# Empathy-Induced Distress: A Psychophysiological Approach

by
Isabella M. Karabinas

A THESIS

submitted to

Oregon State University

Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Biochemistry & Molecular Biology and Psychology
Honors Scholar

Presented May 18, 2020
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AN ABSTRACT OF THE THESIS OF

Isabella M. Karabinas for the degree of Honors Baccalaureate of Science in Biochemistry & Molecular Biology and Psychology presented on May 18, 2020. Title: Empathy-Induced Distress: A Psychophysiological Approach.

Abstract approved:_____

John Edwards

**ABSTRACT**

Empathy is considered a significant motivator of prosocial behavior. Increasing evidence suggests that feelings of personal distress associated with empathy may be stronger or weaker according to the form of perspective taking that an empathizer utilizes. The aim of the present study was to further quantify the stress consequences and personal distress associated with different forms of empathetic perspective taking – affective perspective taking (APT) and cognitive perspective taking (CPT) – and examine the associated effects on helping behavior. This was accomplished through an integrated psychophysiological approach utilizing both self-report and salivary biomarkers of stress. Salivary cortisol, salivary $\alpha$-amylase, and heart rate variability were used to measure stress reactivity in response to an emotionally-provoking video broadcast. We hypothesized that the APT group would demonstrate greater levels of psychological and physiological distress compared to the CPT group and control group. APT and CPT groups reported greater levels of personal and other-oriented distress than the control group. Physiological indicators of stress suggest that APT and CPT groups experienced greater stress than the control group, though the results are largely inconclusive. These preliminary findings confirm the relationship between physiological and psychological responding in this context and demonstrate that empathy likely has a measurable physiochemical basis.

Key Words: empathy, perspective taking, stress, cortisol, alpha amylase

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Honors Baccalaureate of Science in Biochemistry & Molecular Biology and Psychology project of Isabella M. Karabinas presented on May 18, 2020

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I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

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Isabella M. Karabinas, Author

# INTRODUCTION

## *Empathy and Altruism*

Observing someone experiencing an emotion, whether positive or negative, can result in a feeling of shared emotion, in which the observer may feel compassion for one expressing sadness or joy for one expressing excitement. This emotional bond between individuals – empathy – is thought to be the primary motivation for altruistic behavior (Davis, 1996). Philosophers have posited various mechanisms mediating the induction of prosocial behavior. Some philosophers, most notably Kant (1776), have argued that reason and rationality are what drive the motivation to engage in prosocial behaviors. Others, including Hume (1777) have insisted that the drive towards altruism comes from affective motivators such as sympathy and benevolence, which motivate us to act with consideration for others (Miller & Eisenberg, 1988). According to Adam Smith, the author of *The Theory of Moral Sentiments*, the affective states of individuals are linked through sympathy, or what would be defined today as empathy. Showing common emotion through empathy facilitates bonding between individuals by demonstrating approbation and mutual understanding of the other's emotions, thereby validating their responses (A. Smith, 1790).

The capacity for emotional connectedness and altruism can be seen in neural, physiological, and behavioral correlates across animal species, suggesting that the foundational components comprising empathy are much more ancient than humans. Other-oriented behavior is believed to have first evolved in the context of parenting, where greater awareness of an offspring's emotional state would lead to greater chances of its survival. This capacity for emotional connectedness can also be observed in adult-adult interactions across mammalian species (de Waal, 2008). This explanation for the roots of altruism may, at first glance, appear to contradict common evolutionary ideas of reproductive fitness, many of which are based in the idea of " the survival of the fittest." This classic evolutionary approach to natural selection is an individualistic, egoistic approach to survival that is effective for many applications, including the study of altruism. Through a behaviorist lens, people choose their actions so as to maximize personal gain while minimizing the consequences. This form of behavior is inherently egotistic, but it increases the chances of

an individual's evolutionary survival (Davis, 1996). As helpful as self-oriented behavior is for the survival of the individual, it must be balanced with other-oriented behavior to allow for the functionality and evolutionary survival of the larger group. The ability to empathize with conspecifics allows for a greater ability to regulate social interactions and coordinated activity towards group goals, increasing group evolutionary survival and therefore encouraging altruistic behavior (de Waal, 2008). The survival of the individual is often dependent on the greater functioning of the social group as a whole, a goal that is supported by individual, intrinsic motivations to help others.

The relationship between empathy and altruism postulated by philosophers has become a topic of experimental exploration for many psychologists interested in studying the mechanisms that drive social bonding. Empirically-validated associations between empathy and prosocial behavior are so strong that a lack of empathy is often thought to be the basis for psychopathy and violence (Mayer et al., 2018). Empathy is putatively important for normal moral development and the inhibition of aggressive tendencies during childhood development. A child may act out aggressively and then experience their victim's emotional reaction to that aggression. Children that are capable of then empathizing with the victim of their aggression and vicariously experiencing their situation are less likely to continue acting aggressively in the future. As the apparent antidote to psychopathy and the social glue that keeps society functioning, empathy is thought to be integral for personality development, social exchange, and altruism.

In a meta-analysis of the literature examining the relationship between empathy, aggression, and psychopathy, self-report measures of empathy were found to have a significant negative correlation with aggression and antisocial behavior. These results suggested that empathy is involved in the inhibition of aggressive and antisocial behavior, with a potential mediatory role (Miller & Eisenberg, 1988). The conclusions of the study, however, were limited at the time by a gap in the literature; there was a need to study how differential types of empathetic responding could affect the relationship between empathy and antisocial behavior, as well as the relationship between empathy and prosocial behavior. One of the primary goals of this undergraduate thesis is to begin to address the effects of different forms of empathetic responding on altruistic behavior.

### *The Empathy-Altruism Hypothesis*

Empathizing with another and vicariously experiencing their situation fosters an emotional connection, a connection that can motivate helping behavior. The source of motivation driving helping behavior has been a topic of debate in the literature for some time. The empathy-altruism hypothesis, postulated by Batson and coworkers, states that the motivation that an empathizer experiences to help a suffering other is altruistic (Batson et al., 1981). Here, altruism is defined specifically as any helping behavior that is carried out with the primary motivation to help another, with no expectation of a reciprocal reward. Thus, from the perspective offered by the empathy-altruism hypothesis, helping that is motivated by empathy is truly altruistic because the end goal is to reduce negative feelings of distress the other person is experiencing (Batson et al., 1981). There is significant evidence to support the empathy-altruism hypothesis (Batson et al., 1981, 1991, 1997; Stotland, 1969).

The primary opposing perspective to the empathy-altruism hypothesis is the negative state relief hypothesis, which postulates that empathy-driven helping behavior is, in fact, driven by an egoistic sense of motivation directed at the end goal of helping the self. An observer or empathizer will likely express their engagement in helping behavior in other-oriented terms, saying that their behavior was motivated by a true desire to help. While the empathizer may believe that their actions were altruistically motivated, an egoistic desire to reverse their own negative feeling state may have partly or fully driven their helping behavior. Empathizing with another and vicariously experiencing their situation may lead an empathizer to feel a high degree of personal distress (e.g. grief, shock, sadness) as a result of their connection with the other's situation. In addition, an empathizer can anticipate that their negative feeling state will be further affected (e.g. with guilt or shame) if they make no effort to help the other person. After beginning to experience empathy-induced personal distress, an empathizer may be motivated to reduce their own negative feeling state by consoling the other person or carrying out a similar helping behavior to alleviate current feelings of distress and avoid anticipated feelings of guilt or shame (Batson et al., 1981).

### *Defining Empathy and Perspective Taking*

Empathy can be contrasted with sympathy, which involves an inherently more passive understanding of another's emotional state (Davis, 1996). Both empathy and sympathy are emotional responses that are elicited by the emotional state of the other person. The affective difference arises in the appraisal of and response to those emotions. Empathy is a response based in emotions either identical to or similar to those of the other person. Conversely, sympathy is characterized by concern and sadness for the other rather than emotional matching (Eisenberg & Miller, 1987; Miller & Eisenberg, 1988; Wispé, 1986). In the case of sympathy, the observer becomes moved by another person's experience. If that experience is negatively valanced, the observer understands the other's emotional pain as a problem to be solved. Sympathy is oriented towards the events of the other person's situation and their consequences. Empathy comes from a different mindset entirely; to empathize is to intentionally step outside of the self and into the experience of the other for the sole purpose of better understanding his or her subjective experience (Wispé, 1986). The focus in empathy, then, is on the emotional connection between the observer and the other that arises from the observer's cognitive understanding of the situation of the other.

Empathy is a complex construct comprised of multiple integral components. One such component is the capacity for empathetic concern, or concern for another in emotional distress. Empathetic concern requires an observer to correctly attribute his or her feelings of distress to empathetic arousal as opposed to some other factor. Stated differently, the person must maintain a degree of self-other distinction in the interpretation of emotions resulting from empathy (de Waal, 2008). Without this self-other distinction, the observer may experience personal distress in place of empathetic concern, motivating a selfish need to ameliorate one's own empathy-induced distress rather than that of the other in pain (Batson et al., 1997; de Waal, 2008). In this case, the empathizer may choose to escape the situation entirely without engaging in helping behavior, using avoidance as their primary tactic to reduce personal distress (Batson et al., 1991; Buffone et al., 2017). This idea contrasts those presented by the negative-state relief hypothesis, because instead of motivating prosocial behavior, empathy-induced distress is believed to hinder it.

Another essential component of empathy, and the one of primary interest for this research, is perspective taking. Perspective taking requires a deliberate cognitive effort to imagine the situation another is facing, adopt their perspective, and infer the reactions of the other person based on real and imagined contextual information (Davis, 1996; Underwood & Moore, 1981). As the method through which imagined vicarious experience occurs, perspective taking is central to the experience of empathy.

***Different Approaches to Empathetic Perspective Taking***

According to Batson (1997) and Stotland (1969), influential researchers in the areas of empathy and perspective taking research, there are two primary forms of empathetic perspective taking: cognitive and affective perspective taking. The cognitive approach to perspective taking (termed imagine-other by Batson) is conducted through an other-oriented lens. Alternatively, affective perspective taking (imagine-self perspective taking) is accomplished through a self-oriented perspective.

Affective perspective-taking (APT), or "placing oneself in another's shoes" is the most common lay understanding of empathy. APT is focused on the experience of the other through the lens of the observer. This form of perspective taking requires the observer to imagine themselves in the position of the other in order to experience the perceived feelings associated with that situation. In this case, the observer processes the social, cognitive, and emotional aspects imagined to be part of the other's situation in a psychologically intimate manner. The observer's imaginative self-insertion into the other's situation is believed to decrease the observer's sense of self-other distinction with the other in distress, thereby increasing the degree of personal distress the observer may feel (Batson et al., 1997; Buffone et al., 2017).

Cognitive perspective taking (CPT) involves imagining how the other perceives his or her situation, drawing from imagined social and cognitive aspects of the person's situation. CPT is a perspective that is focused on how the other person must be perceiving and reacting to his or her situation, cognitively and emotionally. Without the observer's imaginative self-insertion into the other's reality that is typical of APT, CPT is thought to carry a comparatively smaller emotional load, thereby encouraging feelings of empathetic concern over personal distress. Imagining how the other must feel rather than imagining how oneself would

feel is thought to provide a greater sense of self-other distinction, a necessary step to prevent significant personal distress in the observer (Batson et al., 1997; Buffone et al., 2017).

The primary difference between APT and CPT arises in the degree of distress that is associated with each model. Increasing evidence suggests that the physiological responses (Buffone et al., 2017; Stotland, 1969) and psychological processes (Batson et al., 1997) involved in empathetic perspective taking differ based on the form of perspective taking being utilized. The method that the observer uses to perceive the other's situation can differentially affect the observer's psychological and physiological arousal, with the degree of empathetic connection acting as a potential mediating variable between perspective taking and personal distress. The feeling of shared experience and emotion driven by empathy, both positive and negative, may be directly tied to the way that the empathizer engages with the imagined experience of the other. Stated differently, there may be differential feeling consequences for the empathizer according to their degree of cognitive and emotional connection or distance from the other's situation.

***The Biopsychosocial Model of Challenge and Threat: Connections to Perspective Taking***

When presented with a stressful situation, an individual may either feel threatened or challenged, depending on their perceived ability to confront the given situation. An evaluation of the demands of a situation against the resources available to the individual to manage the situation will result in one of two outcomes: a surplus or adequate amount of perceived resources to those needed to confront the situation, leading to feelings of challenge; or a perceived resource deficit, leading to feelings of threat. This is in accordance with the biopsychosocial model of challenge and threat, which proposes a differential activation of stress response systems according to feelings of challenge or threat (Buffone et al., 2017; Seery, 2013).

Feelings of challenge are associated with the activation of the sympathetic-adrenomedullary (SAM) axis, which coordinates the collaborative activity of the sympathetic nervous system and resultant adrenal response mechanisms. Activation of the adrenomedullary system triggers the release of norepinephrine and epinephrine into the blood stream for a quick energy boost. These two hormones have a relatively fast release time and a short half-life in the bloodstream, on the order of minutes. Epinephrine causes vasodilation of the arteries in the peripheral circulation, increasing blood supply (and thus oxygen supply)

to skeletal muscles in preparation for action. This results in an overall lower total peripheral resistance and a higher cardiac output (Seery, 2013). The activation of the sympathetic nervous system in response to a challenge-oriented stressor results in increased mobilization of energy stores and increased oxygen availability to peripheral muscles in preparation to face a challenge.

Conversely, feelings of threat elicit the activation of the SAM axis in conjunction with the activation of the hypothalamic-adrenal-pituitary (HPA) axis (Seery, 2013). This pairing of stress activation systems increases heart rate but produces vasoconstriction of the arteries leading to skeletal muscles rather than vasodilation; due to the functioning of negative feedback systems, HPA axis activity ultimately restricts epinephrine release. Under feelings of threat, the heart will work just as hard as in the challenge state, but with a lower resultant cardiac output. The activation of the HPA axis results in an elevated release of cortisol into the bloodstream, the effects of which have a half-life of over an hour (Seery, 2013).

Buffone and colleagues (2017) examined the differences in physiological and psychological arousal induced by affective and cognitive perspective taking in the context of threat versus challenge orientation using cardiac and self-report measures of stress. They found that affective perspective taking resulted in a relative threat orientation, and cognitive perspective taking resulted in a (marginally significant) challenge orientation. This example is one of only a handful of studies in the literature to have tested the physiological relevance of the differential stress activation induced by affective and cognitive perspective taking. To our knowledge, the relationship between empathy-induced distress and measures of endocrine stress responses have yet to be examined.

The important role of the observer's emotional attachment to the suffering other in APT may induce not only feelings of empathetic concern, but also significant feelings of personal distress as compared to those induced by CPT (Batson et al., 1997; Buffone et al., 2017; de Waal, 2008). This interaction has been studied and reported extensively within the social psychological literature. However, the large majority of studies in which empathy-induced stress consequences are investigated are conducted with a complete reliance on self-report data. Validation of these results using quantitative measures of endocrine stress

reactivity would further solidify the putative connection between challenge and threat orientations, stress, and empathetic perspective taking.

***Interplay Between the Sympathetic, Adrenomedullary, and Adrenocortical Systems***

The adrenomedullary, adrenocortical, and sympathetic nervous systems are activated in response to various forms of stress. Stressors are phenomena that disrupt homeostasis, and can include metabolic threats such as hypoglycemia, increased energy demands during physical exercise, or more global threats such as emotional distress or shock (Goldstein, 2010). Upon activation of the sympathetic nervous system, efferent neurons originating from the sympathetic chain that enervate the adrenal glands release acetylcholine. Sufficient stimulation of the adrenal medulla by acetylcholine leads to the release of epinephrine and norepinephrine into the blood stream. The activation of the SAM axis results in the elevation of heart rate, blood pressure, and blood glucose, readying an optimized response in the face of direct or anticipated challenges (Herman et al., 2016). This increase in heart rate in turn increases cardiac output, allowing for greater oxygen availability to peripheral muscles reacting to or anticipating a flight-or-fight scenario.

As part of the adrenocortical response to stress, corticotropin-releasing hormone (CRH) is released from the hypothalamus and travels to the anterior pituitary gland, where it causes the release of adrenocorticotropic hormone (ACTH). ACTH binds to receptors in the adrenal cortex, leading to the release of cortisol into the bloodstream (Turpeinen & Hämäläinen, 2013). The paraventricular nucleus (PVN) in the hypothalamus is the sight of CRH synthesis. The PVN is innervated by neurons from the brain stem and limbic structures, among other brain regions. The locus coeruleus (LC), a cluster of noradrenergic neurons in the brainstem, has been implicated in behavioral functions including emotional and adaptative stress responses (S. M. Smith & Vale, 2006). These noradrenergic neurons, which receive input from sympathetic and parasympathetic afferents, can activate the HPA axis in response to stress (Herman et al., 2016). Stimulation of the neurons in the LC results in the release of ACTH (S. M. Smith & Vale, 2006). The functionalities of the noradrenergic and glucocorticoid responses to stressful stimuli are thus linked,

but separate (Goldstein, 2010; S. M. Smith & Vale, 2006). The adrenomedullary, adrenocorticotropic, and sympathetic nervous systems interact to form a complex, multifaceted response to stressful stimuli.

The primary purpose of the HPA axis is the maintenance of blood glucose levels in response to stressors and circadian rhythms. Cortisol is released according to circadian cycles, reaching maximum levels during waking (Herman et al., 2016; Turpeinen & Hämäläinen, 2013). This diurnal fluctuation in cortisol levels is important for maintaining energy homeostasis, allowing for sufficient energy availability for activity during the day (Herman et al., 2016). The HPA axis can also be activated to prepare an organism for a direct or predicted perceived threat (Herman et al., 2016), which can be physical or emotional in nature.

***Salivary Biomarkers of Stress***

Salivary cortisol and salivary α-amylase are used frequently as biomarkers of HPA-axis and SAM-axis activation, respectively (Bendezú & Wadsworth, 2018; Cozma et al., 2017; Nater et al., 2005; Strahler et al., 2017; Turpeinen & Hämäläinen, 2013).

Amylase is an enzyme found in the saliva that aids in the process of breaking down starches in food. It is produced by acinar cells, which are innervated by sympathetic and parasympathetic connections. There is evidence to suggest that salivary α-amylase (sAA) measurements correlate with fluctuations in norepinephrine, leading many to use sAA as a proxy measure of noradrenergic and SAM axis activation (Ali & Nater, 2020; Strahler et al., 2017). Other indicators of autonomic activity, namely epinephrine and norepinephrine, require invasive blood or spinal draws (Ali & Nater, 2020). The ease of saliva sample collection for sAA analysis has allowed sAA to become a common measure of autonomic nervous system activity (Ali & Nater, 2020; Nater et al., 2005).

Salivary α-amylase is used quite often as an indicator of noradrenergic activity, but the relationship between sAA and norepinephrine levels is not perfect. Because acinar cells are innervated by both sympathetic and parasympathetic connections, it is not certain whether sAA levels represent sympathetic activity or possibly a combination of sympathetic and parasympathetic activity. In most cases, sAA and norepinephrine levels appear to co-occur, but in other cases, the sAA and norepinephrine levels have been

shown to increase independently (Petrakova et al., 2015). The use of sAA as a biomarker of autonomic activity is relatively new, and while it is still a candidate salivary biomarker of stress, its overall correlation with noradrenergic activity and easy collection in saliva has made it a popular choice for many researchers studying autonomic activity.

Cortisol is a reliable indicator of system fluctuations in HPA axis activity (Nater et al., 2005). Cortisol is transported through the bloodstream while bound to a carrier protein, most commonly cortisol binding globulin or albumin. The levels of total cortisol in serum (bound and unbound) can be measured through a variety of techniques, including colorimetric assays, mass spectrometry, and immunoassays (Turpeinen & Hämäläinen, 2013). Salivary cortisol (sCort) is an ultrafiltrate of free cortisol and represents the levels of biologically active cortisol. The use of salivary cortisol over serum cortisol as an indicator of HPA axis activity presents several benefits in the experimental setting. The collection of saliva samples for the measurement of sCort is a non-invasive alternative to blood draws, which are necessary to measure serum cortisol levels. In addition, measurements of sCort concentration are highly sensitive, allowing sCort to be used widely in experimental and in diagnostic settings. Because the levels of salivary cortisol are only a fraction of the levels in serum, ultrasensitive detection methods, such as mass spectrometry or immunoassays, should be utilized (Turpeinen & Hämäläinen, 2013).

***Present Study***

In the present study, the relationship between empathetic perspective taking and personal distress was studied from a psychophysiological approach, with the goal of replicating results from previous works (Batson et al., 1997; Buffone et al., 2017; Stotland, 1969) and extending their work by incorporating an endocrine physiology perspective. The inclusion of physiological measures of stress reactivity in the assessment of empathy-induced distress may help to clarify the mechanisms by which empathetic perspective taking is thought to induce stress consequences on an empathizer, and potentially elucidate novel connections that have not been considered previously.

In accordance with recent findings by Buffone and coworkers (Buffone et al., 2017) and earlier findings by Batson and Stotland (Batson et al., 1997; Stotland, 1969), we predicted different emotional and

physiological consequences for APT versus CPT. We hypothesized that APT would lead to feelings of threat whereas CPT would lead to feelings of challenge, and that these differences would be observable through self-report and physiological measures of stress. Attending to the situation of another through APT is expected to result in increased sCort concentrations as compared to using CPT or remaining objective. APT and CPT are expected to result in increased sAA and heart rate compared to an objective control condition. The need situation of Katie Banks, as described by Batson (Batson et al., 1981, 1991, 1997), was adapted into a video format and was used to manipulate empathetic perspective taking. This need situation was chosen due to its ability to invoke feelings of personal distress given an other-oriented perspective (Batson et al., 1997). Saliva samples were collected before and after the stress induction (showing participants the Katie Banks video) for later analysis. Salivary cortisol (sCort) and salivary α-amylase (sAA) were used as biomarkers of stress reactivity to investigate the potential association of threat and challenge orientations with different forms of empathetic perspective taking.

## METHODS

### *Participants*

Participants enrolled in psychology courses at Oregon State University were recruited and scheduled via the School of Psychological Science Experiment Sign-up System (SONA) to participate in a study named "Psychophysiological Responses to Other-Oriented Experiences." The SONA system provided enrolled participants with pertinent information about the study, including criteria for eligibility and exclusion. All participants were reminded of the exclusion criteria by email the night prior to the scheduled appointment, and were asked to complete a questionnaire upon arrival to confirm their eligibility to participate in the study.

The self-reported exclusion criteria utilized to restrict participation in this study were selected in order to limit variance in salivary cortisol and α-amylase levels (Table 1). This was done in accordance with other studies in which the simultaneous measurement of salivary cortisol and α-amylase was used to measure stress reactivity (Schultebraucks et al., 2019; Strahler et al., 2017). Behaviors and conditions that

cause fluctuations in cortisol due to disturbances in circadian rhythm cycles and homeostasis include drug usage, pregnancy, hormonal birth control usage, changes in sleep, obesity, psychiatric diseases, and cardiovascular diseases (Strahler et al., 2017).

Each experimental session was scheduled to take place by individual appointment within the time frame of 1:30 pm – 6:00 pm; cortisol levels are most stable during this time of the day (*Salivary Cortisol ELISA Kit*, 2018). Participants ($N$= 39, 18 women, $Mage$ = 20.5 years, $SD$ = 3.01, age range = 18-34 years) received course credit as compensation for their time. The Interpersonal Reactivity Index (Davis, 1980) and the Social Comparison Orientation Scale (Gibbons & Buunk, 1999) were administered to all participants to examine dispositional tendencies towards engaging in empathetic perspective taking and social comparison, respectively, as potential moderators in the relationship between empathetic perspective taking and stress reactivity.

*Table 1*: Exclusion criteria used to regulate participant enrollment.

| ***Exclusion Criteria*** |
|---|
| *Waking later than 8:00 am* |
| *Caffeine consumption or nicotine usage within 4 hours of the experiment start time* |
| *Alcohol, marijuana, or usage of other drugs within 24 hours of the experiment start time* |
| *Food consumption, sleeping, or exercising within 1 hour of the experiment start time* |
| *Pregnancy or breast feeding* |
| *Steroidal treatments, including hormonal birth control* |
| *Cytokine-based therapy or chemotherapy* |
| *Cancer* |
| *Psychiatric diseases* |
| *Type II diabetes mellitus, hypertension, or cardiovascular diseases* |
| *Cushing syndrome or Addison's disease* |
| *BMI > 30* |
| *Disease of the oral cavity or teeth* |
| *Recent orthodontic procedure* |
| *Vaccination within 24 hours of the experiment start time* |
| *Chronic usage of tobacco or marijuana* |
| *Current medication usage, especially of analgesics, opioids, and sedatives* |

Information about participants' biological sex and gender was also collected for later testing of sex and gender differences in physiological responding. Increasing evidence suggests that both socialized gender norms and biological sex differences can affect individual responding to stressors (Strahler et al., 2017), potentially creating gender and sex differences in salivary biomarker concentrations. All participants reported agreement between their biological sex and gender identity; as such, sex and gender will be referred to simply as gender throughout the rest of this manuscript.

***Empathetic Perspective Taking Stress Induction***

Each participant was randomly assigned into one of two perspective taking conditions or a control condition: affective perspective taking, cognitive perspective taking, or remaining objective (control). Participants then watched a video which was ostensibly of a university news media broadcast and were given different instructions for attending to the broadcast based on their assigned group (adapted from Batson et al., 1997):

> Affective perspective taking
> *While you are listening to this broadcast, try to imagine how you yourself would feel if you were experiencing what has happened to the person being interviewed and how this experience would affect your life. Try not to concern yourself with attending to all the information presented. Just concentrate on trying to imagine how you yourself would feel.*
>
> Cognitive perspective taking
> *While you are listening to this broadcast, try to imagine how the person being interviewed feels about what has happened and how it has affected his or her life. Try not to concern yourself with attending to all the information presented. Just concentrate on trying to imagine how the person interviewed in the broadcast feels.*
>
> Control
> *While you are listening to this broadcast, try to be as objective as possible about what has happened to the person interviewed and how it has affected his or her life. To remain objective, do not let yourself get caught up in imagining what this person has been through and how he or she feels as a result. Just try to remain objective and detached.*

The video broadcast starred a male student radio show host interviewing Katie Banks, a senior at the university struggling with grief and financial troubles. The fictional story of Katie Banks has been used widely within the literature to manipulate empathetic perspective taking. The Katie Banks story as described by Batson and colleagues (Batson et al., 1997) was adapted into a video format with the help of student actors at Oregon State University.

***Assessment of Perceived Stress***

Following the video broadcast, participants were asked to indicate the types of emotions they were feeling during the broadcast in a three-part questionnaire (adapted from Batson et al., 1997). Part 1 prompted participants to select, on a 1-5 scale, the degree to which they felt emotions associated with empathy or with personal distress following the broadcast. Part 2 was designed to determine the nature of

the reported distress: self or other-oriented. Part 3 served as a manipulation check to assess participant's engagement with the video, which was assessed on a 1-7 scale (Table 2).

*Table 2*: Evaluation of perceived psychological stress following the empathetic perspective taking stress induction. The following questions comprise the response questionnaire participants completed after watching the video broadcast.

| **Part 1: Empathy and Distress** | | **Part 2: Direct Distress and Distress for Katie** | | **Part 3: Manipulation Check** | |
|---|---|---|---|---|---|
| Please indicate to what extent you felt the described emotion while watching the broadcast. | | Please indicate the degree to which you felt the described emotion as directed towards yourself or directed towards Katie. | | As you watched the interview, to what extent did you focus on... | Please rate the following: |
| Empathy | Distress | Direct | For Katie | 1. Your personal feelings?<br>2. Katie's feelings?<br>3. Remaining objective? | 1. The broadcast was interesting.<br>2. The time I spent watching the broadcast was worthwhile.<br>3. Katie is in great need of support.<br>4. I was able to emotionally connect with Katie's experience. |
| Sympathetic<br>Soft-hearted<br>Warm<br>Compassionate<br>Tender | Troubled<br>Distressed<br>Upset<br>Disturbed<br>Worried<br>Perturbed | Directly distressed<br>Directly upset<br>Directly disturbed<br>Directly worried | Distressed for Katie<br>Worried for Katie<br>Disturbed for Katie<br>Perturbed for Katie | | |

### *Assessment of Altruistic Behavior*

Following the collection of the fourth saliva sample, participants were informed that the experiment was over and were asked if they would like to write a letter to Katie. It was explained that the letters would be given to Katie to show support from fellow students, and that others in the department were contributing as well. Helping behavior was measured as the participant's willingness to write a letter (yes or no) and the time that they spent composing it.

### *Measurement of Heart Rate Variability*

Heart rate (HR) was measured using a pulse oximeter placed on the participant's index or middle finger. The function of the pulse oximeter was tested and explained to the participant prior to use. HR was monitored starting just before the stress induction and for the remainder of the experiment up to the debriefing. HR was measured continuously starting approximately 1 minute prior to the stress induction up to the end of the study, including during the time that it took participants to write their letter to Katie.

### *Collection and Preparation of Saliva Samples*

Participants were instructed on the passive drool method for providing saliva samples and practiced the method once before providing experimental samples. Four saliva samples were collected from each

participant. The first sample was collected approximately 10 min into the study to allow for proper acclimation to the room, and served as the baseline sample. The second sample was collected immediately after the participant finished watching the video broadcast (sAA post-stress measurement). Then, the third sample was collected approximately 20 minutes following the end of the broadcast (sCort post-stress measurement). The final sample was collected approximately 40 minutes after the end of the video broadcast (recovery measurement). A simple crossword puzzle and a control video were used as filler tasks in order to maintain participants' attention on neutral stimuli for the collection of the final two saliva samples.

***Assessment of Salivary Biomarkers***

All saliva samples were initially stored at -20°C upon collection, then stored at -80°C until biochemical analysis. Salivary cortisol (sCort) concentrations were assessed at time points 1, 3, and 4 (baseline, post-stress sCort, and recovery), while salivary α-amylase kinetic activity (sAA) was assessed at all four time points. Changes in sAA, as well as norepinephrine, occur very quickly; changes in sAA due to a stressor can be detected almost immediately after stress induction. The mechanistic release of norepinephrine, a peptide hormone, is much quicker than the release of cortisol, a corticosteroid. Changes in cortisol secretion can normally begin to be detected at a period of approximately 15-20 minutes following a stress induction (Bendezú & Wadsworth, 2018; Ng et al., 2015).

Sample sCort concentrations were determined by an enzyme-linked immunosorbent assay (ELISA) with competitive binding by a cortisol-horseradish peroxidase (HRP) conjugate. (Eagle Biosciences, n.d.). Cortisol standards of 0, 1, 3, 10, 30, and 100 ng/ml were assayed in duplicate along with all participant samples. TMB substrate (tetramethylbenzidine-$H_2O_2$) was added to each sample well at intervals of 7 seconds; TMB reacts with HRP to produce a yellow color. Stopping solution (sulfuric acid) was added at the same time intervals used to add TMB. Sulfuric acid reacts with TMB, which changed the yellow color of the samples to a blue color. The absorbance of each sample was then measured at 450 nm using a microplate reader. Absorbance values were fit to a four-parameter logistic curve for the calculation of cortisol concentration.

The sAA kinetic activity was determined by spectrophotometric detection of 2-chloro-p-nitrophenol (CNPG3) degradation at 405 nm. CNPG3, a chromogenic substrate, is hydrolyzed by α-amylase to form 2-chloro-nitrophenol, 2-chloro-nitrophenol-α-D-maltoside, (CNPG2), maltotriose, and glucose (*Liquid Amylase Reagent Set*, n.d.). Samples were initially assayed after a 1:10 dilution with water. Samples for which the measured optical density absorbance values surpassed the linearity limit were re-assayed at a greater dilution factor (1:20, 1:40) until linearity was established. After appropriate sample dilutions were executed, the CNPG3 reagent was introduced to each sample at a 1:40 sample-to-reagent volume ratio. Absorbance was measured every minute for 3 minutes using a microplate reader while the samples incubated at 37°C. Amylase concentration was calculated using the millimolar absorptivity of 2-chloro-p-nitrophenol (*Liquid Amylase Reagent Set*, n.d.). All samples and standards were assayed in duplicate.

***Statistical Analyses***

Three participants of the total 38 were excluded from the study, leaving the data from 35 participants for data analysis. Two of the three were excluded due to a failure to complete the response questionnaire. The third participant was excluded based on their expressed skepticism of the video broadcast, as captured in researchers' experiment progress notes. Four additional participants were excluded from sCort analyses, two of which were due to improper sample storage, and another two of which were due to a shortage of ELISA assay materials. Three participants from the 35 total were excluded from the sAA analyses; two participants' samples were excluded due to a shortage of kinetic assay materials, and a third participant's samples were excluded because their sAA values were very strong outliers. In sum, the data from 35 participants were used for analyses of self-reported emotions, saliva samples from 31 participants were used for or sCort analyses, and samples from 32 participants were used for sAA analyses.

Participant responding on the response questionnaire was analyzed via mixed-factor analyses of variance (ANOVA) with repeated measures, one-way ANOVAs, independent samples t-tests, and

dependent samples t-tests to probe the effects of different forms of perceptive taking on self-reported feelings of empathy and distress.

Mixed-factor ANOVA tests with a within-subject factor of time and a between subjects factor of condition (treatment group) were utilized to analyze differences in salivary cortisol (sCort), salivary α-amylase (sAA), and heart rate. The data was organized such that sCort was measured at three time points (baseline, post stress, recovery) and sAA was measured at four time points (baseline, post stress, 20 min post stress, recovery). Here, measurements of sAA immediately following the stress induction and measurements of sCort taken 20 minutes following the stress induction are labeled as post-stress measurements, because that is when we would expect to see stress responding reflected in the levels of these distinct biomarkers.

Participants' sCort and sAA data was tested for interactions with individual scores on the Interpersonal Reactivity Index (IRI) and the Social Comparison Orientation Scale (SCO). The Process v3.4 syntax was used in SPSS to create statistical models with post stress sCort concentration as the dependent variable, condition as the independent variable, recovery cortisol concentration as a covariate, and IRI, SCO, or gender as a moderator. The same process was used with post-stress salivary amylase concentration as the dependent variable to probe interactions of IRI, SCO, and gender on its variation.

Heart rate measurements were averaged for the time points before the stress induction, during the stress induction, and after, giving three averaged heart rate values to analyze per participant via a mixed ANOVA with repeated measures on the within-subjects factor of time. One participant from the 35 total was excluded from the analysis due to an error in data collection. The heart rate data was also analyzed via a different method, in which HR responding over the course of the experiment was compiled and averaged by group in order to observe the continuous distribution of HR data. This is further described in the results section.

## RESULTS

The age of the participants ranged from 18 to 34 years ($N = 35$, $M = 20.49$, $SD = 3.14$). The gender distribution of the sample was almost equal, being comprised of 18 women and 17 men. Participants were randomly assigned to groups, resulting in the following group enrollments: APT $N = 10$, CPT $N = 14$, objective $N = 11$. For the sCort, sAA, and HR analyses, the group distributions were: APT $N = 8$, CPT $N = 12$, objective $N = 11$ for sCort; APT $N = 9$, CPT $N = 13$, objective $N = 10$, for sAA; and APT $N = 10$, CPT $N = 13$, objective $N = 11$ for HR.

### *Effect of perspective taking on self-reported empathy and distress*

In Part I of the response questionnaire, participants reported their emotional reaction to the broadcast (Figure 1). As can be seen in Figures 1a and 1b, participants in all groups responded similarly for many of the emotions, with responses from APT and CPT groups showing the most apparent similarity. There were marginally significant differences in responding between groups for *warm* ($F(2, 34) = 2.857$, $p = 0.072$), *tender* ($F(2, 34) = 3.28$ , $p = 0.051$), and *upset* ($F(2, 34) = 2.51$ , $p = 0.097$), as determined by a one-way ANOVA. Post hoc tests with an LSD correction revealed significant differences between CPT and objective group responding on *warm* ($p = 0.028$) and *tender* ($p = 0.028$), and a marginally significant

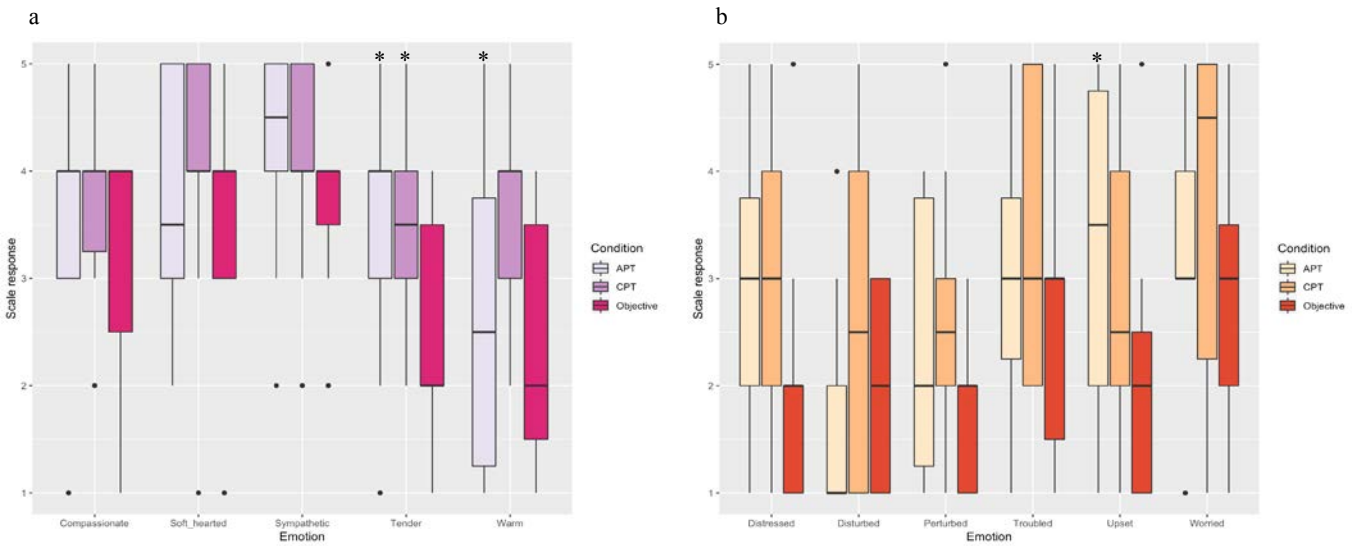


*Figure 1*: A visual representation of participant responses to the stress induction. Participants were asked to indicate the extent to which they identified with a list of emotions (see Table 2), categorized here as being associated with empathy or personal distress for visualization purposes. a) Reported feelings associated with empathy. b) Reported feelings associated with distress. Dots indicate the presence of outliers. Asterisks indicate statistically significant differences in reference to the objective group. APT = Affective perspective taking, CPT = Cognitive perspective taking

difference for responding on *distressed* ($p = 0.066$). In addition, there were significant differences between APT and objective group responding on *tender* ($p = 0.050$) and *upset* ($p = 0.043$).

Empathy and distress indices were created by averaging responses to emotions that are categorized as being associated with empathy or distress, respectively, as modeled by Batson and colleagues (1997). Overall, participants in all three groups reported experiencing more empathy ($M = 3.49$) than distress ($M = 2.67$), $t(33) = 5.903$, $p << 0.001$); see Figure 2a. This result is consistent with other research in which the Katie Banks empathetic perspective taking manipulation was utilized (Batson et al., 1997). A mixed-factor ANOVA with repeated measures on the emotion type factor revealed a significant main effect of the emotion type (empathy or distress) for determining the emotional index score, $F(1, 33) = 32.73$, $p << 0.001$, $\eta_p^2 = 0.514$. There was no significant main effect of the perspective taking group, and no significant interaction between emotion type and perspective taking condition at a 0.05 significance level. Comparisons in separate one-way ANOVAs confirmed the lack of a reliable difference in the empathy and distress indices between groups ($p > 0.05$). Incidentally, scores on the calculated empathy index highly correlated with scores on the calculated distress index, $r(33) = 0.668$, $p << 0.001$. These results suggest that the perspective taking group participants were assigned to did not significantly affect their self-reported emotional responses to the broadcast. Overall, participants reported feeling greater empathy than distress during their viewing of the broadcast.

Participants reported the nature of distress they were feeling – direct distress as well as distress for Katie – on a 1-5 scale in Part 2 of the response questionnaire. Each participant's responses to the direct distress and distress for Katie questions for each of the emotions (distressed, disturbed, upset, perturbed, worried) were averaged, creating a direct-distress index and a distressed-for-Katie index. Participants reported feeling more distress for Katie ($M = 3.21$) than direct distress ($M = 2.74$), $t(34) = -3.37$, $p = 0.002$.

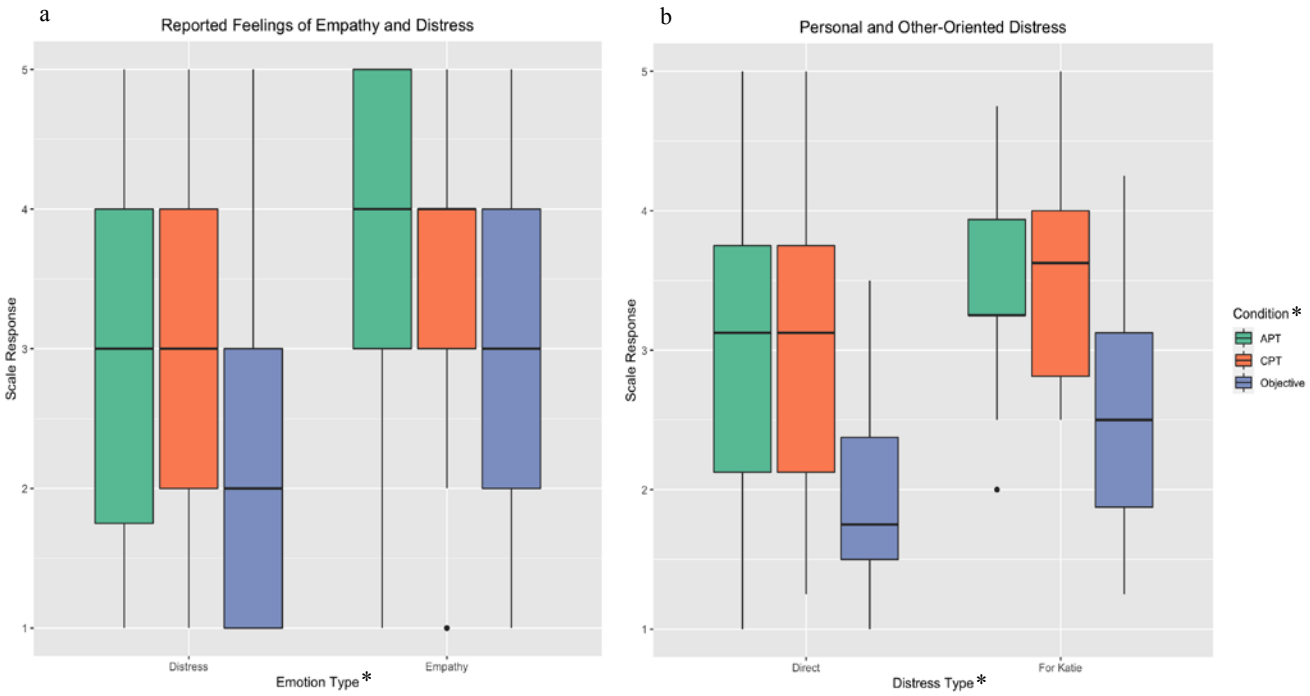


*Figure 2*: Evaluation of perspective taking condition on feelings of empathy and distress. a) Reported feelings associated with either empathy or distress. b) Reported feelings of direct (personal) distress or distress for Katie (other-oriented distress). Asterisks indicate significant main effects with $\alpha = 0.05$. Dots indicate outliers. APT = Affective perspective taking, CPT = Cognitive perspective taking

A mixed-factor, two-way ANOVA was conducted to examine the effects of both perspective taking condition and the nature of the distress (direct or for Katie) on distress index scores (see Figure 2b). There was a significant main effect for the distress type, $F(1, 34) = 10.44$, $p = 0.003$, $\eta_p^2 = 0.246$, and condition, $F(2, 34) = 4.409$, $p = 0.020$, $\eta_p^2 = 0.216$, at the 0.05 significance level, but there was no interaction between the two variables, $F(2, 34) = 0.14$, $p = 0.87$, $\eta_p^2 = 0.008$. Pairwise comparisons revealed that participants in both empathetic perspective taking conditions (APT and CPT) responded with greater distress index scores than participants in the control group ($p < 0.05$), but there was no reliable difference in distress scores between the empathetic perspective taking groups. Perspective taking condition and distress classification appear to have affected overall distress scoring independently. This suggests that the type of empathetic perspective taking that participants used influenced their level of overall level of distress, but its effects on the type of distress is not clear.

***Perception of Katie's need***

Based on answers to the response questionnaire, participants perceived Katie's need to be great ($M$ = 6.57). On a scale ranging from 1 to 7, the lowest given response was a 5 ("Somewhat agree"). There was no significant difference in perceived need between condition groups, $F(2, 32) = 0.256$, $p = 0.775$. Responses to other questions ("The time I spent watching the broadcast was worthwhile; I was able to emotionally connect with Katie's experience), showed no significant difference between groups ($p > 0.05$). Responses to "The broadcast was interesting," did show marginally significant group differences, $F(2, 32) = 2.97$, $p = 0.066$. A post hoc test with an LSD correction revealed that participants in the APT group were less likely to rate the broadcast highly than were participants in the CPT condition ($M$ difference = 1.23, $p = 0.035$).

***Effectiveness of the perspective taking manipulation***

Manipulation check questions in Part 3 of the response questionnaire were examined for variability in responses according to perspective taking condition via a one-way ANOVA. The questions prompted participants to, on a scale from 1-5, rate to what extent they focused on: 1) their personal feelings, 2) Katie's feelings, and 3) remaining objective. There was a marginally significant difference between groups in regards to their focus on personal feelings, $F(2, 32) = 2.71$, $p = 0.082$. In a post hoc test with an LSD correction, APT participants were more likely to focus on personal feelings than participants in the objective group ($M$ difference = 0.84, $p = 0.086$), with a marginally significant difference between those groups. However, there was no difference between APT and CPT responding on this question ($M$ difference = 0.12, $p = 0.78$), or CPT and control group responding. For the manipulation check questions, the most notable difference between groups was in their responses to the prompt asking about the extent of their focus on Katie's feelings, $F(2, 32) = 3.80$, $p = 0.033$). The CPT and objective groups differed on this measure significantly ($p = 0.010$), with CPT group members reporting greater levels of focus on Katie's feelings in comparison to control group members. However, there were no significant differences between CPT and APT responding, or APT and objective responding. The groups showed no reliable difference in their focus on objectivity throughout the broadcast, $F(2, 32) = .943$, $p = 0.40$, suggesting that control participants did

not adhere to instructions to remain completely objective throughout the broadcast. Overall, participants' responses to the manipulation check questions indicate that the empathetic perspective taking manipulation successfully produced differences in group responding to the broadcast. Yet, the resultant group response differences did not align with our hypotheses.

***Effect of perspective taking on salivary cortisol concentration***

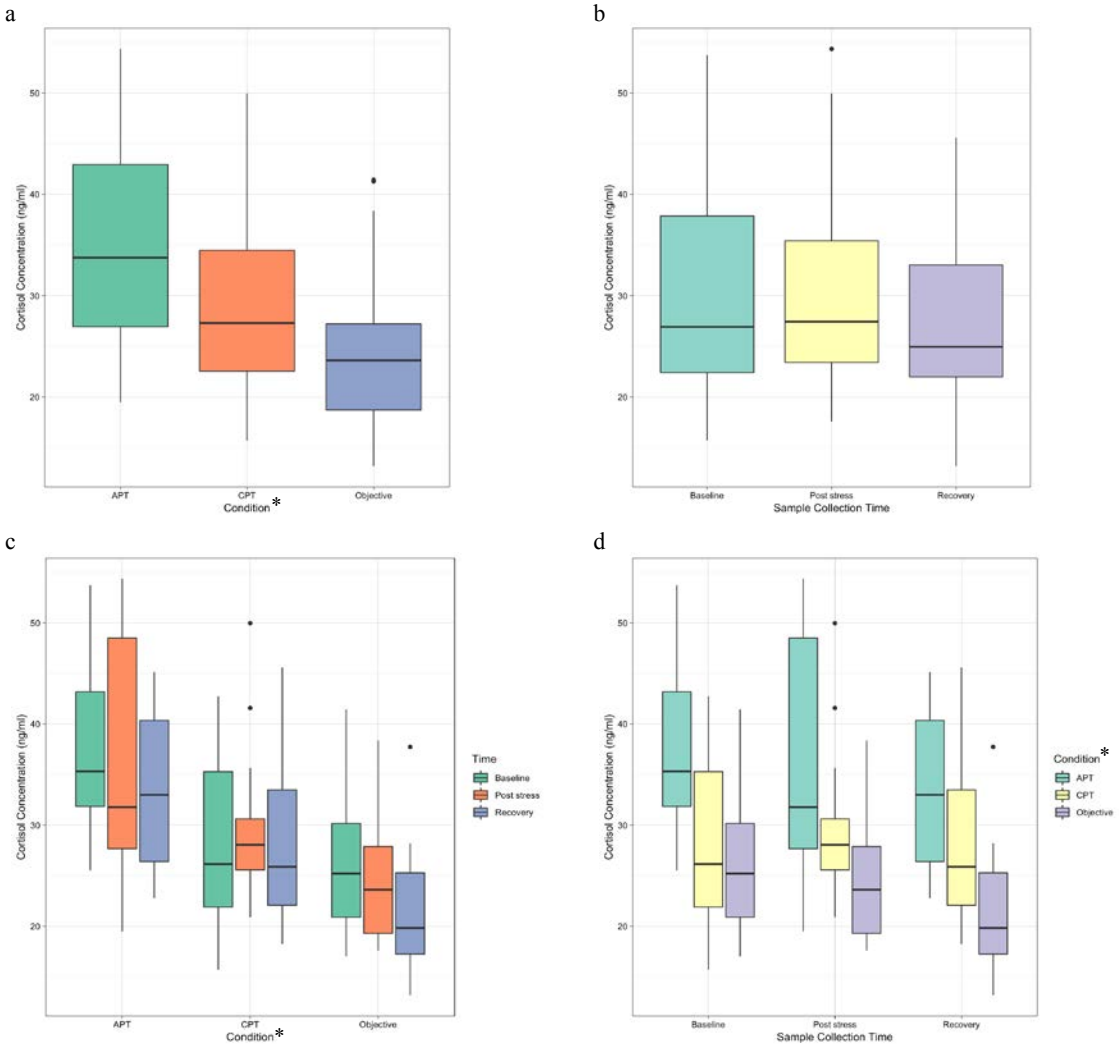


*Figure 3*: Evaluation of perspective taking effects on salivary cortisol levels. a) Overall cortisol concentrations by group. b) Overall cortisol concentrations by sample collection time. c) and d) Cortisol concentrations by group and sample collection time. Dots indicate the presence of outliers. Asterisks indicate statistically significant main effects, with $\alpha = 0.05$.

Salivary cortisol (sCort) concentrations were measured by use of an ELISA assay in baseline, post-stress, and recovery saliva samples. A mixed-factor ANOVA with repeated measures on the sample collection time factor was used to assess two-way effects of sample collection time and empathetic

perspective taking condition on sCort concentration. There was a significant main effect of perspective taking condition, $F(2, 28) = 5.11$, $p = 0.013$, $\eta_p^2 = 0.267$, but no main effect of sample collection time or an interaction between the two factors. Figure 3 shows the distribution of sCort concentrations according to group (a), time (b), and group and time together (c and d). A separate mixed-factor ANOVA was conducted, this time including gender as a covariate, which markedly improved the fit of the model. With the addition of gender to the model, there was a significant main effect of sample collection time, $F(2, 28) = 3.36$, $p = 0.042$ , $\eta_p^2 = 0.11$, a significant main effect of condition. $F(2, 28) = 5.04$, $p = 0.014$, $\eta_p^2 = 0.27$, and a significant interaction between time and gender, $F(2, 28) = 3.33$, $p = 0.043$, $\eta_p^2 = 0.11$. The main effect of gender alone was not significant, $F(1, 28) =$ , $p = 0.27$, $\eta_p^2 = 0.044$.

Pairwise comparisons for the perspective taking condition factor revealed a significant difference between sCort values for participants in the APT group compared to those in the objective group ($p = 0.003$). Additionally, there was a marginally significant difference between APT and CPT sCort values ($p = 0.058$). There were no significant differences between the baseline and post stress sCort measurements ($p = 0.756$), however, suggesting that the overall group differences in sCort measurements may have been due to existing differences between the groups rather than due to the perspective taking manipulation (see Figure 3c and 3d).

An exploratory linear regression analysis was conducted to begin to investigate potential reasons for the existing group differences in sCort levels despite random assignment. IRI score, SCO score, and gender were considered separately as potential moderators of the effect of perspective taking condition on post-stress sCort levels. Moderation models including total IRI score or IRI subscale scores (empathic concern, fantasy, perspective taking, and personal distress) each accounted for between 46% and 52% of the variation in the data ($p < 0.05$). A model including sCort post-stress measurements as the dependent variable, condition as the independent variable, sCort recovery measurements, and the IRI subscale of empathic concern as a moderator was the most fitting ($R^2 = 0.52$, $p = 0.0044$; see Figure 4a). The individual relationship between IRI empathic concern and sCort concentration was marginally significant ($\beta = -1.49$, $SE = 0.79$, $p = 0.074$), as was the relationship between sCort levels and assignment to the control condition

($\beta$ = -42.92, *SE* = 23.02, $p$ = 0.075). However, the interaction between IRI empathic concern and condition was not significant at the 0.05 significance level.

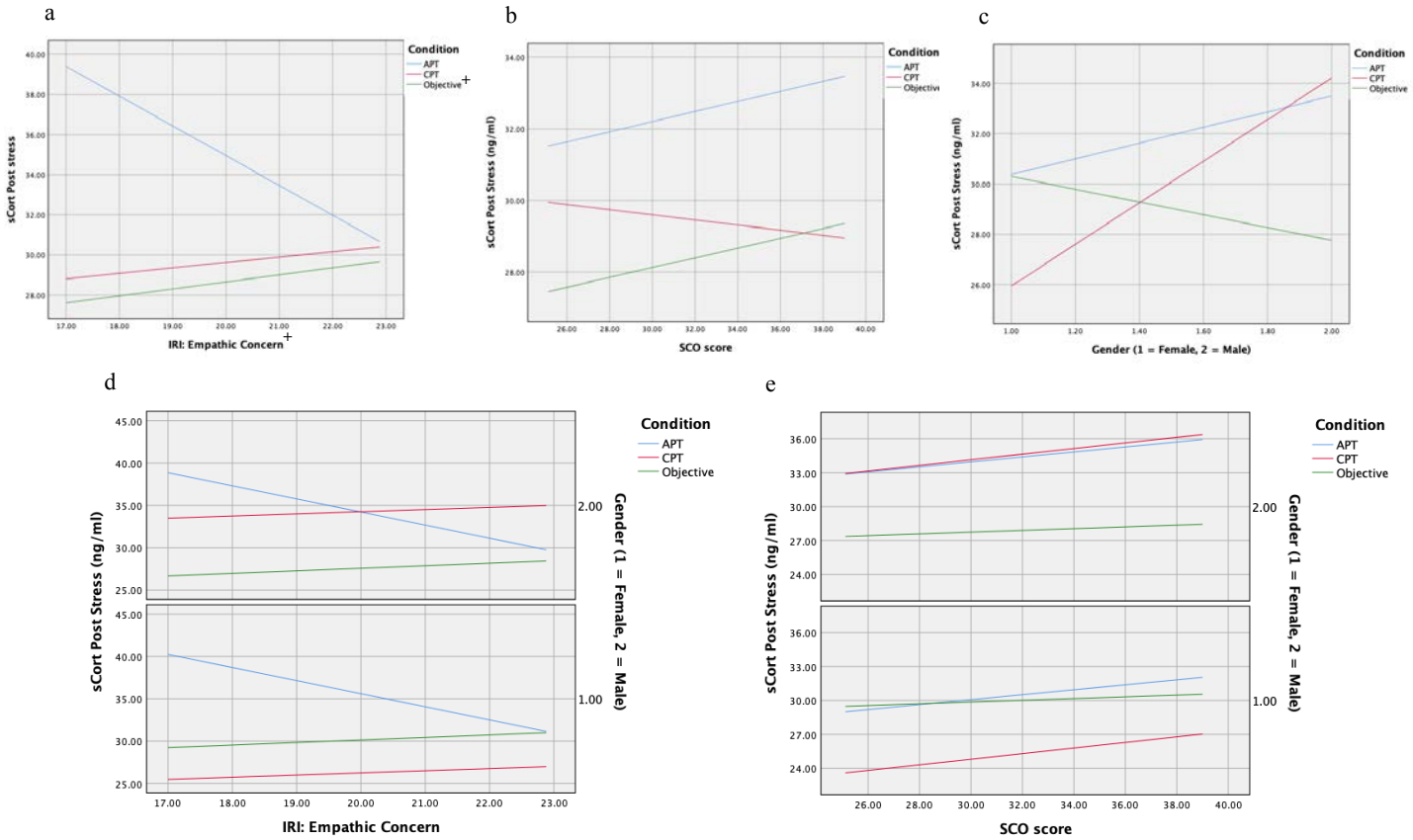


*Figure 4*: Assessment of moderating interactions affecting salivary cortisol levels. Linear regression analysis of the relationship between empathetic perspective taking condition and sCort concentration with a) IRI empathic concern subscale score, b) SCO score, c) gender, d) IRI empathic concern subscale score and gender, and e) SCO score and gender as potential moderators. Addition symbols indicate marginal significance, with $\alpha$ = 0.05. sCort = salivary cortisol, IRI = Interpersonal Reactivity Index, SCO = Social Comparison Orientation

SCO was also tested as a moderator in a linear regression model like the one described above ($R^2$ = 0.45, $p$ = 0.018; Figure 4b). A third model including gender as a moderator also predicted the relationship between condition and sCort post-stress levels effectively ($R^2$ = 0.52, $p$ = 0.0042; Figure 4c). In contrast, the individual relationships of gender and condition with sCort, as well as their interaction, were not significant in this model. Including both gender and IRI empathic concern in a double moderation model did not appear to improve the fit of the model to the data ($R^2$ = 0.59, $p$ = 0.011; Figure 4d), nor did the combination of SCO and gender as moderators ($R^2$ = 0.53, $p$ = 0.031; Figure 4e).

When both IRI empathic concern and SCO were included as moderators, with condition as the independent variable and sCort recovery as a covariate, the relationships of the stated variables with post-

stress sCort shifted. In this model ($R^2 = 0.56$, $p = 0.021$), the individual relationship of IRI empathic concern on post-stress sCort was significant ($\beta = -1.99$, $SE = 0.91$, $p = 0.040$). In addition, the interaction between IRI empathic concern and the control condition was marginally significant ($\beta = 2.30$, $SE = 1.29$, $p = 0.089$).

In sum, the results from the linear regression analysis on the sCort post-stress measurements were largely inconclusive, but appear to suggest that perspective taking condition is the best predictor of sCort levels at the post-stress time point. IRI empathic concern and gender may have slight effects on sCort levels, although the strength of that relationship is not obvious. More research would be required to clarify the strength of the relationship between perspective taking condition and sCort concentration, as well the effects of IRI and SCO scores on sCort concentration, if any.

***Effect of perspective taking on salivary α-amylase concentration***

A mixed-factor ANOVA with repeated measures on the time variable and a between-subjects factor of perspective taking condition indicated that there was a significant main effect of time on sAA concentration, $F(3, 29) = 2.85$, $p = 0.042$, $\eta_p^2 = 0.089$. Pairwise comparisons revealed significant differences between sAA concentrations for baseline and post-stress measurements ($p = 0.019$), post-stress and 20 min post-stress measurements ($p = 0.01$), as well as baseline and recovery measurements ($p = 0.031$). See the visualization of these results in Figures 5a and 5b. There were no significant differences between sAA concentrations for post-stress and recovery measurements, suggesting that an event occurring between the collection of the 20 min post-stress and recovery saliva samples reliably increased participants' sAA.

There was not a significant main effect for perspective taking condition or the interaction between time and condition (Figures 3c and 3d). The addition of gender as a covariate improved the fit of the ANOVA model, $F(3, 29) = 3.43$, $p = 0.021$, $\eta_p^2 = 0.11$, suggesting that there are gender effects contributing to variance in sAA concentration. The interaction of sample and gender was of marginal significance at a 0.05 significance level, $F(3, 29) = 2.37$, $p = 0.077$, $\eta_p^2 = 0.078$.

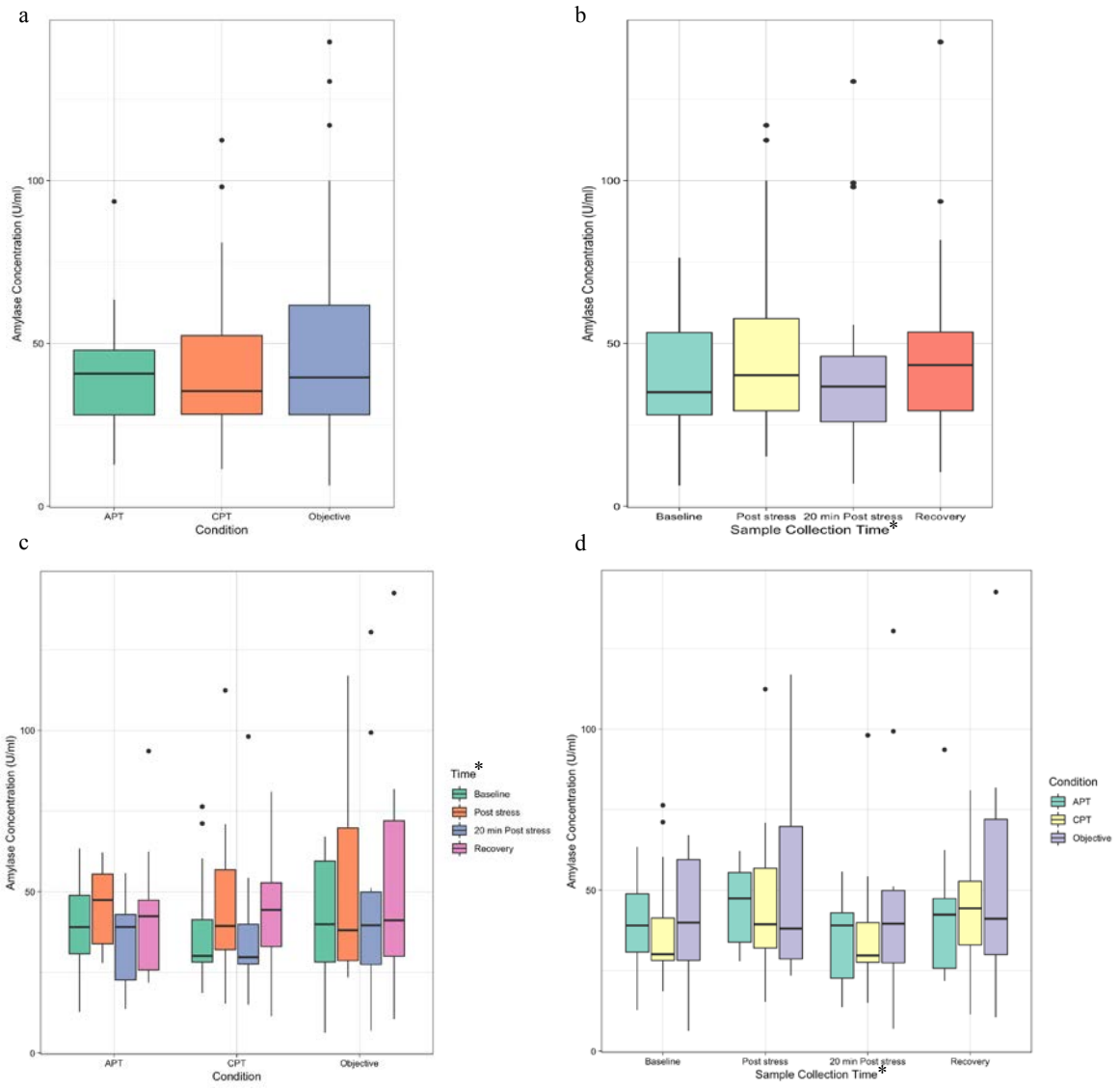


*Figure 5*: Evaluation of perspective taking effects on salivary amylase levels. a) Overall amylase concentrations by group. b) Overall amylase concentrations by sample collection time. c) and d) Amylase concentrations by group and sample collection time. Dots indicate the presence of outliers. Asterisks indicate statistically significant main effects, with $\alpha = 0.05$.

To investigate the effects of gender and other existing individual variables, an exploratory regression analysis was conducted with the aim of probing moderating effects of gender, IRI scores, and SCO scores on the relationship between empathetic perspective taking and post-stress sAA levels. A model including sAA post-stress measurements as the dependent variable, perspective taking condition as the independent variable, sAA recovery as a covariate, and IRI fantasy as a moderator accounted for 68% of the variation in the data ($R^2 = 0.67$, $p < 0.0001$; Figure 6a). The individual relationship between IRI fantasy and sAA was not significant ($\beta$ =0.073, $SE$ = 36.29, $p$ = 0.96), but the relationship between the control

condition and sAA ($\beta$ = 66.12, *SE* = 36.29, $p$ = 0.08), as well as the interaction of the control condition and IRI fantasy ($\beta$ =-3.43, *SE* = 1.82, $p$ = 0.071), were both marginally significant at the 0.05 level. When the IRI fantasy moderator was substituted for any of the other IRI subscales or total IRI score, the model's fit was not as robust.

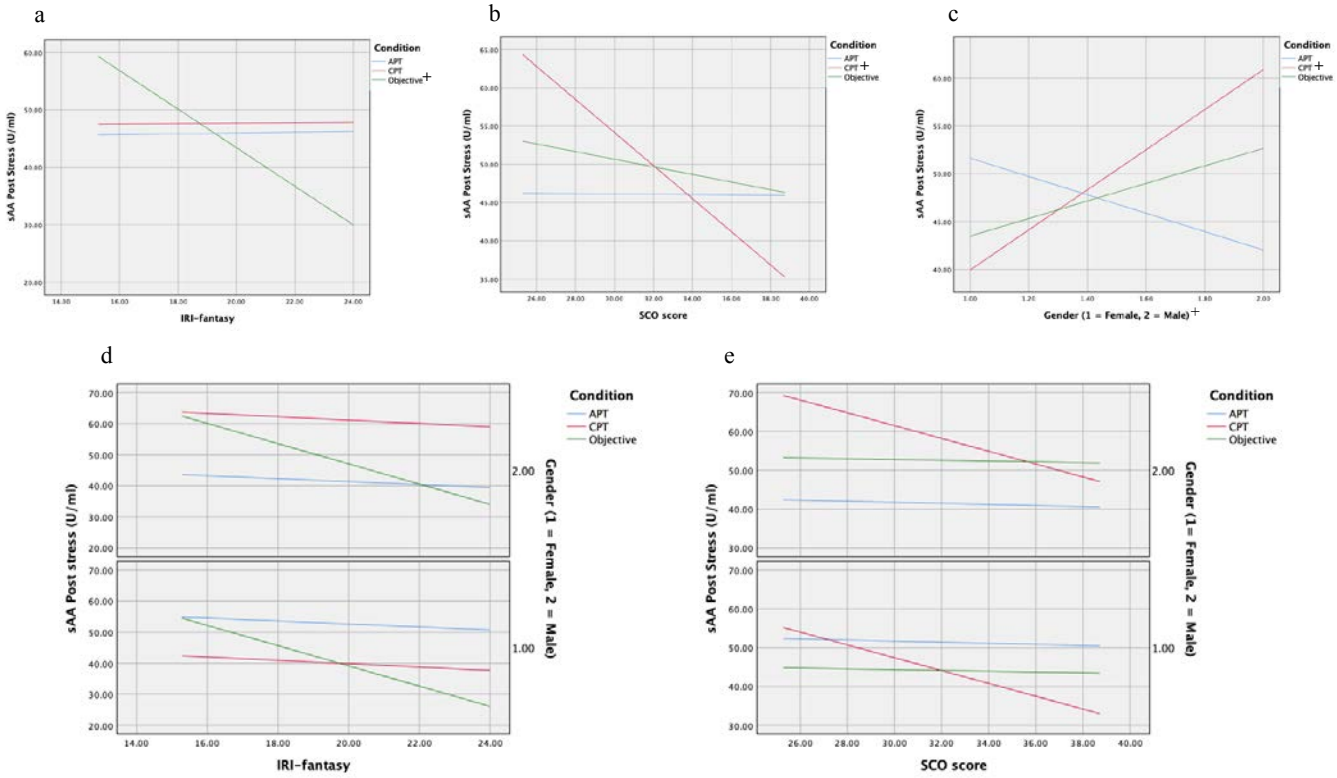


*Figure 6*: Assessment of moderating interactions affecting salivary $\alpha$-amylase levels. Linear regression analysis of the relationship between empathetic perspective taking condition and sAA concentration with a) IRI empathic concern subscale score, b) SCO score, c) gender, d) IRI empathic concern subscale score and gender, and e) SCO score and gender as potential moderators. Addition symbols indicate marginal significance, with $\alpha$ = 0.05. sAA = salivary $\alpha$-amylase, IRI = Interpersonal Reactivity Index, SCO = Social Comparison Orientation

Participants' SCO score may have also had a small effect on their sAA levels after stress induction. In a model with sAA post-stress as the dependent variable, condition as the independent variable, sAA recovery as a covariate, and SCO score as a moderator, 67% of the variation in the data was accounted for ($p$ = 0.0001; Figure 6b). The relationship between CPT condition assignment and post-stress sAA was marginally significant ($\beta$ = 72.24, *SE* = 37.48, $p$ = 0.065). Although the effect of SCO score on its own was not significant, the interaction of SCO and CPT was marginally significant ($\beta$ = -2.14, *SE* = 1.17, $p$ = 0.079). Modifying this model to also include the sAA baseline and sAA 20 min post-stress measurements

improved the fit of the overall model ($R^2$ = 0.87, p < 0.0001), while abolishing individual relationships of SCO and condition on sAA, as well as their interaction.

A model including gender as the moderator ($R^2$ = 0.66, $p$ = 0.0001; Figure 6c), showed a significant effect of the CPT condition ($\beta$ = -42.24, $SE$ = 22.71, $p$ = 0.075) and a significant interaction between the CPT condition and gender ($\beta$ = 30.55, $SE$ = 14.53, $p$ = 0.046).When gender was added as a moderator in addition to IRI fantasy, the double moderation model demonstrated a comparable fit to the data ($R^2$ = 0.76, $p$ = 0.0001; Figure 6d). The key difference between the single IRI fantasy moderation model and the double moderation model was the loss of the significant interaction between IRI fantasy and condition. In the double moderation model, there was a significant interaction between gender and CPT condition ($\beta$ = 32.59, $SE$ =14.16 , $p$ = 0.031), but no other significant relationships. These results suggest that a participant's gender has a greater influence on determining their sAA levels than does their IRI fantasy score.

Including both IRI fantasy and SCO as moderators in a regression model examining post-stress sAA with condition as the independent variable and recovery sAA ($R^2$ = 0.76, p = 0.0001) gives no significant relationship of the individual variables on sAA outcome, but it does reveal interactions between IRI fantasy and condition as well as SCO and condition. An interaction between IRI fantasy and condition was significant with $\alpha$ = 0.05 ($\beta$ = -3.77, $SE$ = 1.77, $p$ = 0.045), and an interaction between SCO and condition was found to be marginally significant ($\beta$ = -2.14, $SE$ = 1.06, $p$ = 0.057).

Taken together, the results from the regression analysis on the sAA data suggest that the variation in sAA can be best explained by sample collection time. It appears that condition, gender, IRI, and SCO likely have a subtle effect on sAA concentration.

***Assessment of helping behavior***

Participants' empathetic perspective taking condition did not predict their choice to write a letter to Katie, $X^2(2, N = 35) = 0.064$, $p$ = 0.969, nor did gender or physiological arousal as measured by sCort and sAA. Total IRI score also did not predict participants' choice to write a letter. There was a marginally significant correlation between SCO score and participants' decision to write a letter to Katie, $r(34) = 0.32$, $p$ = 0.064. One-way ANOVA and linear regression were used to determine the effects of group assignment

or IRI and SCO scores, respectively, on the time that participants spent writing a letter to Katie. There was no significant difference in the amount of time spent on letter writing between perspective taking groups or based on the individual factors of IRI and SCO score, suggesting that participants' willingness to help was not affected by the perspective taking manipulation.

***Evaluation of heart rate variability***

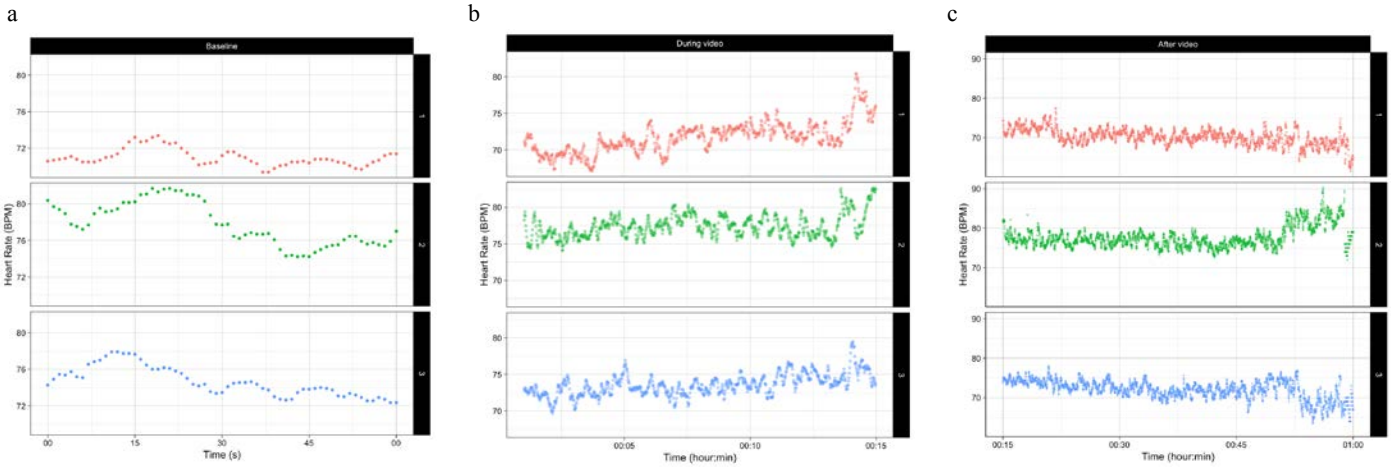


*Figure 7:* Evaluation of heart rate variability over the course of the experiment. Heart rate was measured continuously starting approximately one minute before the showing of the broadcast for a total measurement duration spanning close to one hour. Here, average heart rate measurements per experimental group per second are shown in relevant experimental time blocks: a) one-minute baseline, b) 14 minutes of broadcast viewing, c) 45 minutes following the broadcast. BPM = beats per minute.

Heart rate (HR) measurements were collected continuously at one-second intervals starting approximately one minute before the start of the broadcast viewing through the end of a participant writing a letter to Katie (if they agreed to write a letter). The HR data was organized into discrete blocks of time that approximately aligned with transitions in experimental tasks. The first minute of data became a baseline HR measurement, and the next 14 min of measurements were estimated to be taken while the participant was watching the broadcast. The remainder of the measurements taken following the broadcast showing were grouped together. Due to the sheer number of data points collected, the data was organized and analyzed via two different approaches. In the first approach, HR measurements for each second were averaged across perspective taking condition, creating a single data frame of HR measurements for each experimental group that spanned the entirety of the measurement period. This data was utilized to create visualizations of HR variability over the course of the experiment (Figure 7), where each point in the

scatterplot represents an average response from all participants in that perspective taking condition at the specified time point.

In this format, the HR data was analyzed via a two-way ANOVA to test for differences in HR variability across perspective taking conditions over time. This analysis was conducted without the specification of repeated measures on the time variable. There was a statistically significant effect of perspective taking condition ($p < 0.001$) and time ($p < 0.001$), as well as their interaction, $F(4, 26) = 78.81$, $p < 0.001$, on HR measurements. A post hoc analysis was conducted with a Tukey HSD correction, which revealed that almost all of the pairwise comparisons available showed significant differences at the time and condition levels. There were a few that were not significant: the difference between baseline and recovery measurements, as well as between measurements taken at baseline and during the video for participants in the APT and CPT conditions. This suggests that APT and CPT participants began with greater HR baseline measurements than participants in the objective control condition, limiting the difference between their baseline measurement and observed increases in heart rate during the viewing of the broadcast. However, the visualization of this data by scatterplot in Figure 7a seems to contradict this idea, showing that the control condition had a higher average HR compared to the APT group. Despite this limitation, there was a significant difference between heart rate responding during the video and after the video, but not for measurements taken before and after the video, suggesting that there was a reliable increase in HR during the broadcast even if the starting baseline measurement were somewhat high or inconsistent.

The first method of HR data organization required that the data be completely ungrouped from specific participant identification numbers, which presented an obstacle for analysis; the data could not be analyzed using a mixed-factor ANOVA with within-subject variables in this format. For this reason, a second approach was taken to organize the HR data to allow for analysis via the mixed-ANOVA with repeated measures. Rather than averaging values for every second across experimental groups to create continuous data frames, the data for each participant was averaged across the defined time blocks (baseline, during the video, after the video), giving three discrete averages for each participant's overall responding.

This organization of the data allowed for analysis with repeated measures, but introduced an enormous disadvantage; HR variability over time was necessarily simplified to one data point per time block, removing much of the information that could be important for identifying differences and similarities in responses for each experimental group. A mixed-factor ANOVA with repeated measures was conducted on the data in this format, and there were no significant differences in HR measurements based on group or time ($p > 0.05$).

## DISCUSSION

In this study, we aimed to explore the stress consequences associated with different forms of empathetic perspective taking. The work of various researchers interested in this topic, most notably Batson, describes the psychological stress consequences associated with cognitive (imagine-other) and affective (imagine-self) perspective taking, as opposed to remaining objective (control). The majority of studies focused on this topic have utilized self-report measures, and only a few studies have reported cardiac measures of stress to support self-report measures. The primary purpose of this study was to attempt to quantify empathy-induced distress via endocrine measures of stress while replicating and expanding on those studies that utilized self-report and cardiac measures of stress to study this phenomenon.

Participants were anticipated to react more strongly to a stress induction designed to elicit empathetic emotions if given instructions to attend to the video that aligned with affective perspective taking (APT) compared with those given instructions that encouraged cognitive perspective taking (CPT) or remaining objective (as a control). Additionally, CPT participants were anticipated to react more strongly than control participants. This was assessed by a self-report response questionnaire administered after the stress induction. Specifically, APT participants were anticipated to report more personal distress than CPT participants, and CPT participants were expected to report more other-oriented distress (distress for Katie) than APT participants. Both groups were expected to report more personal and other-oriented distress than control group participants. In addition, it was hypothesized that participants in the APT group would exhibit activation of the HPA and SAM axes in accordance with a threat orientation, indicated by greater sCort and

sAA levels, and that CPT participants would exhibit equal SAM activity but lower HPA axis activity than APT group members, in accordance with a challenge orientation. APT and CPT group participants were hypothesized to demonstrate a greater stress reactivity than control participants on all measures of stress.

Empathetic perspective taking, whether APT or CPT, did not appear to affect self-reported emotional responses to the video broadcast (Figure 1 and Figure 2a), contrary to the central hypothesis in which APT and CPT each were anticipated to evoke stronger emotions than an objective control. This result not only contradicts our hypotheses, but also results from the literature. A study by Batson and colleagues in which the same manipulation and statistical analyses were utilized demonstrated significant differences between groups (Batson et al., 1997). In their study, APT and CPT participants reported feeling more empathy than control participants, with no reliable differences between APT and CPT responding. Also, CPT and control participants reported feeling less distress than APT participants, with no significant difference between CPT and control group responding.

The results of the present study only partially replicated literature results of self-reported emotions in response to an empathetic stressor. This could be due to a number of reasons, most obviously random variation and low participant enrollment. The low number of participants in each group lead to low statistical power in the analyses, exacerbating the effects of random variation and therefore making the discernment of valid conclusions more difficult. It is also possible that the perspective taking manipulation was not conducted effectively or to the degree of consistency required. Answers to the manipulation check questions indicate that the perspective taking manipulation did in fact produce slight group differences in participant's feeling focus. Yet, group differences in the way that participants attended to the video may not have been pronounced enough to amount to differences in self-reported empathy and distress between groups. The difference in participants' focus on their own feelings between the APT and objective groups was only marginal, and there was no reliable difference between APT and CPT groups' focus on personal feelings. This may explain the similar levels of distress reported by APT and CPT group participants, a result that was not consistent with previous literature results. In addition, all groups indicated a similar focus on remaining objective throughout the video, suggesting that participants in the objective group did not

adhere to their instructions. This is a flaw, either in the manipulation or its implementation, that likely affected the rest of the results of the study without remedy; if the manipulation was not effective enough to create strong differences between the groups, differences in psychological and physiological indicators of stress reactivity that are expected to be subtle may become even more difficult, if not impossible, to identify.

Although the empathetic perspective taking manipulation did not significantly affect specific emotional responses and feelings of empathy, the manipulation did appear to affect the magnitude and nature of the reported distress (Figure 2b). The nature of the reported distress, either personal (direct) or other-oriented (for Katie), was significantly different for participants based on their group assignment. Participants in both empathetic perspective taking groups reported higher levels of personal and other-oriented distress following the broadcast compared to control group participants. However, there were no reliable differences in distress scores between the two perspective taking groups or the type of distress they seemed to elicit. In the study conducted by Batson in colleagues, participants in the APT group did report greater distress than those in the CPT or control group. Without a significant interaction between group assignment and distress type, it is not clear that the perspective taking condition influenced whether participants felt more personal or other-oriented distress necessarily, just that the groups felt different amounts of overall distress that they could then attribute to their watching of the broadcast.

The interaction between distress type and condition was significant in Batson's research with the Katie Banks stress induction, suggesting that there may in fact be an interaction between these variables. The interaction between distress type and condition could not be observed here, likely due to the low statistical power of this study. Another difference between their results and our replication of their experiment is in the distribution of our data; here, participants reported high levels of personal and other-oriented distress (an average of 3 points on a 1-5 scale for the perspective taking conditions). In Batson's 1997 study, participants overall reported high levels of distress for Katie but fairly low levels of personal distress (an average of 3-6 points out of 9, depending on the group) (Batson et al., 1997). The participants in this study may have reported greater levels of personal distress due to differences in the way that the Katie Banks narrative was presented. The story was presented in an audio format for Batson's study, but

for this study, Katie's (fictional) story was adapted into a video format in an attempt to make the stressor a stronger emotional stimulus. This change was made to increase the likelihood of detecting the likely subtle physiological stress response to the broadcast. The switch from an auditory format to a combined auditory and visual format for the story may have unintentionally increased the intensity of personal distress arising from the stress induction.

Salivary cortisol (sCort) measurements were hypothesized to differ between the three perspective taking groups, according to corresponding ideas of threat (APT) and challenge (CPT) orientations. Thus, it was hypothesized that sCort levels would be highest for the APT group, followed by the CPT group, and that both APT and CPT sCort concentrations would be higher than those presented by the objective control group. Salivary cortisol levels differed significantly between groups, with a reliable difference between APT sCort concentrations and those from the objective group, and marginal differences between APT and CPT group responses. These results partially aligned with our hypothesis; we hypothesized that sCort concentrations would be highest in APT participants, and second highest in CPT participants in accordance with predictions drawn from the biopsychosocial model of challenge and threat (Buffone et al., 2017; Seery, 2013). The results appear to fit the overall pattern of hypothesized results, without statistical significance to support reliable differences between APT-CPT and CPT-objective responding.

Interestingly, sCort concentrations were not significantly different according to sample collection times, despite the use of a stress induction. The effect of sample collection time, and its interaction with perspective taking condition, only became statistically significant when gender was added to the mixed ANOVA model as a covariate. The effect of gender on its own was not strong enough, however, to be observed as a significant main effect on sCort concentration. These results suggest that there is a slight effect of sex, gender, or both factors on HPA axis activity and sCort production in response to empathetic stress, a result that is consistent with literature knowledge on sex and gender differences in cortisol levels.

Close examination of Figure 3d, along with the wavering relationship between sample collection time and sCort concentration, brings into question the possibility of existing group differences in sCort reactivity. Baseline cortisol levels for the APT group were much higher than those of the other groups,

suggesting that group differences in sCort concentrations were largely due to existing group differences, not group differences caused by the experimental manipulation of perspective taking. Linear regression analyses demonstrated potential moderation effects of gender and the IRI subscale of empathic concern on sCort concentration in addition to the type of empathetic perspective taking. Figure 4a in particular shows an interaction of interest, the direction of which suggests that people with low IRI scores in the APT group may have felt a greater degree of distress than other participants. Participants who are not accustomed to the emotional intensity associated with APT (who thus have a low IRI score) may have felt more stress as a result of the stress induction, causing a greater increase in cortisol levels. The linear regression analysis also highlighted potential gender differences in sCort responding that were consistent with literature results. However, the three experimental groups did not significantly differ in their IRI scoring or their gender makeup. It is unclear at this time what could have caused the differences in baseline sCort concentration between groups other than random variation. With small sample sizes, random variation can have a greater effect on statistical results than it would otherwise. The experiment would need to be replicated with a larger number of subjects in order to draw a more definitive distinction between reliable group differences, those caused by random variation, and those caused by factors that have not been accounted for.

Overall, it appears that the type of empathetic perspective taking participants used to engage with the video broadcast was the best predictor of their sCort concentration. These results support the hypothesis that sCort differences would be observed between perspective taking groups, with APT having the highest sCort concentration. This conclusion, however, is only preliminary; there are many unanswered questions regarding the effects of natural sCort variation on experimental outcomes related to perspective taking. The inconclusive results discussed here would need to be reconsidered in future studies utilizing larger sample sizes to better control for the effects of random variation.

Salivary amylase (sAA) levels were hypothesized to increase in response to the stress induction for the empathetic perspective taking groups compared to the objective group. This would be in line with the challenge and threat orientations, which are anticipated to elicit similar SAM axis activity. Thus, HR and sAA levels were expected to be similar between APT and CPT groups, but elevated in comparison to those

from the control group. Salivary $\alpha$-amylase measurements differed on the within-subjects variable of sample time collection, validating the effectiveness of the stress induction for eliciting changes in sAA levels. However, there did not appear to be a significant difference in sAA levels between groups (Figures 5c and 5d). These results suggest that, while changes in sAA seem to have occurred in response to the stress induction, sAA may not be the best measure of empathy or emotion-induced embodiments of distress. Alternatively, subtle differences in sAA group responding may have been more easily identified had the sample sizes been larger.

Taking existing individual factors into account through a linear regression analysis, gender, SCO, and the IRI subscale of fantasy appear to have slightly affected sAA reactivity in the participants of this study. IRI fantasy scores do not seem to affect sAA responding, that is, unless the participant is in the control condition. Control condition participants with low IRI-fantasy scores tended to have more intense sAA responses to the stressor. Gender appeared to interact with perspective taking group assignment as well. Males tended to respond with higher sAA values than females, especially males that were in the CPT condition. The differences in sAA responding according to gender were consistent with those found for sCort responding. In addition, the sCort and sAA gender differences reported here support literature knowledge of sex and gender differences in stress responding (Strahler et al., 2017). An interaction effect was seen with SCO and CPT, but this interaction was only marginally significant. It is too soon to conclude exactly how these additional variables affect sAA reactivity in response to an emotional stimulus, which would require replication of the experiment with a greater participant enrollment to increase the effect size and power of the computed statistical calculations.

The analysis of the heart rate data from each participant over the course of the experiment presented various challenges. When the HR data was organized to provide more information about variability over time but less information about individual subjects, there were significant differences in HR responding between groups and over time. However, averaging the data to create discrete values for each time point by participant for use in a repeated measures ANOVA gave null interaction effects. Possible methods for improving the analysis of the heart rate data would be to split and average the data across more time points,

possibly five or six instead of just the three. The highly significant results from the between-subjects ANOVA suggest that there is an effect of empathetic perspective taking on HR, but this cannot yet be confirmed.

Not one of the physiological markers (sCort, sAA, HR), individual variables (gender, IRI, SCO), or experimentally-controlled factors (perspective taking condition, sample collection time), predicted participants' willingness to write a letter to Katie or the time that they spent writing it. This may suggest that the video broadcast was not compelling enough to motivate participants to behave altruistically (write a letter to Katie). Participants who did write to Katie may have been motivated by some other factor that was not accounted for here. Previous studies in this area of research examined: physiological differences between perspective taking conditions while participants were performing a helping behavior (Buffone et al., 2017); self-reported differences in distress attributed to the Katie Banks stress induction between APT, CPT, and objective perspectives (Batson et al., 1997); and the likelihood of helping based on factors related to distress, ease of escape, and participant-confederate similarity (Batson et al., 1981). The listed studies are examples of experiments in which different aspects of empathy-induced distress were examined independently, each yielding results that supported a theoretical link between perspective taking, distress, and helping behavior. These studies, however, did not use the Katie Banks perspective taking manipulation as the motivating stimulus for enacting altruistic behavior as it was used in this study. The Katie Banks manipulation may be effective for eliciting emotional responses in participants, but it may not be strong enough evoke altruistic behavior in a research setting.

## CONCLUSION

The results of this study are not conclusive. Yet, these preliminary findings confirm the relationship between the psychological and physiological factors involved in perspective taking that contribute to feelings of empathy and distress. The aim of introducing an endocrine physiology component to the study of empathy was to add a new perspective, in hopes of gaining a more holistic picture that encapsulates not only the reasons why we want to connect with people and help them, but also some of the reasons why

those connections occur. Here, I wondered if the way that we empathize with others and internalize their experiences might affect our stress physiology in measurable ways, and if those different physiological effects then become part of our motivation to help when we decide to act altruistically. The results of this study created more questions than it could answer, and there were irreparable flaws in its execution. Nevertheless, I think that the questions posed in this study are important to consider. Maybe the form of empathetic perspective taking that should be utilized in helping scenarios is best informed by the context of the situation, in which the stress effects on the empathizer and the care that the suffering other needs must be balanced. There is most certainly not a one-size-fits-all way that we should connect with others, and that is not what I am arguing in this thesis; I am not arguing for or against empathy based on the potential link it may have to distress. I believe that the stress effects evoked by empathy are not necessarily negative. Recording the psychological and physiological responses associated with empathy may become one means to quantify the ways that we make and establish connections with others as we continue to learn more about the intersections between our social and biological lives.

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