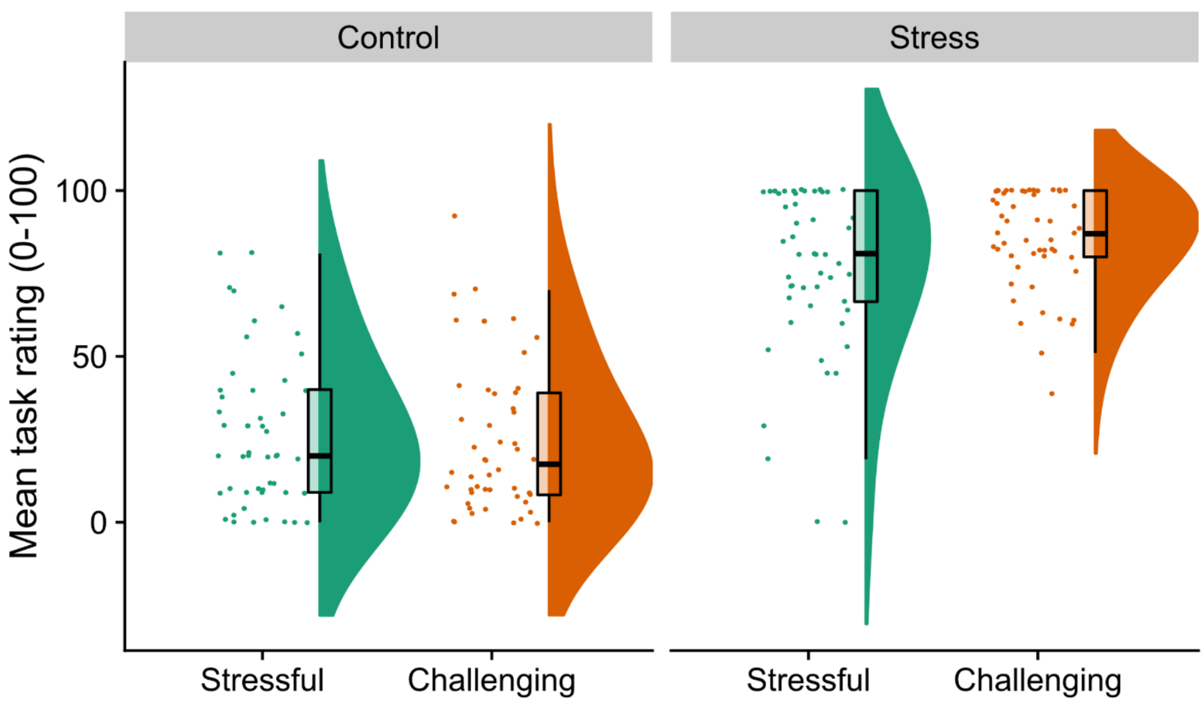



*Note*. Panel A: Mean ratings for control group. Panel B: Mean ratings for stress group. Data-points represent mean mood ratings. Error bars represent standard error.

Additionally, I compared mean task ratings (stressful and challenging) between groups using independent t tests. The stress group rated the TSST-adapted counting task as both more stressful, $t(100) = 10.39$, $p < .001$, $d = 2.06$, and challenging, $t(100) = 15.99$, $p < .001$, $d = 3.16$, than the control group rated the control counting task (Figure 14).

**Figure 14**

*Task Ratings as a Function of Type (Stressful vs Challenging) and Group (Control vs Stress) in Study 2*




In sum, the above results indicate that the stress group showed a greater increase in stress ratings from resting to counting compared with the control group. The stress group also showed increased general negative mood, whereas the control group did not. Finally, the stress group reported finding the TSST-adapted more stressful and challenging than the control group found the control counting task. These findings suggest that the TSST-adapted counting induced subjective stress as well as physiological stress.

Importantly, the stress group showed increased general positive mood from counting to mood elevation. This suggests that the mood elevation task successfully reversed the direction of the stress induction effects. Even the control group showed increased general positive mood, providing additional evidence for the efficacy of the mood elevation task.

### 3.3.3. Preregistered analyses: Effects of stress on mind perception

#### 3.3.3.1. Comparing agency and experience between groups

The test the effect of stress on perceptions of agency and experience, I compared mind survey scores for agency and experience between conditions (control vs stress). If my original hypotheses are correct, then the stress group should show higher overall agency scores and lower overall experience scores compared with the control group. Alternatively, the stress manipulation might produce similar results to Study 1. In this case, the stress group should show higher overall scores for both agency and experience.

I compared agency scores between groups using a 9 (character: woman, man, …) x 2 (group: control vs stress) mixed-model ANOVA. I found a main effect of character, $F(8, 800) = 170.51$, $p < .001$ $\eta_p^2 = .63$, but not of group, $F(1, 100) = .21$, $p = .652$, $\eta_p^2 = .002$. These findings indicate that agency scores differed between characters but not between groups. There was no interaction between character and group, $F(8, 800) = .72$, $p = .674$, $\eta_p^2 = .01$, meaning that the pattern of agency scores across characters did not differ between groups.

As I did for agency, I compared overall experience scores between groups using 9 (character) x 2 (group) mixed-model ANOVA. We found a main effect for character, $F(8, 800) = 353.135$, $p < .001$ $\eta_p^2 = .779$, but not for group, $F(1, 100) = .174$, $p = .677$, $\eta_p^2 = .002$, meaning that experience scores differed between characters but not between groups. There was no interaction between character and group, $F(8, 800) = .885$, $p = .529$, $\eta_p^2 = .009$, meaning that the pattern of experience scores across characters did not differ between groups.

In sum, the above results fail to support either of my original hypotheses because the stress manipulation had no effect on perceptions of agency or experience. By the same token, the current findings do not resemble those of Study 1.

#### 3.3.3.2. Correlating pre-existing stress with overall agency and experience

So far, my results indicate that the stress manipulation was effective but failed to produce any group differences in mind perception. This leaves me with an independent sample to replicate Study 1's correlational findings. I therefore correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall agency and experience scores.

If my original hypotheses are correct, then scores of self-reported stress should correlate positively with overall agency scores and negatively with overall experience scores (across both groups). Alternatively, if the current study replicates Study 1's results, then scores of self-reported stress should correlate positively with both overall agency and experience scores.

Consistent with my original prediction for experience, STAI-S scores correlated negatively with overall experience scores (Table 14). But this correlation was small, and neither of the other stress measures correlated with overall experience scores. In sum, these results do not support my original hypotheses, nor do they replicate Study 1's results.

**Table 14**

*Correlations of Stress Measures with Overall Agency and Experience Scores in Study 2*

| Stress measure | Experience | Agency |
|---|---|---|
| DASS-S | .054 (.296) | .067 (.251) |
| STAI-S | -.165* (.049) | -.052 (.302) |
| STAI-T | -.089 (.188) | .028 (.388) |

*$p < .05$, one-tailed.

## 3.3.4. Exploratory analyses

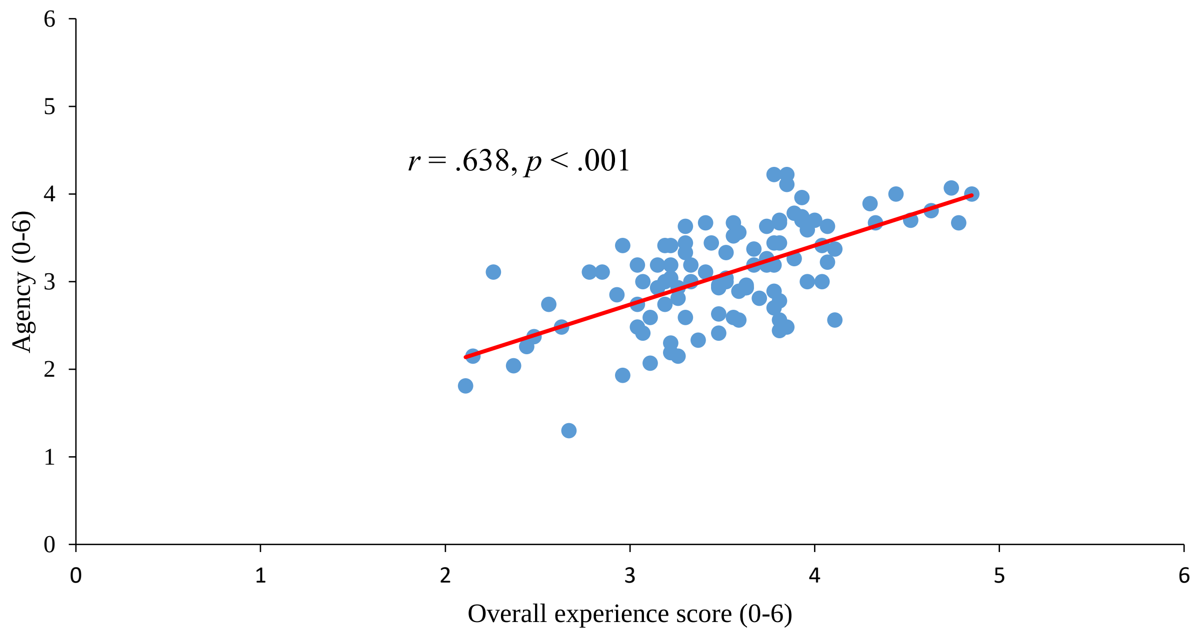
### 3.3.4.1. Correlating overall agency and experience scores

It is possible the current study failed to produce similar results to Study 1 because the current sample ($N = 102$) was underpowered compared with Study 1's sample ($N = 220$). One way to increase the power of my tests is to collapse overall agency and experience scores into overall mind scores. In Study 1, I collapsed overall agency and experience scores because they were highly correlated (Section 2.3.3.1). If agency and experience were similarly correlated in the current sample, then I could collapse them to increase the power of my tests.

As in Study 1, there was a strong positive correlation between overall agency and experience scores (Figure 15). This result indicates that perceptions of agency increased across mind survey characters as perceptions of experience increased (and vice-versa). I therefore collapsed overall agency and experience scores into overall mind scores.

**Figure 15**

*Correlation of Overall Agency and Experience Scores in Study 2*




*Note*. Each dot represents an individual participant. The red line is a best-fit trend-line. There is a strong positive correlation between overall agency and experience scores.

**3.3.4.2. Correlating stress with overall mind scores**

To examine the relationship between stress and overall mind perception, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall mind scores. If the current results replicate those of Study 1, then scores of self-reported stress should correlate positively with overall mind scores. However, DASS-S, STAI-S, and STAI-T scores did not correlate with overall mind scores (Table 15). These results fail to replicate those of Study 1.

**Table 15**

*Correlations of Stress Measures with Overall Mind Scores in Study 2*

| Stress measure | Mind |
|---|---|
| DASS-S | .037 (.711) |
| STAI-S | -.137 (.173) |
| STAI-T | -.073 (.470) |

### 3.3.4.3. Grouping characters by agency, experience, and mind

In Study 1, I used principal components analysis (PCA) to test whether the correlations between scores of self-reported stress and overall scores of agency, experience, and mind were driven by a subset of the mind survey characters. In the current study, I used to same method to check whether the non-significant correlations for overall agency, experience, and mind scores contained any significant correlations for subsets of the characters.

#### *3.3.4.3.1. Grouping characters by agency scores*

As in Study 1, I grouped mind survey characters by their agency scores using PCA (varimax rotation). The rotated solution accounted for eight of the nine characters, explained 46% of total variance, and yielded two components (Table 16). Component one (eigenvalue = 2.06; variance = 28%) included four characters: man, woman, dog, and baby. Component two (eigenvalue = 1.23; variance = 18%) also included four characters: tree, robot, corpse, and Superman. God did not load on either component.

I labelled component one 'minded' because it comprised characters that are typically perceived as high in agency, experience, or both in previous research (e.g., Gray et al., 2007; Gray et al., 2008, 2011). I labelled component two 'mindless' because it mostly comprised entities that are typically perceived as low in both agency and experience (except for Superman). These groups are notably different than those identified for agency in Study 1 (Table 5).

**Table 16**

*Component Loadings of Characters for Agency in Study 2*

| Character | Minded | Mindless |
|---|---|---|
| Man | **.88** | -.19 |
| Woman | **.87** | -.24 |
| Dog | **.67** | .12 |
| Baby | **.60** | .21 |
| Tree | .04 | **.67** |
| Robot | -.20 | **.61** |
| Corpse | -.18 | **.55** |
| Superman | .27 | **.48** |
| God | .17 | .27 |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

In sum, the above results indicate that, in terms of perceived agency, participants tended to group the mind survey characters into minded versus mindless entities.

***3.3.4.3.2. Correlating stress with group agency scores***

To investigate the relationship between stress and perceptions of agency in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with agency scores for each group (minded and mindless)[11]. I calculated group agency scores by averaging agency scores across the characters within each group.

Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. As in Study 1, I dropped the STAI-S from analysis so that I did not have to correct for

[11] Because God did not load in either group and because stress correlated with increased perceptions of agency in God in Study 1, I correlated scores of self-reported stress with God separately. Neither DASS-S, $r$ = -.067, $p$ = .506, nor STAI-T scores, $r$ = -0.75, $p$ = .454, correlated with the agency score for God.

multiple measures of state stress. Because I had two groups, I used an adjusted alpha of .05/2 = .025 for correlations with each group.

DASS-S and STAI-T scores did not correlate with agency scores for the minded or mindless groups (Table 17). DASS-S scores trended towards correlating positively with the mindless group but did not survive correction.

**Table 17**

*Correlations of Stress Measures with Agency Groups in Study 2*

| Stress measure | Minded | Mindless |
|---|---|---|
| DASS-S | -.24 (.406) | .162 (.052) |
| STAI-T | -.124 (.107) | .192 (.027) |

In sum, the above results indicate that the non-significant correlation between self-reported stress scores and overall agency scores did not contain any significant correlations with minded or mindless characters.

***3.3.4.3.3. Grouping characters by experience scores***

Next, I grouped mind survey characters by their experience scores using PCA (varimax rotation). The rotated solution accounted for all nine characters, explained 50% of score variance, and yielded two components (Table 18). Component one (eigenvalue = 2.67; variance = 34%) included four characters: woman, man, dog, and baby. Component two (eigenvalue = 1.01; variance = 16%) included five characters: God, robot, tree, Superman, and corpse.

Component one in the current study included all the same characters as the experiential group in Study 1. I therefore labelled component one ‘experiential’. Additionally, component two in the current study contained most of the same characters as the non-experiential group in Study 1. I therefore labelled component two ‘non-experiential’.

**Table 18**

*Component Loadings of Characters for Experience in Study 2*

| Character | Experiential | Non-experiential |
|---|---|---|
| Woman | **.89** | .12 |
| Man | **.88** | .05 |
| Dog | **.82** | .014 |
| Baby | **.78** | .04 |
| God | .03 | **.55** |
| Robot | -.33 | **.54** |
| Tree | .02 | **.54** |
| Superman | .24 | **.51** |
| Corpse | .21 | **.46** |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

As in Study 1, the above results indicate that, in terms of perceived experience, participants tended to group the mind survey characters into experiential versus non-experiential entities.

***3.3.4.3.4. Correlating stress with group experience scores***

To investigate the relationship between stress and perceptions of experience in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with experience scores for each group (experiential and non-experiential). I calculated group experience scores as I did for agency. Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. I had two groups, so I used an adjusted alpha of .05/2 = .025 for correlations with each group.

DASS-S and STAI-T scores did not correlate with the experience score for the experiential or non-experiential group (Table 19). STAI-T scores trended towards correlated negatively with the experiential group but did not survive correction. These results indicate that the non-significant correlation between self-reported stress scores and overall experience scores did not contain any significant correlations with experiential or non-experiential characters. This fails to replicate Study 1's finding that stress correlate with increased perceptions of experience in non-experiential characters.

**Table 19**

*Correlations of Stress Measures with Experience Groups in Study 2*

| Stress measure | Experiential | Non-experiential |
|---|---|---|
| DASS-S | .002 (.492) | .076 (.224) |
| STAI-T | -.175 (.039) | .026 (.399) |

***3.3.4.3.5. Grouping characters by mind scores***

Finally, I used PCA (varimax rotation) to group characters according to their mind scores. The rotated solution accounted for seven of the nine characters, explained 49% of score variance, and yielded two components (Table 20). Component one (eigenvalue = 2.45; variance = 33%) included four characters: woman, man, dog, and baby. Component two (eigenvalue = 1.16; variance = 16%) included three characters: robot, tree, and corpse. God and Superman did not load on either component.

Component one in the current study (woman, man, dog, and baby) included some of the same characters as the adult human group in Study 1 (man and woman). Initially, dog and baby loaded in the adult human group in Study 1, but I dropped them from analysis because they cross-loaded with another component. For these reasons, I labelled component one in the current study 'adult human'.

Component two in the current study (robot, tree, and corpse) included some of the same characters as the mindless group in Study 1 (tree and corpse). I therefore labelled component two in the current study 'mindless'.

**Table 20**

*Component Loadings of Characters for Mind in Study 2*

| Character | Adult human | Mindless |
|---|---|---|
| Woman | **.91** | -.18 |
| Man | **.90** | -.19 |
| Dog | **.78** | .14 |
| Baby | **.72** | .15 |
| God | .20 | .14 |
| Robot | -.16 | **.70** |
| Tree | .11 | **.67** |
| Corpse | -.01 | **.51** |
| Superman | .29 | .38 |

*Note*. The extraction method was varimax rotation. Component loadings above .41 are bolded.

As in Study 1, the above results indicate that, in terms of perceived mind, participants tended to group the mind survey characters into adult humans and mindless entities.

#### ***3.3.4.3.6. Correlating stress with group mind scores***

To investigate the relationship between stress and perceptions of mind in the groups identified above, I correlated scores of self-reported stress (DASS-S and STAI-T) with mind scores for each group (experiential and non-experiential). I calculated group mind scores by averaging the mind scores across the characters within each group. Because these correlations were exploratory, I applied Bonferroni correction for multiple tests. I had two groups, so I used an adjusted alpha of .05/2 = .025 for correlations with each group.

Both DASS-S and STAI-T scores correlated positively with the mind score for the mindless group (Table 21). Neither DASS-S nor STAI-T scores correlated with the mind score for the adult human group. These results indicate that participants with high self-reported stress tended to perceive more mind in mindless characters.

**Table 21**

*Correlations of Stress Measures with Mind Groups in Study 2*

| Stress measure | Adult human | Mindless |
|---|---|---|
| DASS-S | -.012 (.905) | .281** (.004) |
| STAI-T | -.168 (.091) | .316** (.001) |

**$p$ < .005, two-tailed.

In sum, the above results indicate that, while self-reported stress scores did not correlate with perceptions of mind across mind survey characters, they did correlate with increased mind perception in mindless entities.

### 3.4. Discussion

I hypothesized that stress increases perceptions of agency and reduces perceptions of experience. If my hypotheses are correct, then participants in the stress condition should show higher scores of perceived agency and lower scores of perceived experience compared with participants in the control condition. The findings of the current study do not support either of my hypotheses. The stress manipulation was successful, but failed to produce any effects on perceptions of agency and experience.

One of the measures of self-reported stress correlated with reduced perceptions of experience, consistent with my hypotheses for experience. But this correlation was small, and neither of the other two stress measures correlated with experience. Self-reported stress did not correlate with perceptions of agency.

I might have failed to detect the predicted correlations for agency because the current sample was smaller and underpowered compared with Study 1's sample. Consistent with this, an exploratory principal components analysis that maximised statistical power revealed that self-reported stress was correlated with increased mind perception in entities low in both agency and experience (i.e., robots, trees, and dead people). This pattern of results is similar to what I observed in Study 1.

Because the correlations in both studies so far have generally been small, it is possible the mind survey is not sensitive enough to detect large trends. One concern with the mind survey is that it primarily reflects out conceptual knowledge about the specific entities that are included. Agency and experience may be properties of these conceptual categories, which are presumably built up over a lifetime of interactions. If these properties are part of our stable conceptual knowledge structures, they may not fluctuate with stress levels, even thought mind perception itself might be moderated by stress.

So, my aim in Study 3 was to use a measure of mind perception in the morph task that captures perceptions of a specific mind in the moment, not beliefs about categories of minds. Additionally, the morph task provides a quantitatively more sensitive measure of mind perception than the mind survey because it has higher measurement resolution. This might allow the morph task to detect subtler changes in mind perception.

# 4. Study 3

## 4.1. Introduction

Study 3 was an online survey comprising self-report measures of stress, followed by the morph task. Based on my original hypotheses, I predicted that scores of self-reported stress should correlate negatively with agency thresholds and positively with experience thresholds in the morph task. In other words, stress should correlate with increased readiness to perceive agency and reduced readiness to perceive experience.

Looser and Wheatley (2010) originally created the morph task to find the threshold for perceiving animacy in faces. They morphed 20 inanimate faces (e.g., mannequins, statues, dolls) with well-matched photographs of human faces using FantaMorph software (Version 3; Abrosoft Co., Beijing, China). Each pair of original images was linearly interpolated to produce a set of face morph images at consistent increments of physical change across the morphing continuum.

Participants were presented with 220 images in randomized order. These images were taken from 11 equidistant points within each of the 20 morph continua. Participants rated the extent to which each image appeared alive. After completing these ratings, participants scrolled freely through each morph continuum in 2% increments (50 images per morph) to determine the animacy boundary.

To test whether perceptions of animacy were coupled with perceptions of mind, Looser and Wheatley asked participants to repeat the same procedure but this time judging whether the face was able to formulate a plan, able to feel pain, or had a mind. The capacities for planning and pain were adapted from Gray et al. (2007) as loading highly on agency and experience.

In consultation with Christine Looser (personal communication, 8 April 2019), I modified the morph task to suit the purpose of Studies 3 and 4. I reduced the number of morphs from 20 to

10. I also dropped the method-of-constant-stimuli style image rating trials, including only the method-of-adjustment style scrolling trials. Both these changes were intended to make the task shorter so that participants in Study 4 could complete the task before recovery from stress induction. Pilot data indicated that, on average, participants ($n$ = 6) took 6.83 minutes ($SD$ = 2.44) to complete the morph task, similar to the expected duration of the stress response. Finally, I excluded the mind ratings to avoid the possibility this explicit judgement would serve as a heuristic for the other two ratings.

## 4.2. Method

### 4.2.1. Participants

I determined the sample size for the current study in the same way as in Study 1 (Section 2.2.1). I requested 300 participants from MTurk, but, for reasons unclear, the study was completed with only 295. I excluded 187 participants for failing a response validity indicator (Section 4.2.4). This left a final sample size of 108 (35 females; mean age = 38.86, $SD$ = 11.80). To help ensure data quality (Hauser et al., 2018), I restricted my sample to English-speaking countries (Aotearoa, Australia, Canada, the United Kingdom, & the United States. Unfortunately, I neglected to record the number of participants from each country). All participants provided informed consent and received $1 NZD in return for their participation. The School of Psychology Human Ethics Committee of Te Herenga Waka approved this study.

### 4.2.2. Self-report measures of stress

I adapted each of the stress measures to be presented through Qualtrics (Provo, UT). I did not have access to information about participants' computer or display specifications.

Participants completed the DASS-S, STAI-S, and STAI-T, as in Studies 1 and 2. All three stress measures showed excellent internal consistency in the current sample (DASS-S: $\alpha = .94$; STAI-S: α = .90; STAI-T: α = .91).

### 4.2.3. Morph task

#### 4.2.3.1. Morph task stimuli

My stimuli were a subset of Looser and Wheatley's (2010) morphed images. I used 10 face identities with 50 images each (2% increments along the morph continua; see Appendix H for all included face identities.)

**Figure 16**

*Example of morphed stimuli used in Studies 3 and 4*

Redacted

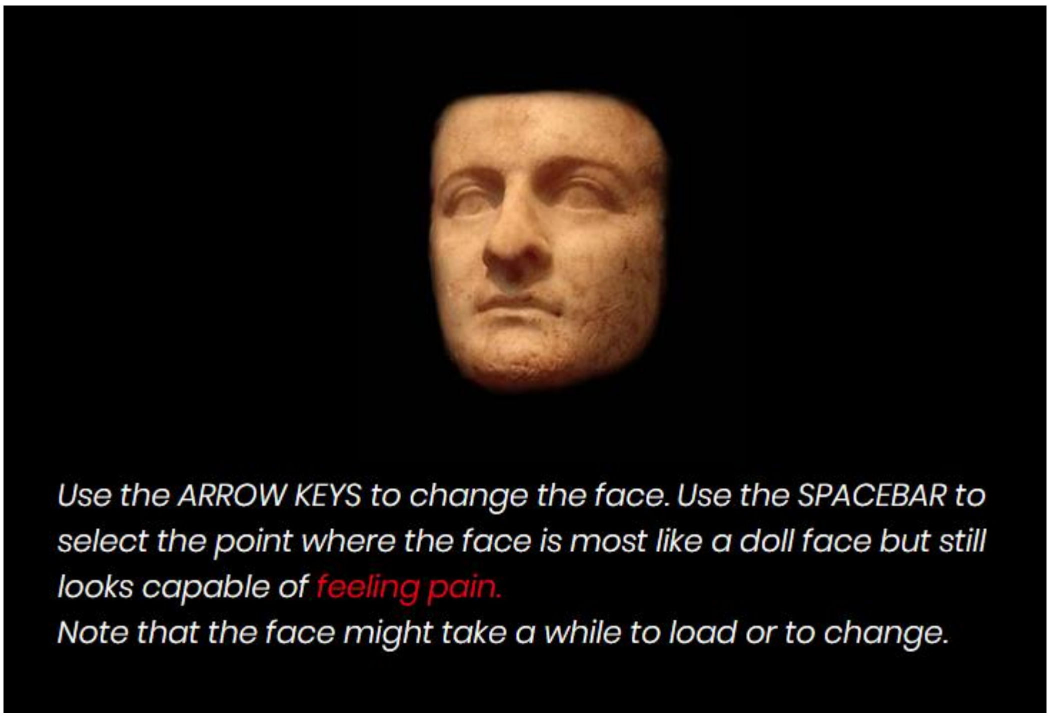
*Note*. This figure shows six images taken from one of the morphing continua. Each morph had 50 images total. From Looser & Wheatley (2010).

#### 4.2.3.2. Morph task procedure

The morph task consisted of an agency block and an experience block. The order of the blocks alternated between participants. Each block contained five morphs presented over five trials. On each trial, a morph image would appear in the centre of the computer screen against a black background (Figure 17). The morph image displayed at the start of a trial was always taken from one of the end-points of the morph continuum (either 100% animate or 100% inanimate). The starting point of each continuum alternated between trials, and the starting point for each face identity was counterbalanced across participants.

**Figure 17**

*A sample trial from the morph task*




Participants could scroll freely through the morph continuum by using the left and right arrow keys to move back and forth. Pressing an arrow key once would cause the morph image to be replaced by the next image in the continuum in the given direction. Pressing and holding the arrow key would cause the morph images to be continuously replaced by the next image in the continuum in the given direction. The qualitative effect of pressing and holding the arrow keys was that face would morph smoothly from a human face to a doll face (or vice-versa).

From anecdotal observation during pilot testing of the morph task, most participants would start each trial by pressing and holding the arrow keys so that they moved back and forth through the morph continuum in big leaps, before narrowing in on the perceived threshold, at which point they would start tapping the arrow key using discrete presses. Once participants had identified the perceived threshold, they would press the spacebar to input their response and move on to the next trial. Each trial was succeeded immediately by the next, with no inter-trial interval.

At the start of the morph task, participants were presented with one of two sets of instructions depending on whether the first block was agency or experience. The instructions for agency were: “You will now see a series of faces. Use the ARROW KEYS to change each face from a human to a doll face or vice versa. For each face, find the point where the face is most like a doll face but still looks capable of formulating a plan. Select the point you have chosen by pressing the SPACEBAR. Note that the faces might take a while to load or to change. Take a moment now to think about the last time you formulated a plan. For example, you might think about the last time you planned a trip, the week’s activities, or a social event. Your task is to find the point where the face looks capable of doing that kind of planning.”

The instructions for experience were identical except they asked participants to “… find the point where the face is most like a doll face but still looks capable of feeling pain”. Additionally, they included common examples of feeling pain: “Take a moment now to think about the last time you felt physical pain. For example, you might think about the last time you stubbed a toe, had a toothache, or accidentally cut yourself whilst cooking. Your task is to find the point where the face looks capable of feeling that kind of pain."

After completing the first block, participants were presented with the second set of instructions. Each set of instructions was preceded by: "Well done! You have completed the first half of the task. In the second half of the task, we are going to ask you to rate a different capacity."

**4.2.3.3. Morph task scoring**

The images in the morphing continua were numbered 1-50 from the human end to the doll end. I reverse-coded the images so that higher numbers indicated higher thresholds (1-50 from doll end to human end). I averaged thresholds across all the morphs in the agency block to calculate an overall agency threshold. I calculated overall experience thresholds in the same way.

**4.2.4 Response validity indicator**

To assess response consistency, one trial was randomly repeated during each block of the morph task (2 repeated trials total). (Repeated trials were not included in main analyses.) The logic behind this check is that attentive participants should generally respond similarly to identical repeated items. I therefore assumed that participants who responded inconsistently to repeated items were inattentive.

I quantified response consistency by calculating difference scores between thresholds on the first and second presentations of each repeated trial. If a participant had at least one difference score less than -5 or greater than 5, then that participant was excluded. This criterion excluded 187 out of 295 participants.

### 4.2.5. Procedure

Participants completed a captcha, followed by the DASS-S, STAI-S, and STAI-T. The stress measures were presented separately in randomized order. Then, participants completed the morph task. Finally, participants were debriefed and remunerated.

## 4.3. Results

### 4.3.1. Descriptive statistics

To characterize the current sample's level of self-reported stress, I calculated means and standard deviations for each stress measure (Table 22). I also calculated means and standard deviations for overall agency and experience thresholds in the morph task (Table 23).

**Table 22**

*Means and Standard Deviations on Stress Measures in Study 3*

| Stress measure | Possible range | *M* (*SD*) |
|---|---|---|
| DASS-S | 0-42 | 14.58 (6.51) |
| STAI-S | 0-80 | 40.02 (12.52) |
| STAI-T | 0-80 | 43.82 (13.21) |

**Table 23**

*Means and Standard Deviations of Overall Thresholds in Study 3*

| Overall threshold | *M* (*SD*) |
|---|---|
| Agency | 26.99 (6.05) |
| Experience | 26.96 (5.42) |

### 4.3.2. Pre-registered analyses

To test my hypotheses that stress increases perceptions of agency and reduces perceptions of experience, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall thresholds for agency and experience. If my hypotheses are correct, then scores of self-reported stress should correlate negatively with overall agency thresholds and positively with overall experience thresholds. In other words, stress should correlate with greater readiness to perceive agency and lower readiness to perceive experience. Alternatively, if the current study produces similar results to those of Study 1, then self-reported stress scores should correlate negatively with overall thresholds for both agency and experience.

However, DASS-S, STAI-S, and STAI-T scores did not correlate with either overall agency or experience thresholds (Table 24)[12]. These results do not support my hypotheses; nor do they resemble the results of Study 1.

**Table 24**

*Correlations of Stress Measures with Overall Agency and Experience Thresholds in Study 3*

| Stress measure | Agency | Experience |
|---|---|---|
| DASS-S | -.081 (.202) | -.138 (.077) |
| STAI-S | -.008 (.469) | -.075 (.221) |
| STAI-T | .068 (.241) | -.014 (.444) |

### 4.3.3. Exploratory analyses

#### 4.3.3.1. Correlating overall agency and experience thresholds

It is possible that I failed to detect the predicted correlations because of a lack of statistical power. As described earlier (Sections 3.2 and 11.2), I aimed to recruit a sample size of 300 in the current study based on previous studies. Two-hundred and ninety-five participants

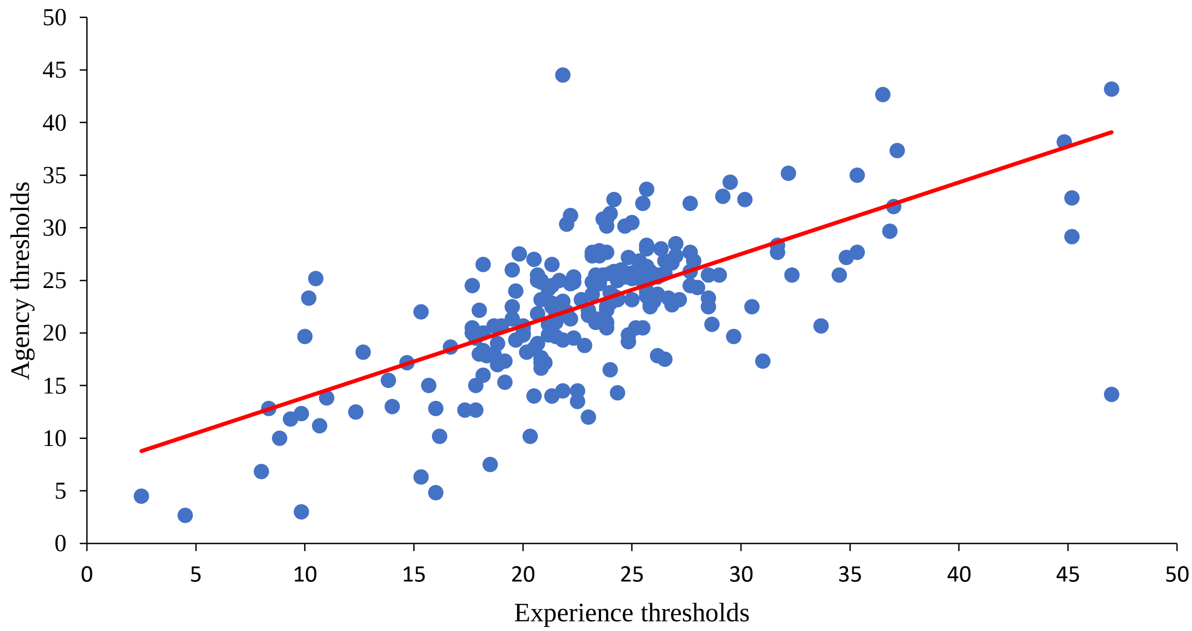
[12] To avoid any carry-over effects due to block order during the morph task, I repeated these correlations separately for participants who were presented with either the agency or experience block first. None of these correlations were significant (all $p$'s > .05), suggesting that block order did not influence responding.

completed the study, but I excluded 187 participants for failing a response validity check (Section 4.2.4). This reduced the power of my sample ($N = 108$).

One way to increase the statistical power of my tests is to collapse the overall agency and experience thresholds into overall mind thresholds. In Studies 1 and 2, I collapsed mind survey scores for overall agency and experience because they were highly correlated. In the current study, there was a strong positive correlation between overall agency and experience thresholds, $r = .79$, $p < .001$ (Figure 18). This result indicates that thresholds for perceiving agency increased across face morphs as thresholds for perceiving experience increased (and vice-versa).

**Figure 18**

*Correlation of Overall Agency and Experience Thresholds in Study 3*




*Note*. Each dot represents an individual participant. The red line is a best-fit trend-line. The correlation between overall agency and experience thresholds was statistically significant and strongly positive.

**4.3.3.2. Correlating stress with overall mind thresholds**

Because overall agency and experience thresholds were strongly correlated, I collapsed them into overall mind thresholds. As I did for overall agency and experience thresholds, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall mind thresholds. However, none of these correlations were significant (Table 25).

**Table 25**

*Correlations of Stress Measures with Overall Mind Thresholds in Study 3*

| Stress measure | Mind |
|---|---|
| DASS-S | -.114 (.240) |
| STAI-S | -.041 (.670) |
| STAI-T | .031 (.748) |

**4.3.3.3. Repeating correlations with data-driven exclusion criteria**

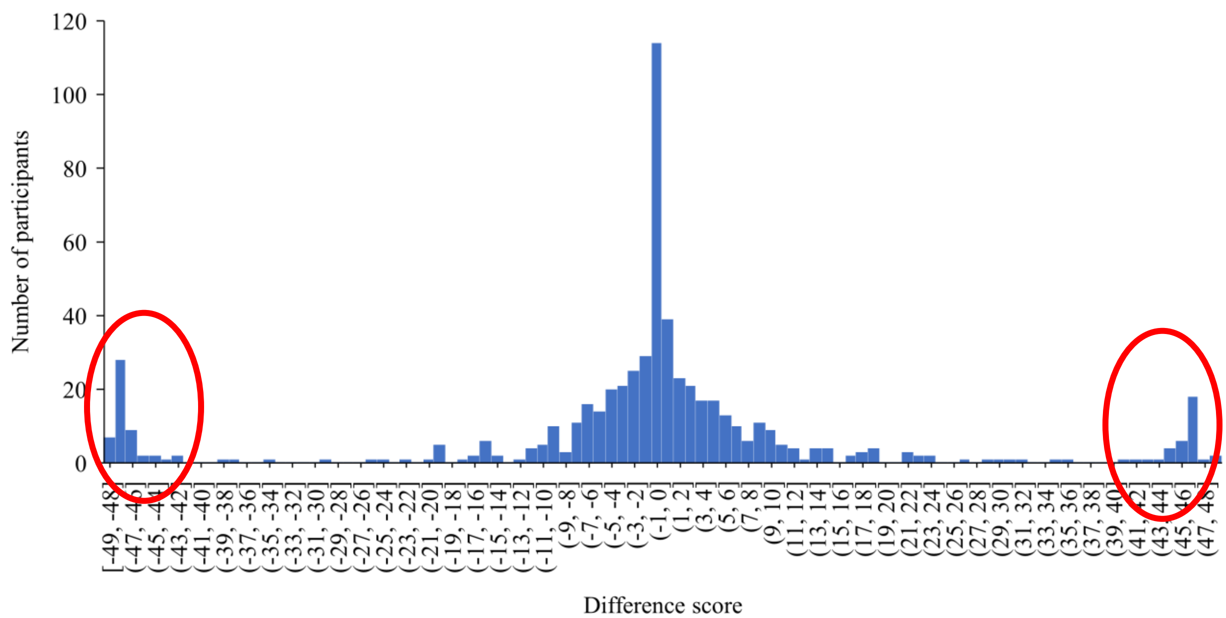
Another way to increase the current study's statistical power is by retrospectively adjusting the exclusion criterion of my response consistency check to reduce the number of participant exclusions. I assumed (a-priori) attentive participants would select thresholds on repeated trials within ± 5 images of their original thresholds. This assumption was likely too conservative because it led to the exclusion of 187 out of 295 participants. Attentive participants might have selected thresholds on repeated trials outside five images of their original thresholds.

To determine a more reasonable exclusion criterion, I used an exploratory data-driven approach. First, I plotted the distribution of all difference scores (2 difference scores per participant; Figure 19). Visual inspection revealed a cluster of extreme scores at each end of the distribution. I defined each cluster as a set of contiguous bars. One cluster comprised difference scores below -41 and the other comprised scores above 40. A difference score in one of these clusters means that the participant selected a threshold over 40 images away from their original threshold, at the other end of the morphing continuum.

I excluded 74 participants with at least one difference score within either of the clusters. I also excluded 29 participants with at least one difference score more than two standard deviations away from the mean of all difference scores. The remaining sample size was 192.

**Figure 19**

*Threshold Difference Scores for Repeated Trials in the Morph Task in Study 3*



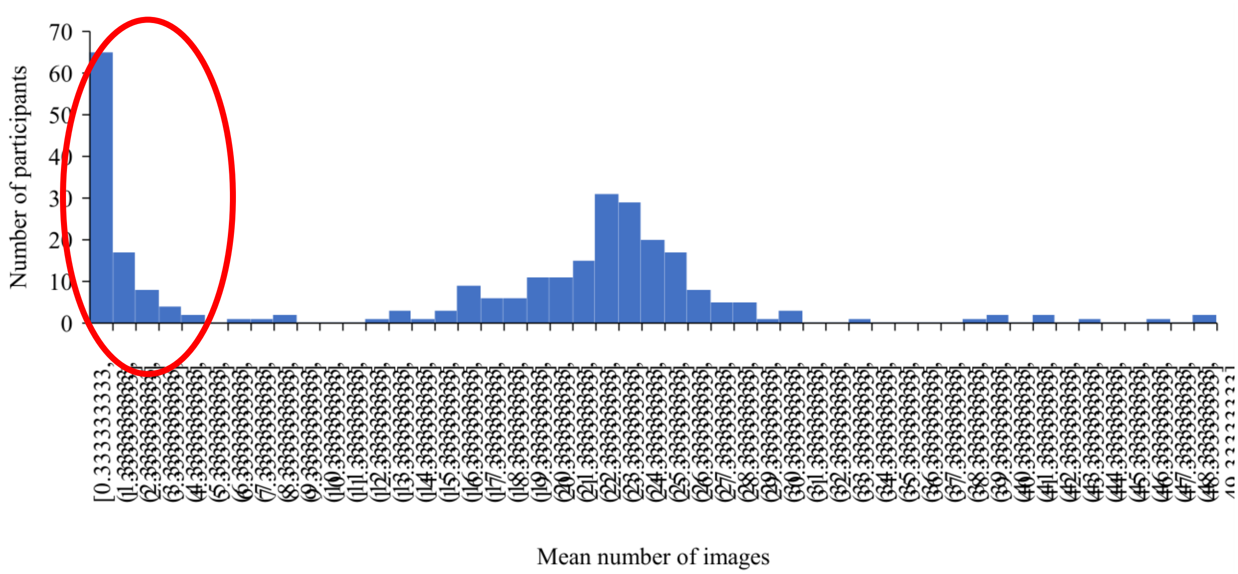

*Note*. Bars represent the number of mean difference scores (2 difference scores per participant). Red circles contains clusters of extreme difference scores.

It is possible some invalid participants inadvertently beat my response consistency check by responding identically on all trials. To screen for identical responding, I calculated the mean number of images each participant scrolled through before selecting a threshold across all the morphing continua. Then, I plotted the distribution of these means (Figure 20).

Visual inspection of the distribution revealed a cluster of data from 0-5 images. I defined this cluster as a set of contiguous bars. On average, participants in this cluster scrolled through less than five images per trial before selecting a threshold, even though the starting of each morph continuum alternated between trials (human versus doll end). I excluded 30 participants within this cluster, leaving a final sample of 161.

**Figure 20**

*Mean Number of Images Each Participant Scrolled Through Morphing Continua in Study 3*




*Note*. Bars represent the mean number of images participants through before selecting a threshold across all morphing continua. Bin width is one image (50 bins total). The red circle contains a cluster of ‘identical responders’ who scrolled through fewer than five images per trial, on average.

Finally, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall thresholds for agency and experience in the remaining sample. However, DASS-S, STAI-S, and STAI-T scores did not correlate with either overall agency or experience thresholds (Table 26). These results do not support my hypotheses; nor do they resemble the results of Study 1.

**Table 26**

*Correlations of Stress Measures with Overall Agency and Experience Thresholds With Exploratory Exclusions in Study 3*

| Stress measure | Agency | Experience |
|---|---|---|
| DASS-S | -.039 (.310) | -.026 (.372) |
| STAI-S | -.039 (.314) | -.025 (.379) |
| STAI-T | -.058 (.231) | .038 (.316) |

## 4.4. Discussion

I hypothesized that stress increases perceptions of agency and reduces perceptions of experience. If these hypotheses are correct, then self-reported stress should correlate negatively with thresholds for perceiving agency and positively with thresholds for perceiving experience. In other words, when people are stressed, they should tend to perceive agency more readily and experience less readily. The findings of the current study are inconsistent with both my predictions. Self-reported stress did not correlate with thresholds for perceiving either agency or experience. In the current study, I searched for associations between stress and mind perception that would be consistent with my hypotheses. In Study 4, I tested my causal hypotheses directly by experimentally inducing stress.

# 5. Study 4

## 5.1. Introduction

Study 4 was a lab experiment with a between-subjects manipulation of stress, followed by the morph task. Based on my preregistered hypotheses, I predicted that stressed participants should show lower agency thresholds and higher experience thresholds compared with controls. Alternatively, if the current study produces similar results to Study 1, then stressed participants should produce higher scores of both agency and experience.

## 5.2. Method

### 5.2.1. Participants

I determined the sample size for the current study in the same way as in Study 2 (Section 3.2.1). I therefore aimed for sample size of 102. One-hundred and eleven participants completed the experiment. I excluded nine participants. Three participants in the stress condition chose to withdraw partway through the experiment. I excluded another three participants because they mentioned during debriefing that they had not understood the morph task instructions. I excluded two other participants for failing to follow experiment instructions (completing the morph task before the stress manipulation). Finally, I excluded one other participant prior to testing because they mentioned they were currently experiencing extreme anxiety.

The remaining 102 participants (68 women; mean age = 20.97; $SD$ = 3.6; range = 18-33) included 67 undergraduate students from Te Herenga Waka and 35 members of the broader Wellington community. All participants had normal or corrected-to-normal vision, spoke English fluently, and reported that they were not currently receiving treatment for anxiety or depression. Participants were randomly assigned to either the stress condition ($n$ = 50; $M_{age}$ = 21.84, $SD_{age}$ = 4.002) or the control condition ($n$ = 52; $M_{age}$ = 20.13, $SD_{age}$ = 2.97). The conditions did not differ significantly in terms of gender distribution, $\chi^2 = 1.469$, $p = .48$, or age, $t = -2.450$, $p = .016$. Students received course credit in for participation. Community participants received a movie or supermarket voucher worth $15 NZD. The School of Psychology Human Ethics Committee of Te Herenga Waka approved this study.

### 5.2.2. Measures

I adapted each of the measures to be presented through Qualtrics (Provo, UT). Participants completed the DASS-S, STAI-S, and STAI-T, as in Studies 1, 2, and 3. The DASS-S showed acceptable internal consistency in the current sample ($\alpha = .72$). The STAI-S and STAI-T both showed good internal consistency ($\alpha = .89$ and .89, respectively).

Participants completed the morph task as described in Study 3. Because I was less concerned with data-quality in the current lab sample, I did not include any response validity indicators. Participants completed the counting task stress manipulation, manipulation checks, and mood elevation task as described in Study 2. Participants completed all measures on a Dell Precision 3630 Tower Workstation.

### 5.2.3. Procedure

The procedure for the current study was identical to Study 2 (Section 3.2.6), substituting the mind survey for the morph task.

## 5.3. Results

### 5.3.1. Descriptive statistics

To characterize the current sample's level of self-reported stress, I calculated means and standard deviations for each stress measure (Table 27). I also calculated means and standard deviations for overall agency and experience thresholds in the morph task (Table 28).

**Table 27**

*Means and Standard Deviations of Stress Measures in Study 4*

| Stress measure | Possible range | *M* (*SD*) |
|---|---|---|
| DASS-S | 0-42 | 12.08 (3.39) |
| STAI-S | 0-80 | 36.10 (8.57) |
| STAI-T | 0-80 | 43.87 (9.02) |

**Table 28**

*Means and Standard Deviations of Overall Thresholds in Study 4*

| Overall threshold | *M* (*SD*) |
|---|---|
| Agency | 26.96 (6.09) |
| Experience | 26.65 (7.06) |

### 5.3.2. Manipulation checks

To check if my stress manipulation was successful, I compared changes in heart rate (HR), skin conductance level (SCL), and stress ratings over time (resting, counting, and mood elevation) between conditions (control and stress). I expected participants in the stress condition (stress group) to show greater increases in HR, SCL, and stress ratings from resting to counting compared with participants in the control condition (control group). (For group means at resting and counting, see Table 29).

**Table 29**

*Group Means (with Standard Deviations) for Physiological Measures Over Time in Study 4*

| | Control | | Stress | |
|---|---|---|---|---|
| Measure | Resting | Counting | Resting | Counting |
| HR [a] | 85.54 (13.15) | 89.57 (11.65) | 83.58 (12.39) | 93.39 (14.36) |
| SCL [b] | 2.31 (3.38) | 13.08 (5.37) | 2.11 (3.51) | 17.78 (8.92) |

[a] In beats per minute (bpm). [b] In micro-Siemens (μS).

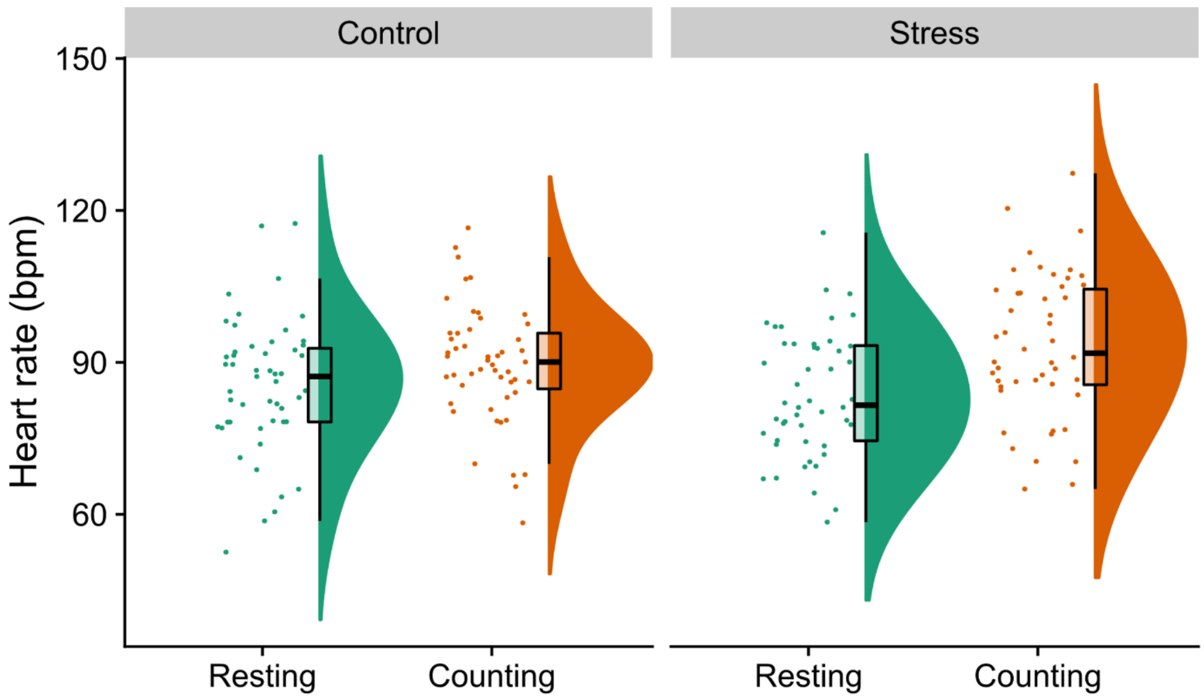
**5.3.2.1. Physiological response**

I compared changes in HR from resting to counting between groups using a 2 (time: resting and counting) x 2 (group: control and stress) mixed-model ANOVA. I found a main effect of time, $F(1, 97) = 56.52$, $p < .001$ $\eta_p^2 = .368$, but not of group, $F(1, 97) = .147$, $p = .702$, $\eta_p^2 = .002$. However, these findings were qualified by an interaction between time and group, $F(1, 97) = 9.86$, $p = .002$, $\eta_p^2 = .092$.

I unpacked the time x group interaction using a pair of independent t tests. First, I compared HR between groups at rest. Groups did not differ in HR during resting, $t(97) = .762$, $p = .448$, $d = 0.15$. Then, I compared the difference in HR from resting to counting between groups. The stress group showed a greater increase in HR than the control group, $t(97) = 3.14$, $p = .002$, $d = 0.63$ (Figure 21).

**Figure 21**

*Mean Heart Rate (HR) as a Function of Time (Resting vs Counting) and Group (Control vs Stress) in Study 3*

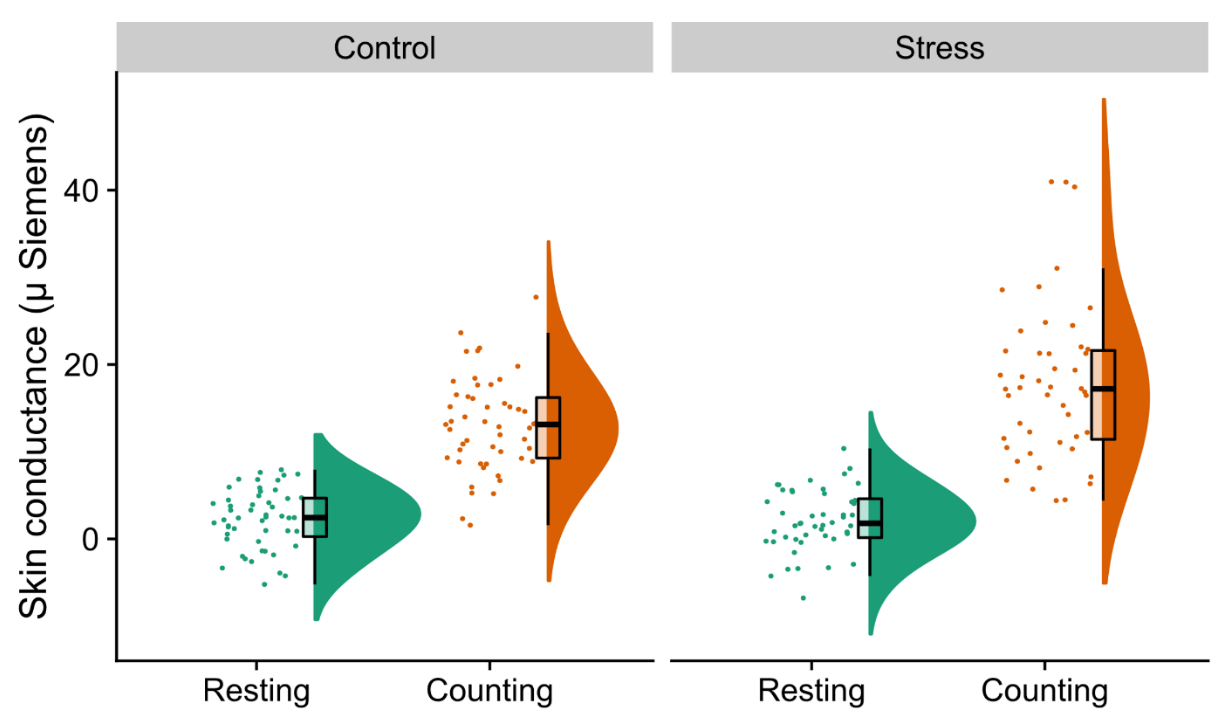



As I did for HR, I compared changes in SCL from resting to counting between groups using a 2 (time) x 2 (group) mixed-model ANOVA. I found main effects of both time, $F(1, 97) = 316.68$, $p < .001$ $\eta_p^2 = .766$, and group, $F(1, 97) = 6.61$, $p = .012$, $\eta_p^2 = .064$. However, these findings were qualified by an interaction between time and group, $F(1, 96) = 148.117$, $p = .017$, $\eta_p^2 = .06$.

As I did for HR, I used a pair of independent t tests to unpack this time x group interaction. Groups did not differ in SCL during resting, $t(97) = .29$, $p = .775$, $d = .06$. The stress group showed a greater increase in SCL from resting to counting than the control group, $t(97) = 3.3$, $p = .001$, $d = 0.66$ (Figure 22).

**Figure 22**

*Mean Skin Conductance Level (SCL) as a Function of Time (Resting vs Counting) and Group (Control vs Stress) in Study 3*




In sum, the above results indicate that the stress group showed greater increases in both HR and SCL from resting to counting compared with the control group. These findings suggest that the TSST-adapted counting task induced physiological stress.

**5.3.2.2. Subjective response**

I compared changes in mood ratings (stress, anger, worry, sadness, happiness) over time between groups using a 3 (time: resting, counting, mood elevation) x 2 (group: control vs stress) mixed-model MANOVA. Using Wilke's Lambda, I found main effects of both time, $F(10, 91) = 9.17$, $p < .001$, $\eta_p^2 = .50$, and group, $F(5, 96) = 7.29$, $p < .001$, $\eta_p^2 = .28$. However, these findings were qualified by an interaction between time and group, $F(10, 91) = 4.27$, $p < .001$, $\eta_p^2 = .32$.

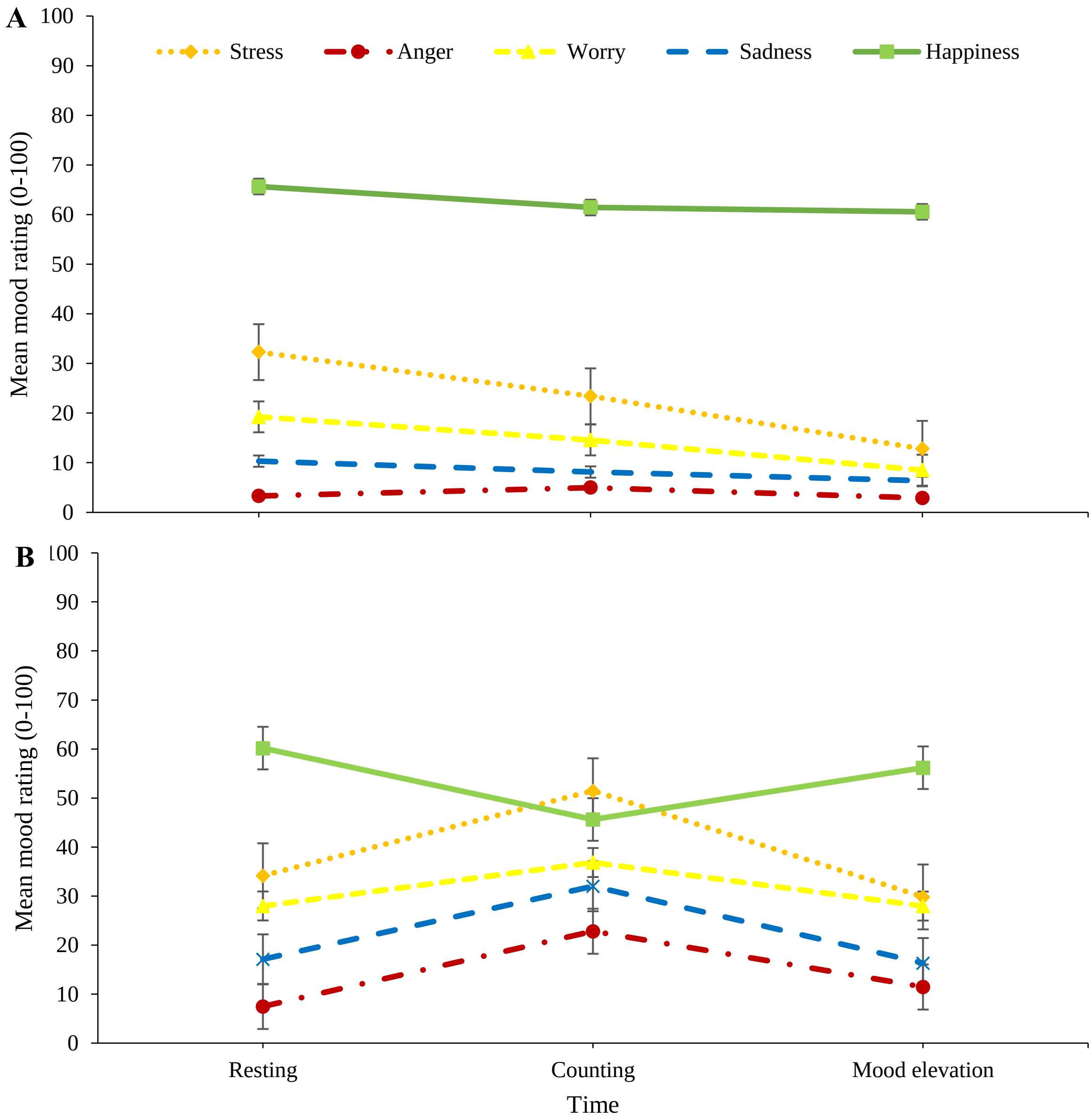
The time x group interaction was significant for all five mood ratings: stress, $F(2, 200) = 17.72$, $p < .001$, $\eta_p^2 = .15$; anger, $F(2, 200) = 9.04$, $p < .001$, $\eta_p^2 = .08$; worry, $F(2, 200) = 5.77$, $p = .004$, $\eta_p^2 = .06$; sadness, $F(2, 200) = 10.62$, $p < .001$, $\eta_p^2 = .09$; and happiness, $F(2, 200) = 6.43$, $p = .002$, $\eta_p^2 = .06$.

To unpack these interactions, I used paired t tests to compare each mood rating between resting and counting, and between counting and mood elevation, within each group. In the control group (Figure 23, Panel A), stress ratings decreased from resting to counting, $t(51) = 3.43$, $p = .001$, $d = .39$, and from counting to mood elevation, $t(51) = 3.72$, $p = .001$, $d = .52$. None of the other mood ratings changed across time (all $p$'s > .05).

In the stress group (Figure 23, Panel B), ratings of stress, anger, and sadness increased from resting to counting (stress: $t(49) = 4.21$, $p < .001$, $d = .64$; anger: $t(49) = 4.29$, $p < .001$, $d = .71$; sadness: $t(49) = 3.69$, $p = .001$, $d = .59$) and then decreased from counting to mood elevation (stress: $t(49) = 7.48$, $p < .001$, $d = .88$; anger: $t(49) = 4.05$, $p < .001$, $d = .53$; sadness: $t(49) = 4.21$, $p < .001$, $d = .63$). Happiness ratings decreased from resting to counting, $t(49) = 4.21$, $p < .001$, $d = .62$, and then increased from counting to mood elevation, $t(49) = 5.38$, $p < .001$, $d = .45$. Worry ratings did not change across time (both $p$'s > .05).

**Figure 23**

*Changes in Mood Ratings as a Function of Time and Group in Study 4*

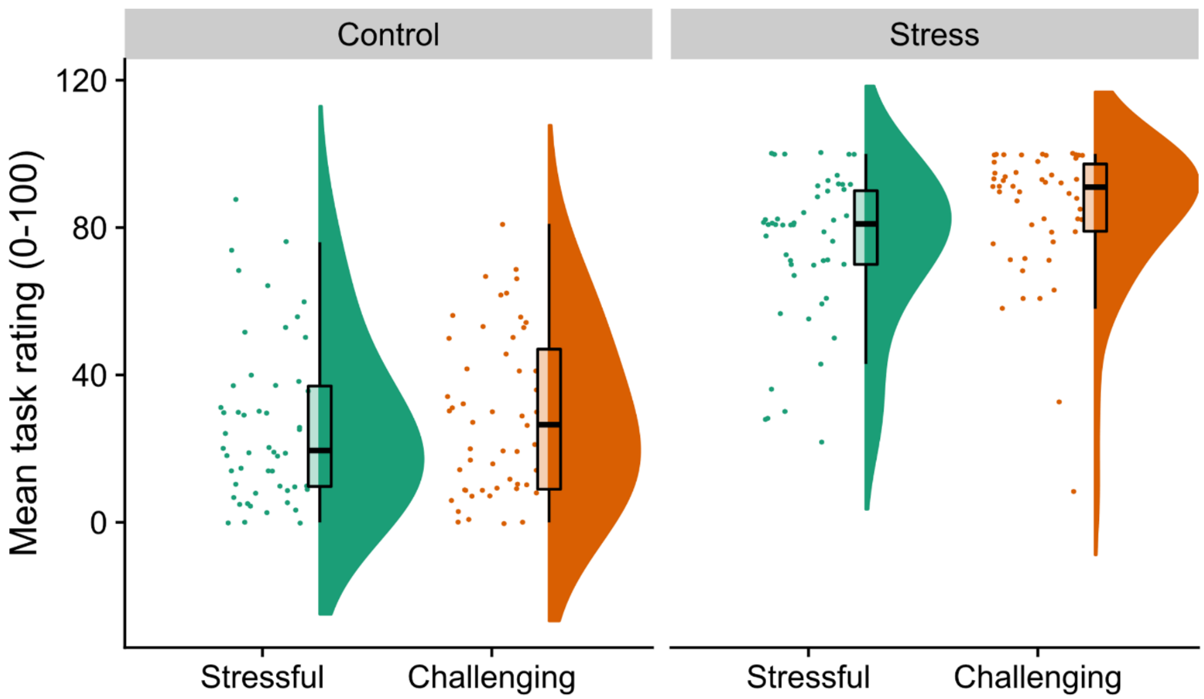



*Note*. Panel A: Mean ratings for control group. Panel B: Mean ratings for stress group. Data-points represent mean mood ratings. Error bars are standard error.

Independent t tests showed that stress group rated the TSST-adapted counting task as both more stressful, $t(100) = 11.52$, $p < .001$, $d = 2.28$, and challenging, $t(100) = 14.06$, $p < .001$, $d = 2.79$, than the control group rated the control counting task (Figure 24).

**Figure 24**

*Task Ratings as a Function of Type (Stressful vs Challenging) and Group (Control vs Stress) in Study 4*




In sum, the above results indicate that the stress group showed a greater increase in stress ratings from resting to counting compared with the control group. The stress group also showed increased general negative mood whereas the control group did not. Finally, the stress group reported finding the TSST-adapted more stressful and challenging than the control group found the control counting task. These findings suggest that the TSST-adapted counting induced subjective stress as well as physiological stress.

Importantly, the stress group showed increased general positive mood from counting to mood elevation. This finding suggests that the mood elevation task successfully reversed the effects of stress induction. Even the control group showed decreased stress, providing additional evidence for the efficacy of the mood elevation task.

### 5.3.3. Preregistered analyses

#### 5.3.3.1. Comparing overall thresholds between groups[13]

The test the effects of stress on perceptions of agency and experience, I compared overall agency and experience thresholds between groups[14]. If my original hypotheses are correct, then the stress group should show lower overall agency thresholds and higher overall experience thresholds compared with the control group. Alternatively, the stress manipulation might produce results similar to those of Study 1. In this case, the stress group should show lower overall thresholds for both agency and experience.

However, the groups did not differ in overall thresholds for agency, $t(100) = .93$, $p = .354$, $d = .18$, or experience, $t(100) = 1.08$, $p = .284$, $d = .21$. These results indicate that the stress manipulation had no effect on thresholds for perceiving agency and experience across the face

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[13] I preregistered a pair of 2 (condition) x 5 (morph) mixed ANOVAs to compare agency and experience thresholds between conditions. But I realised these analyses were impossible because morphs were randomly assigned to each condition for each participant.

[14] I also compared agency and experience thresholds for each face morphs between groups. The stress group showed lower experience thresholds, $t(44) = 2.95$, $p = .005$, $d = .87$, as well as marginally lower agency thresholds, $t(54) = 1.91$, $p = .061$, $d = .51$, for one of the  compared with the control group. Thresholds did not differ between groups for any of the other morphs (all *p*'s > .05). It is unclear why stress affected thresholds for only one of the face morphs. This morph did not have any obvious outstanding physical features compared with the other morphs (see Appendix J).

morphs[15]. These findings do not support my hypotheses; nor do they resemble the findings of Study 1.

**5.3.3.2. Correlating stress with agency and experience thresholds**

My results indicate that the stress manipulation was effective but failed to produce any group differences in agency or experience thresholds. This leaves me with an independent sample to re-test Study 3's preregistered analyses.

To test my hypotheses that stress increases perceptions of agency and reduces perceptions of experience, I correlated scores of self-reported stress (DASS-S, STAI-S, and STAI-T) with overall thresholds for agency and experience (across both groups). If my hypotheses are correct, then self-reported stress scores should correlate negatively with overall agency thresholds and positively with overall experience thresholds. Alternatively, if the current study produces similar results to Study 1, then self-reported stress scores should correlate negatively with overall thresholds for both agency and experience.

However, DASS-S, STAI-S, and STAI-T scores did not correlate with either overall agency or experience thresholds (Table 30). These results do not support my hypotheses. Nor do they resemble the results of Study 1.

[15] To avoid any carry-over effects due to block order in the morph task, I repeated these comparisons separately for participants who were presented with either the agency or experience block first. None of these comparisons were significant (all *p*'s > .05), suggesting that block order did not influence responding.

**Table 30**

*Correlations of Stress Measures with Overall Agency and Experience Thresholds in Study 4*

| Stress measure | Agency | Experience |
|---|---|---|
| DASS-S | -.041 (.340) | .034 (.369) |
| STAI-S | -.099 (.162) | -.055 (.291) |
| STAI-T | -.062 (.267) | -.112 (.130) |

### 5.3.4. Exploratory analyses

#### 5.3.4.1. Comparing thresholds by-items

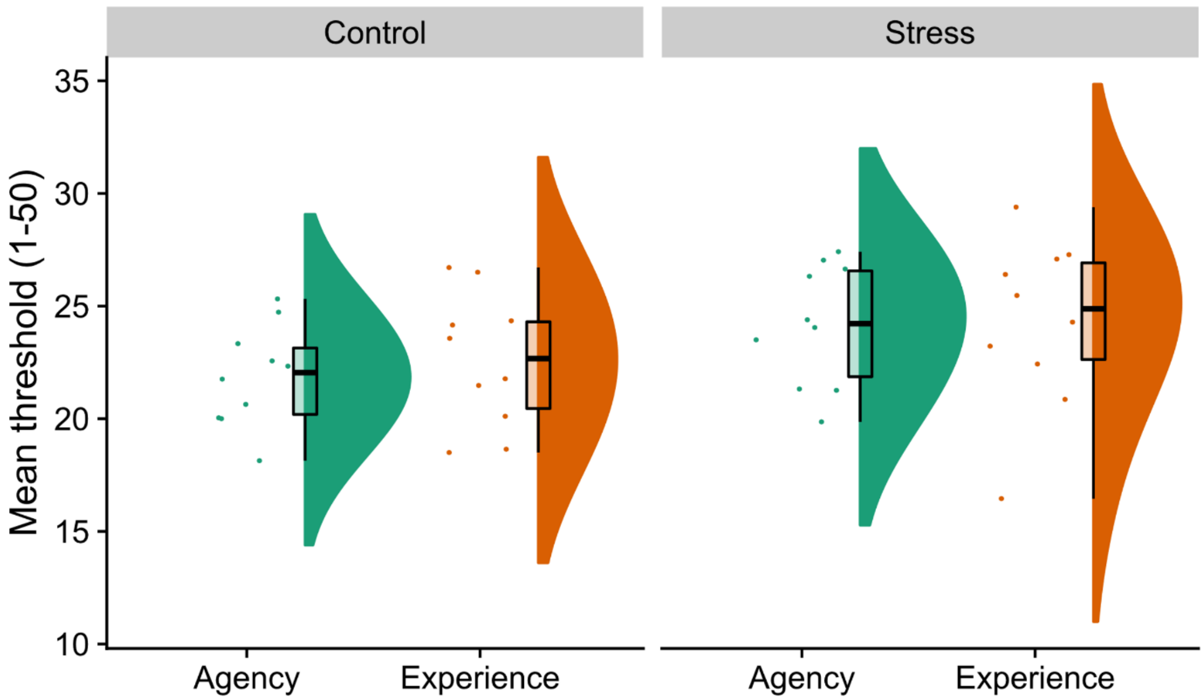
Previously, I compared overall agency and experience thresholds between conditions using by-participants analyses. That is, I calculated the mean threshold for each participant by averaging thresholds across morphs to get the average threshold by-participants within each condition for agency and experience. Then, I compared the mean of the by-participants thresholds using independent t tests.

Here, I used items-analysis to increase the power of these comparisons. I calculated the mean threshold for each morph by averaging thresholds across participants to get the average threshold by-items within each condition for agency and experience. Then, I compared the means of the by-items thresholds using paired t tests (Locker et al., 2007; Raaijmakers, 2003; Raaijmakers et al., 1999).

These by-items comparisons revealed that overall agency thresholds were lower in the stress condition than control condition, $t(9) = 4.745$, $p = .001$, $d = .93$, consistent with my hypothesis for agency (Figure 25). However, overall experience thresholds did not differ between conditions, $t(10) = 1.560$, $p = .153$, $d = .51$, inconsistent with my hypothesis for experience.

**Figure 25**

*Overall Thresholds (Not Reverse-Coded) as a Function of Dimension (Agency and Experience) and Condition (Control and Stress) in Study 4*




*Note*. Plotted data are not reverse-coded. Images in the morphing continua are numbered 1-50 from the human end to doll end. Therefore, higher numbers (closer to doll end) indicate lower thresholds. The plotted data shows a higher mean number for agency in the stress condition than control condition, indicating agency thresholds were significantly reduced in the stress condition.

#### 5.3.4.2. Comparing thresholds by-participants and -items

To resolve the conflict between my subjects analysis and items analysis, I used linear mixed models (LMMs) that included both subjects and items simultaneously within a single analysis. This allowed me to assess the effects of my stress manipulation on agency and experience thresholds without falsely reducing variance by averaging across items (subjects analysis) or participants (items analysis; Locker et al., 2007).

I describe the structure of my models using the syntax designed for lme4 regressions in R, a statistical analysis software package (Bates et al., 2014). My model for agency had the structure: Threshold ~ 1 + Condition + (1|Participant) + (1 + Condition|Item). The dependent variable (threshold) precedes the tilde. Fixed effects immediately follow the tilde. Random effects are placed in brackets. My model for agency thus comprised a fixed effect intercept term, fixed effects of Condition (control, stress), random by-participant adjustments to the intercept, and random by-items adjustments to the intercept and the effect of Condition. The structure of my model for experience was identical.

When reporting the results of my models, I used a rule of thumb for evaluating significance in LMMs by taking t values above .196 as significant at $\alpha = .05$ (Meteyard & Davies, 2020). I do not report degrees of freedom for my models because it is not clear how to define the denominator degrees of freedom in LMMs (Baayen et al., 2008; Bates, 2006; Luke, 2017).

The stress group showed marginally lower thresholds for perceiving agency compared with the control group, $t = 1.87$. Thresholds for perceiving experience did not differ between groups, $t = 1.16$. These results indicate that stressed participants were more willing to attribute agency to inanimate human faces than controls[16].

## 5.4. Discussion

I hypothesized that stress increases perceptions of agency and reduces perceptions of experience. If these hypotheses are correct, participants in the stress condition should show lower thresholds for perceiving agency and higher thresholds for perceiving experience compared with

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[16] After obtaining this finding, I ran similar linear mixed models in Study 3. But these analyses did not produce any significant results.

participants in the control condition. In other words, stress should cause participants to perceive agency more readily and experience less readily. The findings of the current study provide limited support for my hypothesis for agency, but no support for my hypothesis for experience.

Manipulation checks indicate the TSST-adapted counting task induced significant subjective and physiological stress responses relative to the control task. But preregistered by-participants analysis comparing agency and experience thresholds between conditions using independent t tests indicate no significant differences. An exploratory by-items analysis repeating the same comparisons using paired t tests indicated agency thresholds were lower in the stress condition than control condition. Experience thresholds did not differ between conditions. Similarly, exploratory linear mixed models indicate agency thresholds were lower in the stress condition. Experience thresholds did not differ between conditions.

These results indicate that stressed participants were more willing to attribute agency to inanimate human faces than control participants. While this finding supports my hypothesis for agency, it should be interpreted cautiously because it emerged only through exploratory analyses. Additionally, my findings are consistent with Hackel et al. (2014), who found that participants who perceived greater out-group threat had more lenient mind perception thresholds for out-group members.

# 6. General discussion

This thesis is a first step in the investigation of stress's effect on mind perception. To formulate my hypotheses, I reviewed previous research about the effects of stress on psychological constructs related to agency (intentionality) and experience (empathy). Based on this review, I formulated two hypotheses: (1) stress increases perceptions of agency and (2) reduces perceptions of experience. To test these hypotheses, I conducted separate four studies in parallel using two different measures of mind perception (mind survey and morph task) and two different methodological approaches (correlational and experimental). My findings were complex and inconsistent, but a tentative pattern emerges across studies.

## 6.1. Summary of findings

### 6.1.1. Agency

Study 1 showed that participants with high self-reported stress tended to perceive more agency across a range of different entities. But these correlations were small and failed to replicate across my other studies. In both my experimental studies (2 & 4), inducing stress did not have any effect on participants' perceptions of agency according to preregistered analyses. However, in Study 4, more sensitive exploratory analyses showed that stressed participants were more willing to attribute agency to inanimate human faces compared with control participants. This effect was large in a by-items paired t test and marginal in a by-items and -participants linear mixed model.

### 6.1.2. Experience

Study 1 showed that participants with high self-reported stress tended to perceive more experience across other entities, as well as agency. But these correlations were smaller than those for agency and failed replicate across my other studies. In Study 2, participants with high self-reported stress tended to perceive less experience across other entities. But this correlation was small, and significant for only one of the measures of self-reported stress. Self-reported stress did not correlate with thresholds for perceiving experience in either Study 3 or 4. Both preregistered and exploratory analyses indicated that experimentally inducing stress did not affect perceptions of experience in either Study 2 or 4.

#### 6.1.3. Conclusions

My results for agency show some convergence across studies, using different measures of mind perception and different methodological approaches. I therefore take these results to suggest that stress might increase perceptions of agency. I make this conclusion cautiously because the evidence is weak and inconsistent. My results for experience conflict between studies. They are weaker and more inconsistent than my results for agency. Therefore, I find my results for experience inconclusive.

My hypothesis that stress increases perceptions of agency requires further corroboration through refined study designs. Below, I propose a possible mechanism by which stress might increase perceptions of agency. Then, I note some limitations of my studies that might explain why the suggested effect of stress on agency was weak and inconsistent in my results. I recommend study designs addressing these limitations, which might yield stronger results. Finally, I discuss possible implications of the suggested effect of stress on agency for related literature, mind perception, and morality.

### 6.2. Agency as explanation

My findings suggest that stress might increase perceptions of agency in other entities. This could be explained by an increase in the basic human motivation to explain, predict, and control other entities' behaviour, known as effectance motivation (Cohen et al., 1955; Fiske, 2004; Kagan, 1972; White, 1959). Indeed, “human nature abhors a lack of predictability and absence of meaning” (Gilovich, 1991, p. 9).

Effectance motivation increases mind perception because a mind is a concept that can explain the behaviour of almost any entity (Bering, 2002; Epley, 2018; Epley et al., 2013). Consider Heider and Simmel’s (1944) classic study showing participants a film of three geometrical shapes. The shapes were depicted moving in and around a square. Initially, the shapes’ movements seemed random. But they quickly took on meaning as participants described the shapes using mental states (e.g., little triangle is upset with big triangle. Now, little triangle is chasing big triangle around the house). Reasoning about agents in terms of intentionality and mental states “ties together the cause-effect relations” (Heider, 1958, p. 100; see also Malle & Knobe, 1997).

The explanatory power of mental states is also demonstrated by those who have tried to avoid them. Donald Hebb (1946, p. 88) noted that describing chimpanzees’ behaviour without reference to mental states resulted in “endless series of specific acts in which no order or meaning could be found.” But, by using “anthropomorphic concepts of emotion and attitude one could quickly and easily describe the peculiarities of individual animals”[17].

Factors that trigger effectance motivation increase mind perception. One of the basic triggers of effectance motivation is unpredictability. When your car behaves predictably in response to your actions, it seems mindless. But when it starts lurching forward when braking, or stalling when starting, your car might seem to have a mind of its own (Morewedge, 2006). In general, entities that act unpredictably are perceived as having more mind than entities that act

[17] Likewise, the behaviourists disavowed all talk of mentalizing (Skinner, 1957) but ultimately failed to produce an alternative language that psychologists were willing to use (Chomsky, 1959).

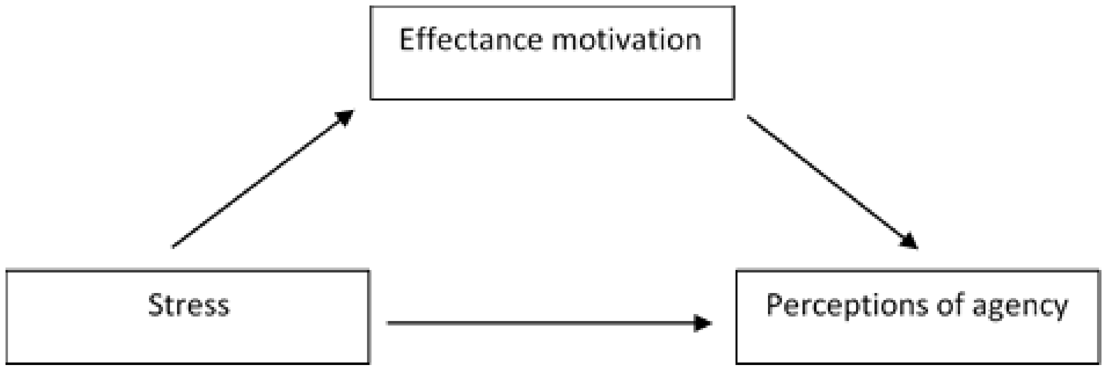
predictably (Epley et al., 2008; Waytz, Cacioppo, et al., 2010; Waytz, Epley, et al., 2010; Waytz, Morewedge, et al., 2010). Manipulating peoples' motivation to predict another entity's actions elicits preferential focus on that entity's agency (Waytz & Young, 2014).

Lacking control also increases mind perception by triggering effectance motivation. When people ruminate on experiences when they lacked personal control, or are primed with thoughts of randomness, they become more likely to believe in an agentic God (Kay et al., 2008, 2010). Similarly, when people are primed with thoughts about powerlessness in the face of death, they become more likely to believe in an agentic God (Norenzayan & Hansen, 2006). Even denying people control over a set of animate marbles increases attributions of intentionality to the marbles (Johnson & Barrett, 2003).

I propose that stress (defined as a cognitive perception of unpredictability and/or uncontrollability; Dickerson & Kemeny, 2004; Henry, 1992; Kim & Diamond, 2002; Koolhaas et al., 2011; Mason, 1968, 1968, 1975; Salvador, 2005) increases perceptions of agency by triggering effectance motivation. This could explain my findings suggesting that stress increases perceptions agency in other entities (particularly God). This could be tested using mediation analysis (e.g., Preacher & Hayes', 2008 bootstrapping method) with stress as the predictor variable, effectance motivation as the mediating variable, and perceptions of agency as the dependent variable (Figure 26).

**Figure 26**

*Postulated effect of stress on perceptions of agency through effectance motivation*




## 6.3. Limitations and future directions

### 6.3.1. The wrong mind perception targets

I might have failed to detect a larger effect of stress on perceptions of agency because I was looking at the wrong targets. Perceptions of agency might be increased mainly in entities related to the stressor. This effect may have generalised minimally to the mind survey characters and face morphs (unrelated to the stressor). In my correlational studies (Studies 1 & 3), the cause of participants' stress was external to the study. In the context of my lab experiments (Studies 2 & 4), the counting task might have increased perceptions of agency mainly in the evaluator.

The counting task combined elements of uncontrollability and social-evaluative threat to produce a strong stress response (Dickerson & Kemeny, 2004; Kirschbaum et al., 1993; Moody, 2016). During performance of the task, the evaluator pressed participants to count faster, particularly those skilled at the task. This created a context of forced failure where participants were unable to succeed or avoid negative consequences despite best efforts, leading to feelings of uncontrollability. To create social-evaluative threat, participants were monitored by the evaluator during the counting task. Performance could therefore be negatively judged by the evaluator.

Poor performance or failure could reveal a lack of a valued trait or ability (e.g., intelligence, competence; Dickerson & Kemeny, 2004; Moody, 2016).

To the extent that the evaluator was perceived as an uncontrollable threat to the social self, participants may have been motivated to explain the evaluator's behaviour, which may have increased perceptions of agency in the evaluator. Consistent with this, Hackel et al. (2014) found that outgroup members perceived as threatening are perceived as having more mind. Similarly, people perceive entities that produce negative outcomes as more intentional than those that produce positive outcomes (Morewedge, 2009; see also Knobe, 2006). Future research should test whether there is a larger effect of stress on perceptions of agency specifically in entities that elicit stress through uncontrollability and/or unpredictability.

#### 6.3.2. Not stressed enough?

Perhaps my participants simply were not stressed enough to produce a larger effect of stress on perceptions of agency. In both my lab experiments, manipulation checks indicated that the counting task induced a significant stress response. Future research should therefore examine the impact of stressful life events on perceptions of agency.

Existing research on religious coping suggests that stressful life events might increase perceptions of agency. People are more likely to believe in God when struck by cancer, heart problems, death in the family, divorce, and injury (for reviews, see Ano & Vasconcelles, 2005; Pargament, 2001). Natural disasters (e.g., earthquakes, tsunamis, and volcanic eruptions) also increase religious beliefs (Ager et al., 2016; Bentzen, 2019; Sibley & Bulbulia, 2012). Other disasters (e.g., war, conflict, and terrorist attacks) have similar effects on religiosity (Henrich et al., 2019; Schuster et al., 2001). Believing in God requires mind perception. People see God as possessing agency but not experience (Gray et al., 2007; Gray et al., 2008; Gray & Wegner, 2010b). The fact that stressful life events increase belief in God suggests an increase in perceptions of agency.

According to religious coping theory, people use religion to understand and deal with adverse and unpredictable situations (Cohen & Wills, 1985; Pargament, 2001; Park et al., 1990; Williams et al., 1991). This often involves finding a reason for the event by attributing it as an act of God. New Orleans Mayor Ray Nagin demonstrated this when he explained Hurricane Katrina as a sign that "God is angry at America [for] being in Iraq under false pretences [and is] upset at black America also" (Martel, 2006, p. A4). Perceiving God's mind behind stressful events transforms those events into instances of meaningful communication from an intentional agent.

Unfortunately, the novel coronavirus (COVID-19) presents an opportunity to examine the impact of stressful life events on mind perception (for an informal review, see Yan, 2020). One way to do this would be to replicate one of my online surveys (e.g., Study 1). The follow-up survey (Study 1b) should be modified to include scales measuring stress related to COVID-19 (e.g., Freedman et al.'s, 2020 COVID-19 Stressful Events and Concerns Scales; see also the International Society for Traumatic Stress Studies COVID measures repository).

Study 1b would allow researchers to examine the relationship between COVID-related stress and mind perception. Because I conducted Study 1 prior to the pandemic outbreak, Study 1b would also allow researchers to investigate whether COVID has moderated the relationship I observed between stress and perceptions of agency. Finally, it might be interesting to compare the influence of COVID-related stress on mind perception between countries with differing levels of current exposure to the virus (e.g., Aotearoa vs United States).

## 6.4. Implications

### 6.4.1. Related literature

My findings suggesting that stress increases perceptions of agency are consistent with previous findings showing that stress makes people more likely to perceive others as acting intentionally.

Rosset (2008; see also Rosset, 2007) found that placing people under cognitive load (due to time pressure) made them more likely to interpret ambiguous actions (e.g., “She stepped in the puddle”) as intentional. Similarly, Kelemen and Rosset (2009) found that cognitive load also causes people to explain natural phenomena as instances of intentional action from an agent (e.g., ‘‘trees produce oxygen so animals can breathe”). Finally, Kubota et al. (2014) found that experiencing a cold-pressor physiological stressor caused people to make intentional attributions of others’ behaviour in everyday situations. Additionally, self-reported stress increased intentional attributions of criminal behaviours.

Consistent with these findings, I found that higher levels of self-reported stress correlated positively with a tendency to perceive agency across a range of different entities. However, exploratory principal components analysis revealed that this overall correlation was driven by increased perceptions of agency mainly in entities with high agency and low experience (e.g., Superman, God, robots), not in ordinary adult humans (high in both dimensions). I also found evidence that inducing psychosocial stress caused people to perceive agency more readily in inanimate human faces. However, this evidence emerged only through sensitive exploratory analyses. It is unclear why Kubota et al.’s physiological stressor might have been more effective than my psychosocial stressor.

Taken together, the previous findings indicate that stress makes people more likely to perceive others' actions as intentional. But, before you can attribute intentions to another entity, you must perceive it as capable of intentionality (i.e., agency). My findings suggesting that stress might increase perceptions of agency therefore provide a possible mechanism by which stress increases attributions of intentions. This could be tested using mediational analysis.

**6.4.2. Mind perception**

My findings suggest that my original hypotheses were incorrect in predicting opposite effects of stress on agency and experience. Perhaps the effect of stress on mind perception is best captured by a single measure of the relative perceptions of agency versus experience. Gray and Wegner (2009; see also 2011) propose a similar idea in their theory of moral typecasting. Moral typecasting describes a tendency to perceive the social world into the two mutually exclusive entities of moral agents and moral patients. In terms of mind perception, moral agents appear to have reduced experiential mental capacities (e.g., sensitivity to pain) and moral patients have reduced agentic mental capacities (e.g., intentionality).

Initially, the idea that perceptions of agency and experience are inversely related might seem to conflict with Gray et al.'s (2007) observation that agency and experience are orthogonal in factor analysis. But this orthogonality indicates only that the dimensions are separable, not that they are independent. Gray and Wegner (2009) note that a 45-degree rotation of Gray et al.'s (2007) original factor solution represents the dimensions of agency and experience in a way that is compatible with my suggestion. On this new rotation, the two dimensions include one dimension of general mind perception (whether or not an entity has a mind, including both agency and experience) and a second dimension of agency versus experience. Perhaps minds are perceived on two dimensions that represent, first, a global measure of mind-having (Dennett, 1996) and, second, a dimension of agency versus experience (Gray & Wegner, 2009).

The agency versus experience dimension could be operationalised as a ratio measure. If the ratio is smaller than one, perceived experience is greater than perceived agency. If the ratio equals one, agency and experience are perceived to be the same. If the ratio is greater than one, agency is greater than experience. The relevant prediction based on my hypothesis is that stress should increase this ratio.

#### 6.4.3. Morality

Perceptions of agency are important for determining whether others' actions are intentional. In turn, determining whether an action was intentional is important for determining responsibility and blame (Heider, 1958; Malle, 1999). People see actions as intentional when the agent had a desire for a particular outcome, a belief that the action would obtain that outcome, an intention to perform the action, the ability to control the action, and awareness of the intention while performing the action (Malle & Knobe, 1997). All these factors reside within the agent, placing responsibility for the action within the agent (Alicke, 2000).

So, the extent to which an agent appears capable of agency (i.e., self-control, planning, intention) is directly related to their perceived responsibility for performing whatever action (Fincham & Emery, 1988; Roberts & Golding, 1991). By extension, an agent's perceived capacity for agency predicts how willing people are to punish that entity for immoral actions (Gray et al., 2007; Gray & Wegner, 2009, 2011; Hogue & Peebles, 1997; Kleinke & Wallis, 1992).

If stress increases perceptions of agency, then it may increase perceptions of responsibility in turn. This carry-over effect on responsibility seems intuitive enough. Anybody who has felt like thrashing their car when it refuses to start can appreciate how stress can make you blame others (even mindless objects) unreasonably (Schultz et al., 2004). Historically, outsized perceptions of agency have led people to prosecute rats for crop-destruction, statues for murder, and the bodies of dead Popes[18] for sacrilege (Berman, 1994). Amusing examples aside, the effect of stress on agency could create serious ethical problems.

The legal system apportions blame and punishment based on criminal action. Judgements of guilt are typically derived from the defendant's intentions (*mens rea*; Shaver, 1985). This is illustrated by the difference between murder (intentional) and manslaughter (unintentional). But if stress increases perceptions of agency, then it might also increase perceptions of intentionality. Criminals whose behaviours is thought to result from intentions are considered treatment-resistant and dangerous (Hanson & Slater, 1988; Kelly, 2000), and are more likely to receive punitive judgements than rehabilitation (Cullen et al., 1985; Grasmick & McGill, 1994). Making matters worse, stress runs high in court-room settings (Kowalski-Trakofler et al., 2003). Legal officials are often under immense stress with caseloads mounting and the defendant's fate hanging in the balance (Eells & Showalter, 1994; Miller & Bornstein, 2004).

Besides creating new perceptions of responsibility, stress might increase perceptions of intentionality, intensifying pre-existing perceptions of responsibility. We are irritated when our neighbour takes our newspaper accidentally, but we are furious when they steal it deliberately (Alicke, 2000; Heider, 1958; Malle & Bennett, 2002; Weiner, 1995). Unintentional sexism can make a person appear oafish, but intentional sexism makes them appear prejudiced (Swim et al.,

[18] If you are curious: On his accession in 896, Pope Stephen VI accused his predecessor, Formosus, of sacrilege. The dead Pope's body was exhumed, dressed in papal robes, and placed on a throne in St. Peter's. A deacon was assigned to defend him. On his conviction, his body was stripped and thrown into the Tiber (see Smith, 1987).

2003). Unintentional harm is immoral, but intentional harm is worse (Darley & Shultz, 1990). Intentional harm even hurts more than unintentional harm (Gray & Wegner, 2008).

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# 8. Appendices

## Appendix A

## Study 1 preregistration

As Predicted:

*"Study 1 (mind survey/MTurk)"* (#25861)

**Created:** 07/16/2019 08:11 PM (PT)

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**1) Have any data been collected for this study already?**

No, no data have not been collected for this study yet.

**2) What's the main question being asked or hypothesis being tested in this study?**

Main question: What is the effect of stress on perceptions of agency and experience?

Predictions: Stress will be positively correlated with perceptions of agency, and negatively correlated with perceptions of experience.

**3) Describe the key dependent variable(s) specifying how they will be measured.**

The main DVs are perceptions of agency and experience, operationalised using the Mind Survey (MS). During the survey, participants rate 6 mental capacities (3 agency; 3 experience) of 9 characters (e.g., an adult human, a tree, a dog, God) on a scale from 0-6. Ratings of the agency and experience capacities are averaged for each character to produce scores for perceived agency and experience, respectively. Ratings of the agency and experience capacities are also averaged across characters to produce overall scores for perceived agency and experience, respectively. Additional DVs include state and trait stress. State stress will be operationalised using the stress scale of the DASS-21 and the state scale of the STAI. Trait stress will be operationalised using the trait scale of the STAI.

**4) How many and which conditions will participants be assigned to?**

This is a correlational study so there is only one condition, including all participants.

**5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.**

Each measure of stress will be correlated with overall scores for perceived agency and experience using Pearson correlations.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

Participants will be excluded from the main analyses if:

They fail a control measure to check for a monotonic increase in attributions of agency from a tree to a dog to an adult human.

They fail the criterion for the attention checks, which consist of 6 randomly-repeated MS items. The differences between ratings of each pair of repeated items is averaged. If the average difference is greater than 2.5, then the participant is excluded.

They fail 2 or more out of 3 memory checks.

**7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.**

The experiment will have 300 participants.

**8) Anything else you would like to pre-register?**

**(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

Nothing else to pre-register.

Appendix B

Study 2 preregistration

As Predicted:

*"Stress and Mind Perception - Mind Survey Experiment, July, 2019"* (#25860)

**Created:** 07/16/2019 07:36 PM (PT)

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**1) Have any data been collected for this study already?**

No, no data have been collected for this study yet.

**2) What's the main question being asked or hypothesis being tested in this study?**

Main question: What is the effect of stress on perceptions of agency and experience?

Predictions: Stress will increase perceptions of agency, and reduce perceptions of experience, relative to no stress.

**3) Describe the key dependent variable(s) specifying how they will be measured.**

The main DVs are perceptions of agency and experience, operationalised using the Mind Survey (MS). During the survey, participants rate 6 mental capacities (3 agency; 3 experience) of 9 characters (e.g., an adult human, a robot, a dog, God) on a scale of 0-6. Ratings of the agency and experience capacities are averaged for each character to produce scores for perceived agency and experience, respectively. Ratings of the agency and experience capacities are also averaged across characters to produce overall scores for perceived agency and experience, respectively.

Additional DVs include state and trait stress. State stress will be operationalised using the stress scale of the DASS-21, the state scale of the STAI, and ratings of current subjective stress on a scale from 0-100. State stress will also be measured through changes in heart rate and skin conductance. Trait stress will be operationalised using the trait scale of the STAI.

**4) How many and which conditions will participants be assigned to?**

The experiment has 2 conditions: stress and control. Half the participants are randomly assigned to each condition.

**5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.**

Scores for each DV (perceived agency and experience for each character) will be entered into 2 (condition) x 9 (character) mixed ANOVAs. We will also use t-tests and Mann-Whitney tests to compare scores of perceived agency and experience between conditions for each character individually. Finally, we will use t-tests and Mann-Whitney tests to compare overall scores for perceived agency and experience between conditions.

Each measure of stress will be correlated with overall scores for perceived agency and experience using Pearson correlations.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

Participants will be excluded from the main analyses if they fail a control measure to check for a monotonic increase in attributions of agency from a tree to a dog to an adult human.

Participants who do not show physiological responses to stress may be excluded from analyses involving physiological measures.

**7) How many observations will be collected or what will determine sample size?**

**No need to justify decision, but be precise about exactly how the number will be determined.**

The experiment will have 100 participants (50 per condition).

**8) Anything else you would like to pre-register?**

**(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

Nothing else to pre-register.

# Appendix C

## Study 3 preregistration

As Predicted:

*"Stress and Mind Perception - Morph Task Survey, July, 2019"* (#25894)

**Created:** 07/17/2019 08:27 PM (PT)

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**1) Have any data been collected for this study already?**

No, no data have been collected for this study yet.

**2) What's the main question being asked or hypothesis being tested in this study?**

Main question: What is the effect of stress on perceptions of agency and experience?

Predictions: Stress will be positively correlated with perceptions of agency, and negatively correlated with perceptions of experience.

**3) Describe the key dependent variable(s) specifying how they will be measured.**

The main DVs are perceptions of agency and experience, operationalised using a morph task. In each trial, participants scroll through a series of 50 images on a continuum that morphs a human face with a doll face (in 2% increments), and select the image where the face first looks capable of either feeling pain (experience) or formulating a plan (agency). There are 10 different faces, and 5 faces are randomly assigned to each capacity. The faces are blocked for each capacity, and the blocks are presented in counterbalanced order. Image choices (1-50) are averaged across participants to produce thresholds for perceived agency and experience for each face. Agency and experience thresholds are averaged across faces to produce overall thresholds for agency and experience.

Additional DVs include state and trait stress. State stress will be operationalised using the stress scale of the DASS-21 and the state scale of the STAI. Trait stress will be operationalised using the trait scale of the STAI.

**4) How many and which conditions will participants be assigned to?**

This is a correlational study so there is only one condition, including all participants.

**5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.**

Each measure of stress will be correlated with overall agency and experience thresholds using Pearson correlations.

To avoid any effect of judging one of the capacities (perceived agency and perceived experience) before the other, all the above correlations will be repeated using only data from participants who were presented with the agency or experience block first.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

Two faces will be randomly repeated (1 for agency; 1 for experience). Participants will be categorized as inattentive to the task and thus excluded from analysis if their response to either of these repeated faces differs from their original choice by more than 5 images on the continuum in either direction.

**7) How many observations will be collected or what will determine sample size?**

**No need to justify decision, but be precise about exactly how the number will be determined.**

The study will have 300 participants.

**8) Anything else you would like to pre-register?**

**(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

Nothing else to pre-register.

# Appendix D

## Study 4 preregistration

As Predicted:

*"Stress and Mind Perception - Morph Task Experiment, July, 2019"* (#25893)

**Created:** 07/17/2019 08:16 PM (PT)

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**1) Have any data been collected for this study already?**

No, no data have been collected for this study yet.

**2) What's the main question being asked or hypothesis being tested in this study?**

Main question: What is the effect of stress on perceptions of agency and experience?

Predictions: Stress will increase perceptions of agency, and reduce perceptions of experience, relative to no stress.

**3) Describe the key dependent variable(s) specifying how they will be measured.**

The main DVs are perceptions of agency and experience, operationalised using a morph task. In each trial, participants scroll through a series of 50 images on a continuum that morphs a human face with a doll face (in 2% increments), and select the image where the face first looks capable of either feeling pain (experience) or formulating a plan (agency). There are 10 different faces, and 5 faces are randomly assigned to each capacity. The faces are blocked for each capacity, and the blocks are presented in counterbalanced order. Image choices (1-50) are averaged across participants to produce thresholds for perceived agency and experience for each face. Agency and experience thresholds are averaged across faces to produce overall thresholds for perceived agency and experience.

Additional DVs include state and trait stress. State stress will be operationalised using the stress scale of the DASS-21, the state scale of the STAI, and ratings of current subjective stress on a VAS from 0-100. State stress will also be measured through changes in heart rate and skin conductance. Trait stress will be operationalised using the trait scale of the STAI.

**4) How many and which conditions will participants be assigned to?**

The experiment has 2 conditions: stress and control. Half the participants are randomly assigned to each condition.

**5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.**

Thresholds for perceived agency and experience will be entered into 2 (condition) x 5 (face) mixed ANOVAs. We will also use t-tests to compare agency and experience thresholds between conditions for each face. We will also use t-tests to compare overall thresholds for agency and experience between conditions.

To avoid any effect of judging one of the capacities (perceived agency and perceived experience) before the other, the above analyses of thresholds for each capacity will be repeated using only data from participants who made judgments about that capacity first. For example, thresholds for perceived agency will be entered into a 2 (condition) x 5 (face) mixed ANOVA using only data from participants who viewed the agency block first; similarly, thresholds for perceived experience will be analysed using data from participants who viewed the experience block first.

Each measure of stress will be correlated with overall agency and experience thresholds using Pearson correlations.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

Two faces will be randomly repeated (1 for agency; 1 for experience). Participants will be categorized as inattentive to the task and thus excluded from analysis if their response to either of these repeated faces differs from their original choice by more than 5 images on the continuum in either direction.

Participants who do not show physiological responses to stress may be excluded from analyses involving physiological measures.

**7) How many observations will be collected or what will determine sample size?**

**No need to justify decision, but be precise about exactly how the number will be determined.**

The experiment will have 100 participants (50 per condition).

**8) Anything else you would like to pre-register?**

**(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

Nothing else to pre-register.

# Appendix E

## Depression Anxiety Stress Scale 21

## (DASS-21; Henry & Crawford, 2005)

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 = Did not apply to me at all

1 = Applied to me to some degree, or some of the time

2 = Applied to me to a considerable degree or a good part of time

3 = Applied to me very much or most of the time

1. I found it hard to wind down
2. I was aware of dryness of my mouth
3. I couldn't seem to experience any positive feeling at all
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)
5. I found it difficult to work up the initiative to do things
6. I tended to over-react to situations
7. I experienced trembling (eg, in the hands)
8. I felt that I was using a lot of nervous energy

9. I was worried about situations in which I might panic and make a fool of myself

10. I felt that I had nothing to look forward to

11. I found myself getting agitated

12. I found it difficult to relax

13. I felt down-hearted and blue

14. I was intolerant of anything that kept me from getting on with what I was doing

15. I felt I was close to panic

16. I was unable to become enthusiastic about anything

17. I felt I wasn't worth much as a person

18. I felt that I was rather touchy

19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)

20. I felt scared without any good reason

21. I felt that life was meaningless

Depression Subscale consists of items 3, 5, 10, 13, 16, 17, and 21.

Anxiety Subscale consists of items 2, 4, 7, 9, 15, 19, and 20.

Stress Subscale consists of items 1, 6, 8, 11, 12, 14, and 18.

*Note*. Depression and Anxiety items were not included in analyses in this thesis.

# Appendix F

## State-Trait Anxiety Inventory

(STAI; Spielberger & Gorsuch, Lushene, Vagg, & Jacobs, 1983)

State Form Y-1 (STAI-S)

**DIRECTIONS:**

A number of statements which people have used to describe themselves are given below. Please read each statement and then select the appropriate response to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

1 = not at all

2 = somewhat

3 = moderately so

4 = very much so

1. I feel calm
2. I feel secure
3. I am tense
4. I feel strained
5. I feel at ease
6. I feel upset

7. I am presently worrying over possible misfortunes
8. I feel satisfied
9. I feel frightened
10. I feel comfortable
11. I feel self-confident
12. I feel nervous
13. I am jittery
14. I feel indecisive
15. I am relaxed
16. I feel confident
17. I am worried
18. I feel confused
19. I feel steady
20. I feel pleasant

*Note*. Items 1, 2, 5, 8, 10, 11, 15, 16, 19, 20 are reverse-coded.

Trait Form Y-2 (STAI-T)

**DIRECTIONS:**

You will now read a number of statements that people have used to describe themselves. Read each statement and then click the appropriate number to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

1 = almost never

2 = sometimes

3 = often

4 = almost always

1. I feel pleasant
2. I feel nervous and restless
3. I feel satisfied with myself
4. I wish I could be as happy as others seem to be
5. I feel like a failure
6. I feel rested
7. I am “calm, cool, and collected”
8. I feel that difficulties are piling up so that I cannot overcome them
9. I worry too much over something that really doesn’t matter
10. I am happy
11. I have disturbing thoughts

12. I lack self-confidence

13. I feel secure

14. I make decisions easily

15. I feel inadequate

16. I am content

17. Some unimportant thought runs through my mind and bothers me

18. I take disappointments so keenly that I can’t put them out of my mind

19. I am a steady person

20. I get in a state of tension or turmoil as I think over my recent concerns and interests

*Note*. Items 21, 23, 26, 27, 30, 33, 34, 36, 39 are reverse-coded.

# Appendix G

## Counting task evaluator script

*Note*. Italicised text indicates instructions for the evaluator.

*Enter the room wearing a white lab coat, with your clipboard, notepaper with correct answers, pen and stopwatch. Sit down on a chair opposite the participant.*

*Maintain a neutral, professional demeanour (i.e., no small talk). You should be more serious/cold than casual or friendly. Say:* "You will now complete a test of working memory and verbal intelligence. You are required to count backwards from 2023 in sets of 17. You must count aloud. It is important that you count as quickly as possible without making any errors. Your performance will be timed and if you make a mistake, you will have to restart. Start counting now."

*Start your stopwatch and look intently at the participant. Tick off each number as they say it. If they make a mistake, say,* "Stop. That was an error. Start again from 2023." *Make a point of stopping and restarting the stopwatch, noting the time and that a restart was made on your clipboard. (In reality, you are just stopping the stopwatch and not restarting, so that you can keep track of how much time has passed).*

*While they are counting, appear to be making notes about their performance, particularly when they appear to struggle. Roughly once per minute, tell the participant,* "You need to count faster."

*After five minutes are up, tell the participant,* "Stop counting now." *Exit the room.*

# Appendix H

## Morph task stimuli

My stimuli were a subset of 10 of the 20 face identities used by Looser and Wheatley (2010). I excluded morphs for various reasons due to salient features that may have signalled lack of animacy (e.g., stone texture). I also excluded morphs that were children or infants because they would likely have a floor effect for perceived agency. Finally, I tried to ensure that there were equal numbers of female and male faces.