WEARING THE INSIDE OUT: THE EFFECTS OF EXOGENOUS OXYTOCIN, READING, AND STRESS ON THE EXPRESSION OF EMPATHY FOR VICTIMS OF TRAUMA

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Considerable psycho-physiological research on empathy examines biological structures such as the hypothalamic-pituitary-adrenal axis (HPA-axis) and oxytocin systems as efficacious methods for strengthening positive emotional responses. This study recruited 76 adult participants (54 female, 23 male) for the purpose of evaluating the effects oxytocin and fiction reading have on empathetic responses. Participants completed a measure of trauma and received either intranasal oxytocin, a story created to induce emotional responses, or a neutral non-fiction story. Stressors were counterbalanced as a family or non-family stimuli to assess changes in stress response measured by salivary cortisol and heart rate variability. Results supported existing research stating that heart rate variability (HRV) is a more sensitive measure of stress. HRV statistically significantly interacted between type of stressor and PTSD symptomology (1, 70) = 5.018, p = .028, η^2 =0.06. Scores on the Interpersonal Reactivity Index (IRI) indicated there were increases in empathy across time, but were not impacted by exposure to stress or treatment condition. Trauma was identified as a statistically significant factor on heart rate variability $F(1, 70) = 8.39$, p = .005, η^2 = .10. Treatment condition did not impact cortisol levels across time $F(2, 71)$ = .2.532, p = .087, η^2 = .11. Taken together, these results suggest support for the use of biomarkers in measuring the rate of stress and recovery for those with and without trauma. These findings suggest potential avenues for translational research and implications for theory and practice.

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Introduction

The phrase *wearing the inside out* refers to one's ability to externalize internal feelings. Particularly in terms of empathy, externalizing feelings can lead to prosocial behavior and helping behaviors. These behaviors are crucial to humanity and for a productive society. However, the neural systems that produce empathy can be compromised by traumatic events, including ones that are life-threatening, those experienced during a child's developmental process, and bearing witness to another's distress.

Empathy and trauma are both affected by environmental stimuli resulting in biological and behavioral fluctuations (Johnstone, Cohen, Bryant, Glass, & Christ, 2015). Trauma, whether developed in the context of a familial, social, or community-based event, negatively impacts individuals' capacities to engage in prosocial behaviors (Olff, 2012; Olff et al., 2014). Empathy is operationally defined as involving three crucial components: behavior, cognition, and affect. Cognition, which underlies the capacity for perspective taking, includes moral and prosocial perspectives. Affect contributes to the capacity to feel for another person. Behavioral empathy combines the aforementioned and is represented in the associated response; when empathy is strong enough to motivate action, a person behaves in a manner to actively relieve another's distress (Krumpal, 2013). Thus, in order to possess empathy, one must be able to take the perspective of another by feeling their distress, this leads to act in a way to relieve that distress. These components are essential in nature and are required to evaluate how we engage with others. These foundations are laid in childhood, but often unforeseen, often traumatic, events even in adulthood can impose crucial threats to this necessary skill (Vrticka & Vuilleumier, 2012).

An event is defined as traumatic when the individual's subjective experience creates a significant physiological stress response. Stimulation of the stress response system is marked by activation of the sympathetic nervous system, physiologically denoted in the functioning of the hypothalamic-pituitary-adrenal axis (HPA-axis) and dampening of responses in the parasympathetic nervous system, often referred to as the fight or flight response (Kindsvatter & Geroski, 2014). The activation of the sympathetic nervous system leads to an increased heart rate, dilated lungs, reduced appetite and sleep, and changes in salivary cortisol production.

Short-term effects of stress system activation are crucial for survival and adaptation (Carthy, Horesh, Apter, Edge, & Gross, 2010). Homeostasis controls sympathetic responses by coordinating the stimulation of other body systems to maintain balance within the body (McEwen, 2000). Allostasis maintains homeostasis in order to control the output of stress hormones. With chronic stress, however, allostatic load represents the deterioration of the body due to continuous fluctuations of stress hormones from allostasis (De Bellis, 2001; McEwen, 2000). While allostasis is necessary to provide the body with adaptive responses to stress, when a stressor event is acute or chronic, the physiological changes can lead to psychological distress (Carthy et al., 2010). In this instance, the adaptive responses can result in inefficient operation of the HPA-axis, where continued activation can lead to general dampening of responses to the stressor and eventually other events. Conversely, the experience of acute or chronic stress can lead to an increase in sensitivity of responses to stress due to continued activation of the sympathetic nervous system (McEwen, 2000). These negative effects of allostatic load can cause chemical imbalances and can result in atrophy of brain structures that support responses to stress, i.e., to a threat or trauma (De Bellis, 2001; McEwen, 2000). For those with anxiety disorders, depression, aggression, and post-traumatic stress disorder (PTSD), these imbalances can have detrimental effects on social interactions and empathetic responses.

These physiological changes in the adaptive functioning of the stress response system can result in changes in behavior in response to the traumatic event. The victim may become reclusive, avoid social interactions, or act out violently as a way to seek vengeance (Carthy et al., 2010).

Understanding the pervasiveness of how individuals can experience stress as trauma has gained attention in both research and practice (Bal & Veltkamp, 2013; Johnstone et al., 2015; Olff, 2012; Olff et al., 2014) with clear evidence that childhood bullying, chaotic environments, and child maltreatment can be experienced as traumatic, resulting in physiological changes in capacity to respond to stressful events or exhibit empathy. The research has connected individuals' experiences of these types of trauma with feelings of abandonment, betrayal, fear, and retaliation. To help ameliorate the over activation or dampening of the stress response system and resulting in disturbances in the capacity to respond appropriately to stressful events or to engage in empathetic responses to others' distress, efforts to address this concern focuses on decreasing the response of the sympathetic nervous system and activating the parasympathetic nervous system. Antisocial reactions would benefit from new and efficacious treatments lending support to trauma victims, increasing victims' capacity to move beyond these effects and engage in prosocial, empathic behaviors (Carthy et al., 2010).

There is conflicting evidence, however, regarding the relation between *empathy* and the experience of a traumatic event. It is unclear as to whether following trauma, victims are more sensitive, thereby generating more empathic responsiveness, or whether these victims are less sensitive after the event (Frijling et al., 2014). This occurs in the face of challenges defining the concept of empathy. The triarchic model of empathy described above is a comprehensive view of defining empathy (Batson, 2009; Decety & Jackson, 2004; Ikezawa, Corbera, & Wexler, 2014). For victims of trauma, psychosocial care is therefore the most important aspect of the healing process (Olff, 2012; Olff et al., 2014).

The Oxytocin System

Supporting individuals' engagement in prosocial behaviors following trauma is essential to support biological and emotional healing. Changes in response sensitivity are often addressed by examining victims' levels of oxytocin as a mechanism associated with empathic responses (Olff, 2012; Olff et al., 2014).

Oxytocin is a neuropeptide, naturally occurring in mammals (Alves, Fielder, Ghabriel, Sawyer, & Buisman-Pijlman, 2014; Bartz, Zaki, Bolger, & Ochsner, 2011; Van IJzendoorn & Bakersmans-Kranenburg, 2012). The foundational oxytocin system is established by early caregiver-child bonding and continues to respond to social interactions throughout the lifespan (Alves et al., 2014). The early contact between the main caregiver and infant is crucial for establishing a secure, pair-bonding foundation. During this bonding period, oxytocin is mutually expressed between caregiver and child, becoming a driving force for secure attachment. Secure attachment leads to a healthy functioning stress response system and a child's engagement in more prosocial, empathetic behavior (Riem, Bakermans-Kranenburg, Huffmeijer, & Van IJzendoorn, 2013; Witvliet, Mohr, Hinman, & Knoll, 2015). When a caregiver is responsive to a distressed infant, the infant's neural circuitry begins to form a healthy HPA-axis system. This circular system causes oxytocin circulation to increase throughout the brain when interacting with others. When released, oxytocin creates a feeling of elation, calming the stress response and interacting with brain systems regulating pleasure and reward. Because the influx of this hormone generates positive emotional outcomes associated with the hormonal changes, the person is motivated to continue making social connections (Lukas & Neumann, 2011).

Oxytocin also allows a person to recover from a stressful event. Oxytocin works on the reward circuitry, creating feelings of calmness and euphoria, particularly after sexual activity. When given intranasally, oxytocin decreases social inhibitions, promoting prosocial behavior (Lukas & Neumann, 2011). The presence of trauma has been linked to both increases and decreases of oxytocin output. If the traumatic event interrupts the parenting process, then more of the hormone is produced in order to guide the victim(s) into seeking socioemotional support (McCullough, Churchland, & Mendez, 2013). Other times, victims seek solitude and avoid social interactions altogether.

These results support the use of oxytocin in treating those with psychopathology such as post-traumatic stress disorder (PTSD), anxiety, and depression (Frijing et al., 2014; McQuaid, McInnis, Stead, Matheson, & Anisman, 2015; Olff, 2012; Olff et al., 2014).

Fictional Narrative Experience

One non-physiological empathy-building treatment method to increase levels of oxytocin and engagement in empathic behavior is reading fictional narratives (Kidd & Castano, 2013). Fictional narrative experiences play an important part in how readers learn about themselves by assessing which characters and decisions reflect their own lives (Mar & Oatley, 2008). Readers identify with characters in the stories, which creates perspective taking and therefore increases empathetic responses (Bal & Veltkamp, 2013; Djikic, Oatley, & Moldoveanu, 2013; Johnson, 2012, 2013; Kidd & Castano, 2013). Fiction is a verbal representation of social interactions where interpersonal experiences are described in detail by a main character or narrator. In these stories, readers read through characters' cognitive processes, which can lead readers to adopt these behaviors in their daily lives (Busselle & Bilandzic, 2009; Kidd & Castano, 2013). When the reading experiences involve empathy, readers are able to participate in the characters' cognitive, affective, and behavioral processes from a first-person perspective. Implications are well-supported, suggesting that reading has a profound effect on empathy, behavior, and neurological structure (Bal & Veltkamp, 2013; Busselle & Bilandzic, 2009; Kidd & Castano, 2013). When utilized as an imaging paradigm, reading increases blood flow to the limbic system, which is responsible for emotional process and expression (Busselle & Bilandzic, 2009).

Theoretical Framework

The importance of both fiction and administration of oxytocin as a mechanism to increase empathetic responses is supported by the association of these interventions with the components in the process-person-context-time model (PPCT). Trauma victims' biological drive for social exposure can be explained using components within this model (Bronfenbrenner, 2005; Campbell, Dworkin, & Cabral, 2009). Processes are interactions with either people or objects and contribute to how individuals make sense of their worlds and how each person fits into society (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006). The experience of trauma and the subsequent changes in oxytocin and cortisol production can impact engagement in prosocial and moral behavioral processes associated with empathic behavior.

The role of person acknowledges that people differ in terms of personality, attitudes and beliefs, and even physiological responses (Riggins-Caspers, Cadoret, Knutson, & Langbehn, 2003). When interacting with others, trauma victims receive implicit or explicit cues on how they respond to the event. Individual differences in the oxytocin system can inhibit or produce a greater need for social interactions (McQuaid et al., 2015). Thus, depending on the person's physiological responses, bonding capacity, and how one responds to stress can greatly impact the quality of social interactions.

Further impacting engagement in empathic behavior is the role of environmental context (Tudge, Mokrova, Hatfield, & Karnik, 2009). The context in which a traumatic event occurs affects an individual's response to trauma. If the trauma occurred within the family, there can be adverse reactions within the individual's home (Bartz, Zaki, Bolger, & Ochsner, 2011). If the individual's stress response system is hypersensitive as a result of trauma, repeated stress may develop, causing an avoidance to social interactions. This, in turn, could increase or decrease oxytocin production (Bartz et al., 2011). And finally, time refers to the occurrence of any traumatic event or social interaction throughout someone's daily life, and the extent to which these events influence a particular behavior, i.e., reclusion, occurs on a consistent basis (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006).

Purpose

The effectiveness of administration of oxytocin and use of fiction reading interventions as a mechanism for increasing an individual's capacity to respond in an empathetic manner to stressful events or stressors experienced by others is the focus of this study. The purpose of this study was to assess the effectiveness of administration of oxytocin and use of fictional reading as different methods to increase empathic responses, including both self-reported and objective changes in empathy, with the latter based on physiological measures that evaluated sympathetic and parasympathetic responses to emotion (Bal & Veltkamp, 2013; Chen et al., 2015). As objective, physiological measures of empathy, heart rate variability and salivary cortisol levels indicate the body's response to external stimuli. When exposed to micro-level stressors, such as within a family-context, cortisol is expressed indicating discomfort or apprehension (Cărnuţă, Crişan, Vulturar, Opre, & Miu, 2015). An increase in salivary cortisol is anticipated as a physiological response indicating associated stress. Following this activation of the stress response system after the experience of the stressor, recovery would be marked by the activation of the parasympathetic response indicated by a decrease in cortisol.

Saliva sampling allows assessment of the change in cortisol that determines an individual's recovery after the stressful event. Using this objective measure provides additional robust data unavailable through traditional self-report questionnaires. Self-report measures often result in social desirability bias, which is the tendency for participants to respond to survey questions making themselves appear more favorable to others (Krumpal, 2013). Participants can consciously change their behavioral response to a stressor event, but this does not necessarily indicate a similar change in their physiological experience of stress. This dissociation between physiological and behavioral markers of stress was evidenced as early as 4 to 6 months of age (Middlemiss, Granger, Goldberg, & Nathans, 2012). Thus, in this research, the measure of both behavioral (as indicated in the questionnaire data) and physiological (as indicated in the measure of cortisol and heart rate variability) provided a clearer indication of participants' experiences of stressor events and the impact of the intervention for both stressor response and recovery.

Recent advances in understanding neurological hormones and chemical changes have made testing this connection between physiological changes associated with the autonomic nervous system functioning, reading, and administration of oxytocin on empathy plausible (Barraza, McCullough, Ahmadi, & Zak, 2011; Lukas & Neumann, 2011; Luo et al., 2015). Just as reading has been shown to increase empathic and prosocial behavior, oxytocin achieves similar effects by altering brain chemistry (Acheson, Wells, & MacDonald, 2008; Alves et al., 2014; Frijling et al., 2014). However, there is little research examining whether reading would have the same effects as oxytocin in calming the stress response system. While both reading and oxytocin have been shown to influence similar outcomes, they do so through different physiological pathways (Berns, Blaine, Prietula, & Pye, 2013; Van IJzendoorn & Bakermans-Kranenburg, 2012). Reading increases connectivity throughout the brain, creating faster communication between neurological systems, whereas oxytocin is produced as a chemical, signaling the body to behaviorally respond (Berns et al., 2013; De Vignemont & Singer, 2006; Stanovich & West, 1989).

Research Questions and Hypotheses

There have been few, if any studies, testing the manner in which oxytocin affects empathy. Even more so is the need to address how individual context affects a person's ability to be transferred into a narrative. This research examined these variables by evaluating empathy through Davis's (1983) Interpersonal Reactivity Index, stress as measured by salivary cortisol and heart rate variability, and a psychological assessment for trauma (PTSD Checklist-Civilian Version). The research questions below are grouped by topic:

(1) What is the relationship between trauma scores on the PTSD Checklist- Civilian Version (PCL-C) and empathy, as measured on the Interpersonal Reactivity Index (IRI)?

  a. Hypothesis: Scores on the PCL-C will be moderately to highly ($r \geq .30$) correlated with the baseline measure of empathy from the IRI.

(2) Is participation in either a reading activity or one-time administration of oxytocin associated with increased levels of empathy as measured by the Interpersonal Reactivity Index (IRI)?

  a. Hypothesis: There will be statistically significant increases ($p < .05$) between baseline measures of empathy and empathy scores following the treatment.

  b. Hypothesis: There will be statistically significant increases ($p < .05$) between the baseline measure of empathy and the final measure of empathy following the stressor.

(3) Does the type of stressor (family or non-family-related) significantly affect changes in empathy scores?

  a. Hypothesis: There will no effects of empathy ($p > .05$) on type of stressor due to the counterbalanced design; the order of stressor will have no impact on empathy scores.

(4) Does experience of trauma as indicated by scores on the PTSD Checklist-Civilian Version affect participants' physiological response to the stressor event as measured by salivary cortisol?

a. Hypothesis: Symptomology will statistically significantly ($p < .05$) impact cortisol response, with those high in PTSD scores demonstrating greater time for recovery than those with low PTSD scores.

b. Hypothesis: There will be a statistically significant interaction effect ($p < .05$) between stressor and PTSD symptomology on cortisol levels.

(5) Does experience of trauma as indicated by scores on the PTSD Checklist-Civilian Version affect participants' heart rate variability (HRV)?

a. Hypothesis: Participants with PTSD symptoms will have statistically significant increases ($p < .05$) in HRV following the stressor event at time 3.

b. Hypothesis: There will be a statistically significant interaction effect ($p < .05$) between stressor and PTSD symptomology on HRV.

(6) Does participation in either a reading activity or one-time administration of oxytocin affect participants' physiological response to the stressor event as measured by salivary cortisol?

a. Hypothesis: Cortisol will decrease following the intervention and continue to decrease following the stressor. These differences will be statistically significant ($p < .05$).

b. Hypothesis: There will be a statistically significantly interaction effect ($p < .05$) between group membership and cortisol across the three measured time points.

(7) Does participation in either a reading activity or one-time administration of oxytocin affect participants' heart rate variability in response to the stressor event for participants with PTSD symptomology?

a. Hypothesis: The main effect of stressor will be statistically significant ($p < .05$).

b. Hypothesis: There will be a statistically significant interaction ($p < .05$) effect between stressor and PTSD symptomology.

c. Hypothesis: There will be a statistically significant ($p < .05$) decrease in HRV following the treatment (time 2). HRV will not statistically significantly ($p > .05$) increase following administration of the stressor (time 3).

Method

Participants

Participants were recruited through flyers discussing an overview of the study and contact information for the researcher. Upon completing of the study, participants received a $25 gift card. Participants were 77 students and faculty from a public university in the southwest United States. There were 39 undergraduate students; 32 graduate students participated; and 6 university faculty members participated. The majority of participants identified as white (54), followed by Hispanic (16), and black/African American (8). Of the participants 54 were female. Although existing literature underrepresents women because of the focus in using oxytocin as a treatment for both schizophrenia and PTSD for returning soldiers, there are consistently no gender effects (Alves et al., 2014; Bartz et al., 2011; Van IJzendoorn & Bakersmans-Kranenburg, 2012; Weisman, Zagoory-Sharon, & Feldman, 2012). Ages of participants ranged from 19-years to 54-years (M = 29; SD = 7.04); participants held a variety of institutional degrees in a dozen different fields and 50% were employed with a majority making less than $20,000 annually. Sixty-six identified as heterosexual (straight) and most were never married or had been divorced (57, 20, respectively).

Using a random control trial research design, participants were randomized into one of three groups, oxytocin treatment, reading treatment, or control group. Using a computerized random number generator, ID numbers 1-75 (where 1-25 were assigned for the reading group, 26-50 assigned to the oxytocin treatment, and 51 -75 to the control) were reordered. With the randomized series of numbers, group membership was randomly assigned by chance based on order of enrollment across the recruitment period. This ensured each participant an equal chance for selection into one of the three groups.

In this study protocol, participants self-administered a low-dose, single administration of nasal oxytocin in the treatment group, or saline in the reading or control groups. This dose of oxytocin was consistent with what previous literature has used with human subjects (Alves et al., 2014; Bakermans-Kranenburg, van IJzendoorn, Riem, Tops, & Alink, 2011; Bartz et al., 2011; Lukas & Neumann, 2011). Because oxytocin can lead to premature contractions during pregnancy, female participants were required to take a urine pregnancy test before beginning the study. While rare, oxytocin can cause spontaneous abortion when given in high doses. Oxytocin has been shown to remain in the body for as long as 4 hours, with effects of intranasal doses peaking around 2 hours (Born et al., 2002). The entire protocol was completed within this timeframe lasting approximately 90-100 minutes.

All participants completed a reading task as part of the protocol with participants in the reading treatment group reading a fictional story previously used in empathy research and shown to affect empathy. Participants in the oxytocin treatment group and control group read a story about a desert cactus. Given the university derived recruitment plan, participants' reading level was not identified as a potential consideration.

Missing Data

Missing data was reviewed with the multiple imputation method in SPSS. A total of 5 iterations were completed before the complete data set generated. The imputation model contained data for the IRI measure, as this was the only measure with missing data. Missing data was completely missing at random (MCAR). One person was dropped from analyses due to 40% missing data, bringing the total sample size from 77, to 76. Additionally, one participant's cortisol levels were undetectable for times 2 and 3, therefore that person's data was removed from cortisol analyses (n = 75).

Assessments and Measures

Empathy

- Interpersonal Reactivity Index (IRI). Davis's IRI (1983) is a well-validated, commonly used 28-item multidimensional scale measuring empathy. The instrument is comprised of four subscales: fantasy (FS), the ability to transpose oneself into fictional situations; perspective-taking (PT), being able to shift perspectives, also known as the cognitive component of empathy; empathic concern (EC), experiencing positive regard for an observed individual, or behavioral empathy; and personal distress (PD), the participant's personal feelings of fear and discomfort when witnessing the negative experiences of others (i.e., affective empathy).

The IRI utilizes a 5-point Likert scale (A-E) where A indicates whether an item does not describe the participant well, and E is whether the item describes the respondent very well. Davis (1983) defines empathy as the reaction one individual feels when observing the experiences of another. This is reflective of the utility of empathy throughout this proposal. An example of a question related to cognitive empathy is, *I try to look at everybody's side of a disagreement before I make a decision.* Questions from the empathic concern subscale read from a behavioral empathy perspective; for example, Question 9 asks, *When I see someone being taken advantage of, I feel kind of protective towards them*. Affective empathy is assessed by items such as Question 5, *I get really involved with the feelings of the characters in a novel*. Scores from the IRI can be evaluated and interpreted individually, or combined to yield a total empathy score.

Each subtest yields an individual score along with a total score. The individual score can be used to indicate a particular score in a specific component of empathy, whereas the total score gives an overall empathy score (α = .908). The internal consistency for each time point as well as for each subscale was calculated (see Table 1). The diversity of this measure's scales makes it one of the most widely used and accepted measures of empathy in the empirical literature. The test-retest reliability was also strong demonstrating the stability and precision of empathy scores across time (Empathy1 – Empathy2, α = .942; Empathy1 – Empathy3, α = .901; Empathy2 – Empathy3, α = .955). Previous research has used the IRI (1983) at different time points within the same study consistently (Castillo, Salguero, Fernández-Berrocal, & Balluerka, 2013; Colonnello, Domes, & Heinrichs, 2016; McFarland, Malone, & Roth, 2016). In order to address potential practice effects, the order of the subtests were randomized at each of the three time points.

Table 1

Internal Consistency of each Subscale for Interpersonal Reactivity Index (IRI)

Time 1		Time 2		Time 3	
Scale	Alpha (α)	Scale	Alpha (α)	Scale	Alpha (α)
PT	.669	PT	.809	PT	.815
FS	.830	FS	.869	FS	.726
EC	.869	EC	.850	EC	.864
PD	.801	PD	.801	PD	.878
TOTAL	.876	TOTAL	.908	TOTAL	.885

Physiological Measures

- Vagal tone. With respect to this proposal, heart rate variability (HRV) provided measures of both the sympathetic and parasympathetic response systems, both of which are crucial for reporting to acute stress and long-term responsiveness. Heart rate variability was measured using a 4-lead electrocardiogram (EKG), which assessed the functioning of the autonomic nervous system by measuring the alterations from beat-to-beat of the heart (Kawachi, 1997). The leads were placed on participants' left and right wrists and the other two similarly positioned on their ankles. This heart rhythm was mediated by parasympathetic activity in relation to vagal tone. HRV is a biomarker of two important physiological processes. The first is related to frequent activation in response to sudden stress. The second marker is based on inadequate response, which results in over-activity of the sympathetic nervous system (Kawachi, 1997). Increased heart rate indicated higher stress and an activated sympathetic response system. EKGs were administered at three timepoints; means and standard deviations for each point in time were calculated (M = .765, SD = .141; M = .811, SD = .138; M = .816, SD = .151)

- Stress. Cortisol is a commonly employed measure of stress levels in social science research and is assessed through a number of biometrics (Fisher, McLellan, & Sinclair, 2015). In this study, participants donated saliva samples by using the passive drool method after receiving the oxytocin spray or saline solution. Each participant was instructed to let drool and saliva pool or collect on the floor of the mouth as indicated by the Salimetrics (2014) protocol. The spitting valve was then placed in the corner of the mouth where drool flowed into the vial. A second collection took place 20 minutes after exposure to the first stressor, and a final collection was taken 30 minutes post-stressor. Salivary samples were stored in vials labeled by time and ID and kept frozen until the assay process. Outliers in data were identified if they were +/- 3 standard deviations from the mean for each variable time point. These values were replaced with the mean value for that variable as per standard protocol. Data were positively skewed, therefore base logarithms for each value were transformed in SPSS.

Stressors

Based on literature identifying different effects that familial or general trauma have on individual responses, the study introduced two different stressors, counterbalanced in the design to examine the impact of reading or oxytocin as related to stressor type. The types of stressors were selected based on reviewing the literature. The purpose of including these within the design was to provide varying contexts to elicit stress responses. Theoretical arguments were made that nature of stressor may affect response following the stressor given the bioecological model's emphasis on process, person, context, and time, all of which include a family and interpersonal relationship component.

- Non-family stressor. The non-family stressor consisted of completing as many multiplication problems as possible within a 3-minute period. Arithmetic problem-solving, such as multiplication, has been identified as a safe, reliable way of systematically inducing a stress response in order to measure differences in reactivity, anxiety and activation of the HPA axis. This non-family stressor is consistently used in the Trier Social Stress Test (TSST; Birkett, 2011).

- Family stressor. For the family stressor, participants were presented with an audio recording of infant cries for 3 minutes. Infant crying was identified as an essential social cue for males and females signaling to attend to an infant's needs (Bakermans-Kranenburg et al., 2011). Depending upon an individual's background and history, these sounds activate the stress response system and stimulate feelings of behavioral empathy, which create the desire to react with sensitivity to the infant. In an aversive outcome, irritation and harsh or abusive responses may be elicited. Excessive irritation or stress in reaction to infant stimuli is often the result of early parental experiences with harsh discipline (Van IJzendoorn & Bakersmans-Kranenburg, 2012). For others coming from a responsive and sensitive caregiving background, infant cries do not elicit strong stressful responses, but lead to caring behavior (Bakermans-Kranenburg et al., 2011).

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Trauma

- PTSD Checklist- Civilian Version (PCL-C). The PTSD Checklist- Civilian Version (PCL-C; Weathers, Litz, Huska, & Keane, 1994) is a self-report measure of the DSM-IV symptoms of PTSD requiring participants to indicate the extent to which 17 response items have affected their lives within the last month. Examples include, *Repeated, disturbing dreams of a stressful experience from the past?* and *Feeling jumpy, or easily startled*? Using a Likert scale of 1 (n*ot at all*) to 5 (*extremely bothered by*), test items are divided into three subscales: avoidance, hyperarousal, and re-experiencing (Weathers et al., 1994). The highest score is an 85, with scores of 51-85 being considered moderate to high risk of PTSD and scores of 34 or below being non-symptomatic of PTSD. Questions can also be evaluated individually. Responses of 3 to 5 are symptomatic, and questions answered as 1 or 2 are non-symptomatic. The PCL-C had strong internal consistency for trauma scores (α = .91), which is consistent with results in other studies (Conybeare, Behar, Solomon, Newman, & Borkovec, 2012).

Interventions

- Exogenous oxytocin. Participants assigned to the oxytocin group received an intranasal oxytocin dose of 40 international units (IU) after completing the baseline measure of empathy (IRI). One IU of oxytocin is equal to 2 mcg. The solution was contained within a metered nasal spray canister where participants puffed and inhaled the solution via one or alternating nostrils. The dose was self-administered intranasally by the participants under researcher supervision. This dose was consistent with other studies in producing positive effects and does not yield adverse outcomes or side effects (Frijling et al., 2014; Krueger et al., 2013).

Other research suggested doses ranging from 24-40 IU depending upon whether given as a single dose or overtime. The use of 40 IU has shown to increase levels of vasopressin, oxytocin's peptide counterpart, within cerebrospinal fluid suggesting similar effects for oxytocin (Born et al., 2002; Krueger et al., 2013). Other studies have concluded this dose penetrates the blood brain barrier and reaches the central nervous system (Born et al., 2002; Weisman et al., 2012). The placebo nasal spray contained .8% of sodiumchloride (NaCl) based on standard recommended saline dosages (Born et al., 2002; Frijling et al., 2014; Krueger et al., 2013). This product was administered in the same manner as oxytocin, where participants self-administered using the puff and inhale method.

- Reading. Participants in the reading group read a story used to examine the impact on empathy (Johnson, Cushman, Borden, & McCune, 2013). The story took between 10 to 15 minutes for participants to read, with a word length of 1,710. The Flesch-Kincaid grade formula, which determined a standardized reading level calculated Johnson's story at a grade level of 4.4; the Flesch reading ease score was 85.1. The reading level accommodated the reading level of those participating in the study based on participants' educational and professional background as students and faculty (University of North Texas Admissions, 2016). The story was designed to provoke affective empathy and generates strong imagery by describing the story characters' sensations, the use of figurative language, and metaphors (Johnson et al., 2013).

The story revolved around a pre-teenage boy who came from a difficult home environment. His parents routinely engaged in physical and verbal altercations, fueled by his father's frustrations of not finding a job and excessive drinking. The author emphasized the boy's feelings and emotions throughout the story, particularly when his parents could not afford to buy him a bicycle. The story also included a prosocial model, the boy's teacher, who acts as a surrogate parent and served as an emotional support system (Johnson, 2012; Johnson et al., 2013).

Participants in the oxytocin and control groups read an emotionally neutral story. The story was comparable to the treatment story, with 1,539 words and a Flesch-Kincaid grade formula rated the story at a 5.1 grade-level; the Flesch reading ease score was 77.5. The story was chosen from a database online, which provides stories for classroom use. The story was a non-fiction explanation of a saguaro cactus, found throughout the southwestern United States. The story was pilot tested where participants explained how the story made them feel.

Participants agreed they felt no emotion or transference into the story. Many said it was difficult for them to take the perspective of the cactus, nor did they feel emotionally connected to any part of the story.

Procedures

The study was conducted in the Applied Physiology Laboratory within the Department of Kinesiology, Health Promotion, and Recreation under the supervision of the laboratory director and the dissertation chair. All data was collected by K. Seddio. Participants entered the laboratory where they signed informed consent paperwork authorized by the Institutional Review Board at the University of North Texas. No participants declined to participate. Females were directed to take a urine pregnancy test.

All participants had their own desk and laptop to complete the protocol. Desk set-ups were identical for each participant and all laptops and materials were the same for all participants. This minimized threats to internal and external validity. Initially, participants each completed the PTSD Checklist- Civilian Version (PCL-C). Participants were then one-by-one connected to a heart rate monitor as a measure of heart rate variability. A baseline measure of empathy was administered using the Interpersonal Reactivity Index (IRI). After approximately 10 minutes, participants were instructed to self-administer the oxytocin or placebo, and read the stories. Participants in the oxytocin group received oxytocin and read the neutral story. The control group self-administered the placebo and read the control story. Reading group members read the treatment story and self-administered the placebo nasal spray.

After baseline measures and treatments were administered, the stressors were introduced for 3 minutes; some receiving the non-family stressor, others receiving the family stressor. After the stressor and initial recovery, all participants completed the IRI for the second time. At 20 minutes post stressor, stress response to the stressor event was measured with participants donating 2 mL of saliva. At 30 minutes post stressor initiation, participants donated a second salivary sample to assess physiological stress recovery. Saliva was donated using standard vials attained from Salimetrics and labeled according to participant ID and donation time. Participants had a timer at their desks and were instructed to set it for 20 minutes before giving the first sample, then 10 minutes where they gave the recovery sample.

Following completion of the cortisol stress recovery task, the second EKG was administered. The second stress and recovery task were then given again, counterbalancing the type of stressor. The third and final EKG was administered followed by the demographics questionnaire. Finally, participants completed the final measure of empathy.

Results

Trauma and Empathy

This research question addressed the conflicting literature examining whether trauma victims have stronger or weaker empathy scores. Correlational analyses were used to examine the relationship between subscale scores on the IRI and total scores on the PCL-C. Results indicated no statistically significant correlations among IRI scores and trauma. The relationship between total scores from the IRI and total trauma scores indicated a weak correlation (r = .012, p = .918, n = 77, 2-tailed). When Pearson's correlations were tested between those only with symptoms of PTSD and baseline empathy scores, results were not statistically significant and there was no relationship between those who had PTSD symptoms and empathy, $r = .236$, $p = .542$, $n = 9$, 2-tailed. In general, the results suggested that trauma scores and IRI scores were not correlated among this sample, which did not support the hypothesis. It is possible these results are indicative of the few participants who met the requirements for being symptomatic of PTSD. Nine out of 77 participants scored 51 or higher on the PCL-C; whereas 45 participants scored below 34. Thus, the majority of participants were not symptomatic of severe trauma, suggesting a need for equal groups between those with and without symptoms of PTSD. This would increase the power and chances of statistically significant correlations, regardless of strength.

Empathy and Type of Intervention

A 3 × 3 split plot ANOVA examined group differences for the control, oxytocin, and reading groups across each of the three time points assessed by the Interpersonal Reactivity Index (IRI). The data was normally distributed, as evaluated by Shapiro-Wilk's test of normality ($p > .05$). There was homogeneity of variances ($p > .05$) and covariances ($p > .05$), as measured by Levene's test of homogeneity of variances and Box's M test ($p > .05$), respectively. These tests assumed equal variances of empathy for each of the three times, for all three groups. Mauchly's test of sphericity indicated the assumption of sphericity was violated, $x^2(2) = 14.044$, $p = .001$. The Greenhouse-Geisser correction was used to correct for the *F*-distribution degrees of freedom (Gueorguieva & Krystal, 2004; von Ende, 2001). There was no statistically significant interaction between the interventions and control groups on three assessed points of empathy scores, $F_{a \times b}(3, 120) = .790$, $p = .515$, $\eta^2 = .02$.

The main effect of time showed a statistically significant difference in mean empathy scores at the different times assessed, $F(2, 120) = 8.63$, $p = .001$, $\eta^2 = .11$. This effect size although small, was the highest here. It represents 11% of the overall variance for total empathy was explained by changes across time in IRI scores. However, the between-subjects effects of group membership showed there was no statistically significant difference in mean empathy scores between intervention and control groups $F(3, 71) = .488$, $p = .616$, $\eta^2 = .03$ (See Table 2). This indicated group empathy averages were equal across each of the three times assessed. The between-subjects pairwise comparisons additionally showed no statistically significant comparisons between empathy compared to the different time points. The effect sizes for the interaction effects and conditions were small, amounting to less than 1% for both. This affirms the non-statistically significant results that group membership did not account for much variance in changes in scores across time.

Table 2

Results from the Split-Plot ANOVA Analysis

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Time (a)	2	276.164	163.183	8.628	.001*	.11
Error (a)	120	2272.434	18.912			
Condition (b)	3	665.861	337.931	.488	.616	.013
Error (b)	71	48404.64	681.755			
Group × Time	3	50.572	14.941	.790	.515	.02
Total	73	49070.50				

Note. Time indicates the mean empathy scores across each point assessed. Condition refers to the treatment group assigned (oxytocin, reading, or control). Statistical significant p-values are indicated with an *.

Pairwise comparisons for within-subjects (e.g., empathy at each time point) showed statistically significant differences across time for all groups from time 1 (M = 71.03, SD = 15.15, p = .027) to time 2 (M = 69.24, SD = 71.92, p = .027). Existing comparisons between measurements at time 2 and time 3 were also statistically significant (M = 71.92, SD = 15.995, p < .001; M = 69.24, SD = 71.92, p < .001), which was the time after receiving treatment or control conditions, to the final measure, which occurred following the final stressor (see Table 3). Post hoc analyses revealed no statistically significant differences amongst the groups. Taken together, these results showed increases in empathy scores occurred regardless of group membership. The oxytocin, reading, and control conditions were irrelevant to changes at each of the three points empathy was assessed with the IRI. The results of the pairwise comparisons supported the hypothesis that empathy would change from baseline to post-intervention and from baseline to final measure.

However, the reading scores decreased over time even after the intervention. Both oxytocin and control groups started low at baseline, increased after the treatment, then decreased after the final stressor.

Table 3

Means and Standard Deviations for Empathy at each time point by Group

Group	*n*	Time 1		Time 2		Time 3	
		M	*SD*	*M*	*SD*	*M*	*SD*
Reading	24	74.33	16.48	73.85	17.94	71.50	16.74
Oxytocin	28	69.82	13.85	70.71	13.92	68.29	13.17
Control	22	68.95	15.35	71.34	16.76	68.01	14.87

Note. Time 1 is baseline; Time 2 is after treatment; Time 3 is following stressor

Empathy and Type of Stressor

A one-way ANOVA was conducted to compare the effect of type of stressor (family vs. non-family) on the total score from the IRI. There was no statistically significant effect of stressor on total empathy score [$F(1, 72) = .421$, $p = .519$, $d = .00$)], thus the null hypothesis was rejected (see Table 4). These results indicated there were no differences between participants who received the non-family stressor first, versus the family stressor first. Results supported the hypothesis that order of stressor would be irrelevant to the final empathy outcome; the counterbalanced design controls for this order effect. The stressors were counterbalanced within the design, which meant half of the participants received the non-family stressor first (M = 208.79, SD = 48.01, n =37), while the second half received the family stressor first (M = 215.59, SD = 41.96, n = 37). Additionally, independent samples t-tests were conducted to compare cortisol levels across time of day. The body's circadian rhythm leads to fluctuations in cortisol levels through the day. There were no statistically significant differences between mean levels measured between 10 AM and 11:59 PM, 12:00 PM and 1:59 PM, or 2:00 PM or later.

Table 4

One-Way ANOVA of Empathy Scores by Stressor (family vs. non-family)

Source	*df*	*SS*	*MS*	*F*	*p*	*d*
Between groups	1	855.443	855.44	.421	.519	.00
Within groups	72	146256.06	2032.72			
Total	73	147211.51				

Cortisol Stress Response and Stressor Event

This question asked whether the type of stressor had an impact on cortisol response to stressor for participants with and without PTSD. A one-way ANOVA was first conducted to determine whether cortisol was impacted by order of the stressors. Results were not statistically significant, $F(1,72) = 1.449$, $p = .233$, $d = 0.02$, meaning order of the stressor (family vs. non-family) did not impact changes in cortisol collection times (see Table 5). Additionally, chi-squared analyses indicated no relationship between symptomology and type of stressor, $\chi(1) = .722$, $p = 1.000$. This indicated there would be an equal likelihood of either variable impacting cortisol across time. Additionally, both Phi and Cramer's V values were low, meaning there was a weak relationship between the two variables ($\phi = .041$, $p > .05$).

Table 5

One-Way ANOVA of PTSD Scores by Stressor (family vs. non-family)

Source	*df*	*SS*	*MS*	*F*	*p*	*d*
Between groups	1	.040	.040	1.449	.233	.02
Within groups	72	1.965	.027			
Total	73	2.04				

Note. Dependent variable was the second cortisol collection.

A repeated measures ANOVA demonstrated no statistically significant changes in cortisol levels across the three times collected $F(1.707, 124.58) = 1.167$, $p = 309$, , $\eta^2 = .00$. Table 6 provides the means and standard deviations for cortisol at each time point assessed. These values are the absolute values from the original data.

Table 6

Means and Standard Deviations for Cortisol at each time point

Time 1		Time 2		Time 3	
M	*SD*	*M*	*SD*	*M*	*SD*
1.917	.646	2.034	.601	1.994	.643

Note. Means and standard deviations are absolute values for cortisol.

A two-way ANOVA (factorial) was conducted examining the interaction effect of stressor (family vs. non-family) and symptomatic vs. asymptomatic of PTSD on salivary cortisol (see Table 7). The second cortisol collection was used as the dependent variable, while stressor and PTSD were independent variables. The second sample was utilized because this was the immediate response to the stressor. The hypothesis suggested there would be a statistically significant interaction effect between stressor and PTSD on cortisol response to stressor; this was not supported [$F_{a \times b}$ (1, 74) = .571, p = .452, η^2 = .01].

There was no statistically significant main effect of symptomology, indicating PTSD did not impact cortisol following the stressor, $F(1, 74) = 1.711$, $p = .195$, $\eta^2 = .02$. The effect size was 2%, indicating that 2% of the total variance for response cortisol was comprised of the main effect of type of stressor. Symptomology did not yield statistically significant effects on cortisol, $F(1, 74) = .003$, $p = .958$, η^2 = 00. Both results did not support the hypotheses.

Table 7

Two-Way Factorial ANOVA of Symptomology and Stressor Type (non-family vs. family)

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Symp (a)	1	.001	.001	1.711	.195	.02
Stressor (b)	1	.627	.627	.003	.958	.00
Stressor × Symp	1	.209	.209	.571	.452	.01
Error	74	25.655	.367			

Note. Symp refers to participants with and without symptoms of PTSD. Outcomes are based on cortisol response to stressor.

Heart Rate Variability and Stressor Event

This question asked whether the type of stressor had an impact on heart rate variability for participants with and without PTSD. A one-way ANOVA was first conducted to determine whether heart rate variability was impacted by order of the stressors. Results were not statistically significant, $F(1,72) = 3.150$, $p = .080$, $d = 0.04$, meaning order of the stressor (family vs. non-family) did not impact changes in heart rate (see Table 8). Additionally, chi-squared analyses indicated no relationship between symptomology and type of stressor, $\chi(1) = .722$, $p = 1.000$. This indicated there would be an equal likelihood of either variable impacting heart rate variability. Additionally, both Phi and Cramer's V values were low, meaning there was a weak relationship between the two variables ($\phi = .041$, $p > .05$).

Table 8

One-Way ANOVA of PTSD Scores by Stressor (non-family vs. family)

Source	*df*	*SS*	*MS*	*F*	*p*	*d*
Between groups	1	.060	.060	3.150	.08	.04
Within groups	72	1.362	.019			
Total	73	1.422				

A two-way ANOVA (factorial) was conducted examining the interaction effect of stressor (family vs. non-family) and symptomatic vs. asymptomatic of PTSD on heart rate variability (see Table 9). The second measure from the EKG was used as the dependent variable, while stressor and PTSD were independent variables. The second heart rate measure was utilized because it occurred 20-minutes post stressor. This is the peak time at which stress is heightened following a stressor. Because the one-way ANOVA found stressor order to not be statistically significant, there was no statistical rationale for using the second heart rate measure versus the third. The hypothesis suggested there would be a statistically significant interaction effect between stressor and PTSD. This was supported, therefore, the null hypothesis was rejected; there was a statistically significant interaction between the effects of stressor and PTSD on heart rate variability, $F_{\mathrm{a}\times\mathrm{b}}(1, 70) = 5.018$, $p = .028$, $\eta^2 = 0.06$. Stressor and PTSD *did* interact to effect heart rate variability. There was also a statistically significant main effect of stressor, indicating stressor did impact overall heart rate variability means, $F(1, 70) = 8.39$, $p = .005$, $\eta^2 = .10$. The effect size was 0%, however, therefore these results should be taken with caution. The effect size indicated that 6% of the total variance for heart rate variability was comprised of the interaction between stressor and PTSD. This interaction effect represented the combined effects of type of stressor and PTSD diagnosis on heart rate variability at time two.

Table 9

Two-Way Factorial ANOVA of Symptomology and Stressor Type (non-family vs. family)

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Stressor (a)	1	.152	.152	8.388	.005*	.10
Symp (b)	1	.011	.011	.591	.445	.00
Stressor × Symp	1	.091	.091	5.018	.028*	.06
Error	70	1.266	.018			

Note. Symp refers to participants with and without symptoms of PTSD; statistically significant *p*-values are indicated with an *.

Intervention and Cortisol Response to Stressor Event

A 3 × 3 split plot ANOVA examined group differences for the control, oxytocin, and reading groups across each of the three cortisol collection periods. The data was normally distributed, as evaluated by Shapiro-Wilk's test of normality ($p > .05$). Mauchly's test of sphericity indicated the assumption of sphericity was violated, $x^2(2) = 11.592$, $p = .003$. The Greenhouse-Geisser correction was used to correct for the *F*-distribution degrees of freedom (Gueorguieva & Krystal, 2004). There was no statistically significant interaction between the interventions and control groups on three assessed points of cortisol, $F_{\mathrm{a}\times\mathrm{b}}(3, 123) = 1.759$, $p = .150$, $\eta^2 = .050$; it was hypothesized there would be an interaction effect.

The main effect of time demonstrated a non-statistically significant difference in mean cortisol scores at the different times assessed, $F(2, 123) = 1.385$, $p = .254$, $\eta^2 = .02$. The between-subjects effects of group membership showed there were also no statistically significant differences in mean cortisol measures between intervention and control groups $F(2, 71) = .2.532$, $p = .087$, $\eta^2 = .11$ (see Table 10). This indicated group heart rate averages were equal across each of the three times assessed. An effect size of 11%, although not statistically significant, indicated a small-moderate amount of variance of cortisol was explained by group membership. The between-subjects pairwise comparisons additionally showed no statistically significant comparisons between cortisol compared to the different time points.

Table 10

Results from the Split-Plot ANOVA Analysis

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Time (a)	1	.612	.353	1.385	.254	.02
Error (a)	123	31.395	.225			
Condition (b)	1	3.578	1.789	2.532	.087	.11
Error (b)	70	50.168	.707			
Group × Time	2	1.556	.448	1.759	.150	.05
Total	73	33.563				

Note. Time indicates the mean cortisol scores (time) across each point assessed. Condition refers to the treatment group assigned (oxytocin, reading, or control).

Pairwise comparisons for within-subjects (e.g., cortisol at each time point) showed no statistically significant increases across time for all groups. Tukey's post hoc analyses revealed no statistically significant differences between the groups. Taken together, these results demonstrated a zero effect of intervention (e.g., reading, oxytocin, control) on cortisol levels during the protocol. These results did not support the hypothesis. It was expected that cortisol changes across time would show statistically significant differences. The number of participants in each group was low, reducing the amount of power to produce statistically significant results. Table 11 presents the means and standard deviations for cortisol for each group. Cortisol levels for the reading group increased after the treatment (*M* = 2.037, *SD* = .580), but decreased after the stressor (*M* = 1.996, *SD* = .691). Similarly, the oxytocin group means also increased after the treatment (*M* = 2.198, *SD* = .666), and decreased after the stressor (*M* = 2.009, *SD* = .668). This suggests the treatments may have had a buffering effect for stress. Conversely, the control group increased in stress at each time point. With more participants, these differences may have been statistically significant. The fact that group membership had a small-moderate effect size, gives some support these treatments were effective.

Table 11

Means and Standard Deviations for Cortisol at each time point by Group

Group	*n*	Time 1		Time 2		Time 3	
		M	*SD*	*M*	*SD*	*M*	*SD*
Reading	24	1.948	.616	2.037	.580	1.996	.691
Oxytocin	28	2.131	.651	2.198	.666	2.009	.668
Control	22	1.610	.564	1.821	.481	1.974	.582

Note. The absolute values are provided here for cortisol levels for clarity. Time 1 is baseline; Time 2 is after treatment; Time 3 is following stressor

Intervention and Heart Rate Variability Response to Stressor Event

A 3 × 3 split plot ANOVA examined mean group differences for the control, oxytocin, and reading groups across each of the three time points assessed by EKG measures of heart rate variability (HRV). The data was normally distributed, as evaluated by Shapiro-Wilk's test of normality ($p > .05$). Mauchly's test of sphericity indicated the assumption of sphericity was violated, $x^2(2) = 16.864$, $p < .001$. The Greenhouse-Geisser correction was used to correct for the *F*-distribution degrees of freedom (Gueorguieva & Krystal, 2004). There was no statistically significant interaction between the interventions and control groups on three assessed points of heart rate variability, $F_{\mathrm{a}\times\mathrm{b}}(3, 73) = .557$, $p = .661$, $\eta^2 = .013$.

The main effect of time showed a statistically significant difference in mean heart rate variability scores at the different times assessed, $F(2, 117) = 12.26$, $p < .001$, $\eta^2 = .14$. This was the largest effect size, indicating 14% of the variance of measures of heart rate was accounted for by group membership. However, the between-subjects effects of group membership showed there was no statistically significant difference in mean heart rate values between intervention and control groups $F(2, 71) = .477$, $p = .623$, $\eta^2 = .063$ (see Table 12). This indicated group heart rate averages were equal across each of the three times assessed. The between-subjects pairwise comparisons additionally showed no statistically significant comparisons between empathy compared to the different time points.

Table 12

Results from the Split-Plot ANOVA Analysis

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Time (a)	2	.119	.072	12.260	.000*	.14
Error (a)	117	.691	.003			
Condition (b)	2	.052	.026	.477	.623	.063
Error (b)	71	3.853	.026			
Group × Time	3	.011	.003	.557	.661	.013
Total	73	.821				

Note. Time indicates the mean EKG scores (HRV) across each point assessed. Condition refers to the treatment group assigned (oxytocin, reading, or control). Statistically significant p-values are indicated with an *.

Pairwise comparisons for within-subjects (e.g., HRV at each time point) showed statistically significant increases across time for all groups from time 1 ($M = .776$, $SD = .143$, $p = .002$) to time 2 ($M = .812$, $SD = .140$, $p = .002$). Existing comparisons between measurements at time 1 and time 3 were also statistically significantly higher ($M = .776$, $SD = .143$, $p = .002$; $M =$

.818, *SD* = .152, *p* < .001; see Table 13). Tukey's post hoc analyses revealed no statistically significant differences between the groups. These results indicated increases in heart rate variability values occurred regardless of group membership. The oxytocin, reading, and control conditions were irrelevant to changes at each of the three points HRV was assessed with the EKG. The results of the pairwise comparisons supported the hypothesis that heart rate variability would change from baseline to final reading, although it was hypothesized HRV would decrease from time 1 to time 3. The second hypothesis was not supported in that group membership did not impact HRV.

Table 13

Means and Standard Deviations for HRV at each time point by Group

Group	Time 1		Time 2		Time 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Reading	.74	.16	.81	.12	.80	.17
Oxytocin	.77	.14	.80	.17	.83	.13
Control	.80	.12	.83	.13	.84	.13

Note. Time 1 is baseline; Time 2 is after treatment; Time 3 is following stressor

Discussion

In order to explain individual differences in empathetic responses following exposure to stress, the present study divided 76 healthy adults into two treatment groups and one control group to assess sympathetic nervous system (SNS) responses with measures of salivary cortisol and heart rate variability. Findings were mixed (see Table 14); empathy was impacted by treatment condition, but salivary stress was not. The most significant findings were related to heart rate variability and changes across the course of the protocol. Heart rate variability showed a statistically significant interaction effect between the type of stressor and whether participants were identified as having symptoms of post-traumatic stress disorder. This finding is noteworthy given the small sample size since interaction effects are often difficult to detect even in larger studies (Gordis, Granger, Susman, & Trickett, 2006).

These results indicated the impact that PTSD can have on the sympathetic nervous system. Increased heart rates indicated higher stress following the stressor. This was regardless of the order of the stressor. This reinforces the literature suggesting severe trauma can have a 'significant' impact on stress response, particularly heart rate (Allwood, Handwerger, Kivlighan, Granger, & Stroud, 2011; Kudielka, Schommer, Hellhammer, & Kirschbaum, 2004). This provides clinicians with evidence to incorporate skills into treatments for PTSD that lower heart rate. Participants did not provide examples of what their specific traumas were related to, but these results suggested both stressors were strong enough to elicit sympathetic responses.

PTSD has been linked to a number of psycho-physiological effects for both males and females. Current literature shows trauma has a significant impact on how the HPA-axis regulates responses to external stimuli. Other research has focused on the emotional effects of PTSD on behavior (Allwood et al., 2011). This study did not find any correlation between empathy and PTSD symptomology, however, the number of participants who identified as having PTSD was small. With a larger sample size, it is possible these results would have shown a negative correlation, where the presence of PTSD would be associated with weaker empathetic responses. Using a targeted sample of trauma victims may also effect stronger changes in levels of cortisol.

Conversely, it is possible the stressors utilized within this study did not elicit a strong enough stress response for significant changes in cortisol across time. Many studies have confirmed that heart rate variability is much more sensitive to stressors than salivary cortisol (Engert, Plessow, Miller, Kirschbaum, & Singer, 2014; Gordis et al., 2006; Henckens et al., 2015; Saalfield & Spear, 2014). These studies have used compatible sample sizes to this one and found heart rate and systolic and diastolic blood pressure markers to be more accurate predictors of SNS activity than salivary cortisol. Even with these findings, salivary cortisol is still the gold standard for measuring HPA-axis activity.

This study found no statistically significant findings related to cortisol for treatment condition or empathy. There were detectable differences in cortisol means across time for the entire sample, but these were not statistically significant. In one instance, treatment condition yielded a small-moderate effect size in variance accounted for by cortisol averages across time. The associated *p*-value was not statistically significant, but was close. Sample size may have impacted overall power for the study, however, meta-analyses examining sample size for studies involving cortisol have found average participant numbers to be between 40 to 100 in total (Sanada et al., 2016).

Criticisms of cortisol research suggests most studies are under-powered. The same is said of research involving oxytocin (McCullough et al., 2013; Sanada et al., 2016). There are conflicting findings as to whether intranasal oxytocin penetrates the blood brain barrier, meaning if it does not, then findings in these studies are null. This study had the advantage of a control group and an additional comparison group. When cortisol levels were evaluated at each time point for the condition group, oxytocin and control group averages were within decimals of each other, but the reading group showed much higher mean averages across time. None of these were statistically significant changes, but could suggest the oxytocin did not reach the blood stream or participants may have incorrectly applied the nasal spray. Many participants were unfamiliar with nasal sprays and required direct instruction on how to apply both the oxytocin and saline solutions. The nasal spray canisters were metered in a way to ensure dosage was applied evenly, but there was no quality check to further ensure participants took the entire dosage. Future studies should monitor participants' nasal application or take blood or urine samples to measure oxytocin levels before and after the study (Mackersie & Calderon-Moultrie, 2016). For empathy, however, there were statistically significant changes in empathetic responses following the treatment and stressors. It could be that oxytocin is better utilized as a promoter for social responses rather than as a buffer for stress response. This supports existing literature; on a larger scale, oxytocin could serve as a treatment for antisocial behavior rather than as an inhibitor for the sympathetic nervous system.

Future research should focus on replication using a larger sample size and more stable measures of both cortisol and oxytocin. While saliva is about 90% accurate in detecting cortisol, time of day can affect levels (Kudielka et al., 2004). Blood tests may also yield fluctuating levels of cortisol at different times during the day, but this method is more common for medical tests, suggesting more accurate readings. In follow-up research, it would be beneficial to schedule participants at the same time each day rather than allowing for all day scheduling (Engert et al., 2014; Kudielka et al., 2004). This was done due to time constraints for participants and accessibility to laboratory equipment. Additionally, some participants were recruited during examination periods at the end of a semester, potentially impacting instability of cortisol detection.

Table 14

Summary of Results for Research Questions and Hypotheses

Research Questions	Hypotheses	Results
1 Trauma and Empathy		
	Scores on the PCL-C will be positively correlated with empathy	Not Supported
2 Empathy and Type of Intervention		
	Increases between baseline empathy and scores after treatment	Supported
	Increases between baseline empathy and scores after stressor	Supported
3 Empathy and Type of Stressor		
	Order of stressor will not impact empathy scores	Supported
4 Cortisol Stress Response and Stressor Event		
	PTSD will impact cortisol response	Not Supported
	Interaction effect between stressor and PTSD on cortisol	Not Supported
5 Heart rate Variability and Stressor Event		
	PTSD will impact HRV response	Supported
	Interaction effect between stressor and PTSD on HRV	Supported
6 Intervention and Cortisol Response to Stressor Event		
	Cortisol will decrease after intervention and after stressor	Not Supported
	Interaction effect between treatment and cortisol	Not Supported
7 Intervention and Heart Rate Variability Response to Stressor Event		
	Main effect of stressor $p < .05$	Not Supported
	Interaction effect between treatment and HRV	Not Supported
	HRV will decrease after intervention and after stressor	Supported

Conclusions

The finding that type of stressor interacted with PTSD symptomology across measures of heart rate variability builds on existing literature relating physiological responses with stress response (Allwood et al., 2011). This study was advantageous in that it used two separate biomarkers to indicate stress. There is an increasing amount of research supporting the need for integration of biological systems to measure psycho-physiological responses (Bowman, Thorpe, Cannon, & Fox, 2017). In doing so, this study found differences between the HPA-axis and SNS, a remarkable and unexpected finding. The increases in empathetic expression following treatment and stressor support findings in the area of emotional development. With evidence supporting results that prosocial behavior can be strengthened, there is hope that one-day developmental science will discover effective treatments for those with severe traumas and problem behaviors.

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APPENDIX

EXTENDED LITERATURE REVIEW

Introduction

The concept of empathy has plagued researchers for decades as the search for a comprehensive definition of the term is fundamentally flawed. Researchers generally agree empathy is important to human behavior, although the function of the term is widely disagreed upon. Batson (2009) argues empathy is currently being applied to almost a dozen phenomena, with disagreement in how to define this elusive term. Most definitions of empathy involve a cognitive, affective, or behavioral component (Decety & Jackson, 2004; Ikezawa, Corbera, & Wexler, 2014). The empathy research generally attempts to explain what empathy is, but also ways to improve it (Bal & Veltkamp, 2013; Djikic, Oatley, & Moldoveanu, 2013; Johnson, 2012;). Generally, these approaches emphasize self-report measures and few focus on neurobiological mechanisms (Chen et al., 2015).

Cognitive Empathy

The cognitive definition of empathy is usually defined as perspective-taking (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb; 2001; Holt et al., 2014; Lamm, Batson, & Decety, 2007). This largely refers to concepts of metacognition and Theory of Mind (ToM; Keysers & Gazzola, 2007). Essentially, the cognitive view of empathy asks whether one person is capable of understanding that another person has different feelings and thoughts. Cognitive empathy does not require the person to feel what another is feeling (De Vignemont & Singer, 2006). The adage “Put yourself in someone else’s shoes” is an example of utilizing cognitive empathy. Research suggests that torturers and those with violent tendencies possess a great deal of cognitive empathy in that they take the perspective of their victims to know what type of violence to inflict, while also having the absence of sympathy (Blair, 2008; Blair & Lee, 2013).

Participants in Philip Zimbardo's (Drury, Hutchens, Shuttlesworth, & White, 2012) classic prison experiment took the perspective of their personal representations of prison guards, while failing to have sympathy for how their behavior affected the study's prisoners. In many instances of antisocial behavior, such as psychopathy, the brain lacks the capacity to take the perspective of another person (Blair, 2008; Blair & Lee, 201). This often leads to the psychopath's inability to choose between right and wrong (Kiehl, Laurens, Bates, & Hare, 2006). Without comprehending whether personal actions will infringe on someone else's feelings or actions, decision-making can lead to immoral behavior and harm to others. Similarly, victims of this behavior, such as the prisoners from Zimbardo's study, may lack the ability to take the perspective of their oppressors, causing a more negative reaction to the event (Drury et al., 2012).

The cognitive nature of empathy further implicates language and linguists in understanding the thoughts and feelings of another. Witvliet and colleagues (2015) assessed college students who reported being the victims of an offensive event and how rumination affected their written accounts of the incident. Using a counterbalanced design, participants were presented with periods of offensive rumination followed by different coping strategies (Witvliet, Hofelich, Hinman, & Knoll, 2015). The coping strategies included different trials with instructions to either reflect on the person who hurt them (i.e., negative language), suppress the emotions felt during the offense, or to think about the offender as a human being, someone who has feelings, thoughts, and could permanently change their offensive behavior (i.e., positive language). At the midpoint of the study, participants were asked to record how they felt emotionally and physically, their thoughts, and what they would say to their offenders (Witvliet et al., 2015).

Analyses of the written responses indicated an overall decrease in negative language used after coping than participants whose responses came after rumination (Witvliet et al., 2015). Further, only compassionate reappraisal, where participants were asked to think about the offender as a person, produced an interaction effect with coping (Coping × Strategy Type $F(1, 61) = 8.07$, $p = .006$, partial $\eta^2 = .12$). When asked to take the perspective of their offenders, participants expressed a more positive response to their traumatic event (Witvliet et al., 2015). Results of the study provided evidence to support the association between cognition and language with perspective-taking and emotional response. This strategy of imploring cognitive empathy can, therefore, attenuate negative emotionality, creating a healthier perception of harmful events (Witvliet et al., 2015).

In another study participants were asked to either increase or decrease their emotional responses when watching another participant receive a series of electric shocks where the expression of empathy was manipulated in order to assess its relationship with social fear learning (Olsson et al., 2015). A portion of the manipulated participants were asked to appraise the situation by watching the shock participants' facial expressions throughout the tasks. Those assigned to this group were more likely to later experience fear to a neutral stimulus than those who were asked not to appraise the faces. This supported evidence that not only is fear a learned response, but that observing facial expressions is in fact enough to create this empathic bond between two people (Olsson et al., 2015). Other studies have attempted to uncover additional vicarious responses but without providing context for participants' expressions

(Ikezawa et al., 2014). In these experiments, researchers typically assess the ability of participants to read others' emotions without contextual cues (Ocja, López-Pérez, Ambrona, & Fernández, 2009).

Affective Empathy

Affective empathy is what is traditionally operationalized as the ability to feel another's emotions (De Vignemont & Singer, 2006; Ocja et al., 2009). It is beyond putting oneself in another shoes, but to actually have that person's feelings transferred to another. This concept has recently been attributed to the discovery of mirror neurons. These anomalies discovered in the late 20th century led to the paradigmatic shift in understanding the feelings of others.

Italian researchers initially uncovered these neurons when studying the premotor cortex (area F5) in primates (Iacoboni et al., 2005). They discovered when electrodes were applied to the monkeys' brains, neurons in area F5 would fire simply when they viewed other monkeys move and grasp items even when they themselves were not moving (Iacoboni et al., 2005). This led to the research of mirror neurons in humans. Specifically, one of the first experiments on mirror emotional responses studied the concept of disgust (Wicker et al., 2003).

Functional magnetic resonance imaging (fMRI) is the crown jewel of measuring neural activity. Images produce volumetric measures of the activation in particular areas of the brain. The areas that produce the greatest volume of neural activity indicate which brain regions are targeted during specific tasks (Kiehl et al., 2001).

Several studies have addressed the question of whether empathy traits are tied to morphological differences in brain structure (Banissy, Kanai, Walsh, & Rees, 2012). Affective empathy was found to be related to a decrease in grey matter in the brain's left hemisphere

(Banissy, et al., 2012). Increased grey matter was associated with perspective taking. The left hemisphere is the analytical brain, responsible for mathematical abilities and logic. For most, language is lateralized in the left hemisphere, making this an important region for reading and speaking (Decety & Jackson, 2004).

Participants in another disgust study were presented with photos of individuals who had been presented with offensive odors, such as the smell of rotten butter (Cattaneo & Rizzolatti, 2009). Those viewing the images had mirror neural activation with those who *had* been presented with the odors. This occurred in olfactory regions of the brain for both groups, curiously even for those in the control group. Similar results have been validated when viewing others who are pricked with needles or when images of pain and anguish are presented (Janowski, Camerer, Rangel, & 2013).

Measuring Empathic Intention

Recently, researchers are focusing on measuring whether *intention* can be mirrored in the brain (Iacoboni et al., 2005). In an interesting study, participants were presented with three scenes depicting context, action, and intention during an fMRI session. The scenes were arranged in the context of a tea party. The first images portrayed a specific scene to signal that the tea party had begun, with a hand grasping a teacup with intent to take a drink. Another set of images implied the tea party was over and the hand holding the teacup was clearing the table. The final scene displayed the teacup alone, sitting on a table with no hand (Iacoboni et al., 2005).

Neural activation indicated mirrored activity was strongest in the premotor cortex along with other areas associated with movement and action while participants viewed the first two scenes (Iacoboni et al., 2005). In the final images where no context was given, the teacup alone on the table, little activity was recorded with the fMRI. The significance of this study as well as others implicate neural systems as a method of explaining both affective responses and the intention to act. The transference of feelings from one to another is inherent in the brain's systematic purpose. When we view others in pain or distress, our brains are signaled to activate the neural emotional regions (Iacoboni et al., 2005).

This is a somewhat less romanticized version of what students of empathy have traditionally been taught. Even those trained in helping professions, such as therapists and counselors, often view affective empathy as "emotional contagion," caused by an evolutionary, intrinsic drive to understand another's emotions (Decety & Jackson, 2004). The emotional contagion theory does not proof cross-culturally, while the neuronal view does. Despite the imaging studies depicting mirrored brain behavior, there are doubts about the legitimacy of this viewpoint (Vrticka & Vuilleumier, 2012). Some postulate that neurons are simply neurons without the intelligent capacity to mirror behavioral activation. The mirrored images of activation may merely be the byproduct of neurons being in the right place at the right time (Churchland, 2011).

Others argue the intention results are only present when the intent lies with goal-directed behavior, such as clearing the table from a tea party (Iacoboni et al., 2005). Regardless of the latter argument, much of the research on motivational behavior suggests most performed actions are the result of attempting to achieve some goal or are based on outcome-driven conduct (Vrticka & Vuilleumier, 2012). From an evolutionary standpoint, the intent to bond with others is also outcome-driven. Mammals are social creatures and yearn for love, whether it be between parent and child or sexual in nature (Vrticka & Vuilleumier, 2012).

Neuroscience has made great strides in uncovering the areas of the brain associated with bonding and attachment (Vrticka & Vuilleumier, 2012). Recently, researchers in Switzerland have been able to link an area of the brain associated with attachment with those required for emotional sharing and perspective taking. From the developmental psychology attachment theory perspective, researchers suggest not only does the foundation for relationships begin with the parent-bond, but empathizing and acting in an emotionally intensive manner is also established early in life (Vrticka & Vuilleumier, 2012). Similar to attachment, if trauma or a horrific event occurs during this critical period, the ability to engage in empathic behavior is severely limited (Buckholdt, Parra, & Jobe-Shields, 2014; Carthy, Horesh, Apter, Edge, & Gross, 2010).

Behavioral Empathy

Fortunately, an inclusive explanation for affective empathy merges neuroscience discoveries with the evolutionary drive to help relieve the pain and suffering of others (Decety & Jackson, 2004). This concept of behavioral empathy is perhaps the most crucial component to understanding empathy, particularly for its biopsychosocial context (Chen et al., 2015; Decety & Jackson, 2004). Behavioral empathy is probably the least familiar form of empathy due to its common ties with what are commonly viewed as moral and prosocial behavior. Morality is broadly viewed as the set of values concerning right or wrong behavior. These principles are typically informed by cultural influences that are reinforced by society (Greene & Haidt, 2002).

A distinction between actions that are immoral versus those that are amoral is warranted to describe the nature of behavioral empathy (Blair & Lee, 2013). Whereas immorality refers to the cognitive act of rationalizing whether something is right or wrong, amorality is the absence of or indifference to right and wrong behavior. Immorality acknowledges the cognitive component of empathy with perspective-taking being a course for acting morally. Amorality is the absence of perspective-taking and the inability to affectively respond to another (Blair & Lee, 2013).

Likewise, prosocial behavior is known as voluntary behavior aimed at benefitting others. This social behavior typically involves bettering society as a whole. Volunteering at non-profit organizations, donating to charity, and even obeying traffic laws are all considered to be prosocial in nature (Preston, 2013). This is very similar to altruism, the selfless motivation to act for the benefit of others without expecting a reciprocal response. These last two concepts are thought to be evolutionary in nature, originally for the purpose of working collectively in order to survive as a species.

These subtle differences are typically recognized when understanding that motivation is the core tenant behind behavioral empathy with a central question being, *What motivates someone to act in a moral manner?* By taking the perspective of the person in distress, the agent views the act of relieving pain and suffering as a moral obligation, thus serving as the impetus for this behavior (Greene & Haidt, 2002; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001). The agent receives an emotional arousal, invoking empathetic concerns for another. This leads to feelings of compassion and sympathy, motivating someone to provide a prosocial or altruistic response (Lamm et al., 2007). Behavioral empathy, therefore, understands that the drive to help others originates from social standards of right and wrong and how the *right* standards provide emotional relief for others (Greene et al., 2001).

Even in the absence of a moral context, empathic decision-making is present in both experimental paradigms and in neural imaging (Janowski et al., 2013). In an experiment where active participants were given biographies and lists of likes and dislikes of passive, unknown individuals, the neural regions associated with empathy and emotional processing were highly activated (Janowski et al., 2013). The ventromedial prefrontal cortex (vmPFC) specifically deals with decision-making and emotional regulation, both of which are important functions in the social appropriateness of emotional reaction (Lamm et al., 2007). When the active participants were then asked to choose from a list of popular movie titles to give to the passive group, participants more often chose titles based on what interests were described in the biographies (Janowski et al., 2013). This was contrasted with similar studies where biographies were not presented and active agents chose movie titles based on their own, personal interests (Vrticka & Vuilleumier, 2012). The crucial difference is in the motivation behind the decision-making. On the one hand, those who gained even a snapshot of an unknown person's personality made choices based on empathic concern for what the confederate would find pleasurable. Otherwise, participants simply chose what interested themselves rather than placing any sort of social context into their decisions.

Empathy and Economics

Kirman and Teschl (2010) came to similar conclusions when reviewing research on empathy's role in economics. Without empathy, all decisions on economic welfare would have the same outcome. The ability to allocate funds responsibly takes a great deal of perspective taking. It is difficult for a governing body to choose to donate resources to a refugee crisis in another country without developing some sort of empathic position. Whether this position is to give aid or refrain from giving, there are rarely decisions made without eliciting some spectrum of emotions throughout the process (Kirman & Teschl, 2010).

De Vignemont and Singer (2006) give credence to the notion that morality requires a sense of empathy, but that empathy is not the sole motivation behind prosocial behavior. The example given explains the plight of a political prisoner held under a dictatorship. A person may assist the prisoner in escaping, but this does not necessarily mean that person empathizes with him. Rather, it could be because the person disagrees with the dictatorship and has strong opposition to the judicial treatment of its citizens. This thinking implies a Kohlbergian higher-order morality stage where one acknowledges that laws and rules do not always benefit the good of all citizens (Blair & Lee, 2013).

The cost-benefit analysis of empathy plays a role in how people value others' emotions also (Kirman & Teschl, 2010; Vrticka & Vuilleumier, 2012; Zak, 2004). In the case of giving aid to another country, leaders weigh the risks and benefits before making a decision. Oceja et al. (2009) defined this risk assessment as a system of checks and balances involving vicarious distress and empathy. Oceja et al. (2009) suggested when personal distress is weighted more heavily against helping behavior, such as witnessing an act of violence but fearing for personal safety at the same time, choosing to walk away from the situation rather than granting aid expends less energy than providing relief.

With each of the three described components of empathy, cognitive, affective, and behavioral, a specific purpose is met. On the one hand, cognitive empathy is important to grasp the reality that we all have different thoughts and feelings (Lamm et al., 2007). These thoughts and feelings serve as a social bond within the human species. It allows us to read the emotions of others without context, but also requires perspective taking skills in order to sympathize. Affective empathy stands on the heels of emotional contagion, the concept that empathy can be transferred to another person as well as intended actions (Banissy et al., 2012). Behavioral empathy combines the aforementioned by viewing empathy from a moral and prosocial perspective. When empathy is great enough to motivate action, a person behaves in a manner to actively relieve another's distress (Preson, 2013). These components are essential in nature and are required to evaluate how we engage with others. These foundations are laid in childhood, but often unforeseen events even in adulthood can impose crucial threats to this necessary skill (Vrticka & Vuilleumier, 2012).

Without empathy, chaos and social manipulation would be rampant (Blair, 2008). The inconsiderate and devaluing of emotions would drive wedges between societies and create havoc within nations (Blair & Lee, 2013; De Vignemont & Singer, 2006). Murder and crime rates would soar, infringing on human rights and moral fairness (Blair & Lee, 2013). Even with the ability to empathize, inherent levels are often not enough to engage prosocial behavior (De Vignemont & Singer, 2006). Fortunately, researchers have found and developed new methods to increase prosocial behavior and even perspective taking (Bal & Veltkamp; Djikic et al., 2013; Johnson, 2012; Johnson, 2013; Kidd & Castano, 2013).

Reading

Language arts have been fundamental skills in the United States' educational establishment for centuries. These crucial foundations teach reading and writing, skills which are necessary to survive in society. Recent research has focused on the implications of language arts beyond the context of the classroom. Specifically, reading has been studied to assess its effects on social emotional development (Manguel, 2014; Mar & Oatley, 2008).

Historically, reading was taught in order for children, mostly young boys, to obtain a decent job beyond the skills necessary for simple manufacturing and farming vocations. Reading was a privilege typically devoted to the higher class (Manguel, 2014). Children who could read would go on to study law or become employed in prestigious positions that required unique, meaning-based understanding of the English language. The comprehensive-based reading curriculum was later commonplace in the education system by the early 20th century (Manguel, 2014). Publishing companies began pushing novels written especially for children involving the retelling of more popular classics, such as *Alice's Adventures in Wonderland* and *Gulliver's Travels*. Literate children then flourished when phonics-based learning became standard in the mid-20th century (Manguel, 2014).

Even at this time, researchers were curious to understand how reading classic stories could further children's abilities to interact and engage with peers (Dewey, 1938). The reading of activities that people participate in daily became known as fictional narratives. Watching operas and plays in which characters are viewed as participants in real-world scenarios was especially of interest to researchers studying the impact such literary and theatrical performances had on children (Manguel, 2014). Of interest was the narrative experience of transference, or the ability of the audience to feel as though they were living the lives of the characters (Busselle & Bilandzic, 2009).

This fictional narrative experience plays an important part in how readers learn about themselves by assessing which characters and decisions reflect their own lives (Mar & Oatley, 2008). Many studies focus on the effects substantial fictional reading has on empathy (Kidd & Castano, 2013). Fiction is a verbal representation of social interaction where interpersonal experiences are described in great detail by a main character or narrator. In these stories, readers have a chance to read the thought processes and logic behind characters' decisions and encounters (Busselle & Bilandzic, 2009; Kidd & Castano, 2013).

Emotional transference is based on the narrative transportation theory, which proposes when readers lose themselves in fictional stories their personal feelings and attitudes change to match that of the story (Djikic, Oatley, & Moldoveanu, 2013). A study by Bal and Veltkamp (2013) hypothesized that empathy was only changed by reading when the reader was emotionally transferred in to the story. They argued other studies previously assessed this view, but none were empirical. Using an experimental design, the researchers randomly assigned Dutch students into a treatment or control group and obtained a baseline measure of empathy using the *Interpersonal Reactivity Index* (*IRI*; Davis, 1983) assessment (Bal & Veltkamp, 2013).

Bal and Veltkamp (2013) gave treatment group participants an excerpt from a Sherlock Holmes story, while the control group was given a selection from a newspaper. This nonfiction piece included personal accounts by those affected by Libyan riots or the nuclear disaster in Japan, 2011. These selections were made to reflect the emotional engagement present in the fictional story. Using a scale from Busselle and Bilandzic (2013), no statistical differences were found between the two groups; they were both equally as transported into either the nonfiction or the fictional materials (Bal & Veltkamp, 2013).

At the end of the one-week trial, participants' level of empathy was re-evaluated. Statistically significantly higher levels of empathy were found in the treatment as compared with the control group. Bal and Veltkamp (2013) found this interesting given that both groups had been equally transported into the story, suggesting the transportation theory does have merit, but only when reading fictional narratives do these ideals impact empathy. The authors also proposed that cognitive transportation is possible, where the readers' problem-solving and reasoning skills can be impacted when emotional transference fails. This may be more likely in non-fiction stories or even in fiction if the reader fails to identify with the character (Busselle & Bilandzic, 2009).

A study by Guarisco and Freeman (2015) implemented an empathy-based curriculum, which included reading R. J. Palacio's *Wonder* and empathy-building activities led by a school counselor. *Wonder* was a story about a young boy, Auggie, with facial deformities who enrolled in a preparatory school after being homeschooled for years. The students ridiculed him, but the boy soon befriended another, and the two fought through obstacles together. At the end of the story, Auggie received an award for exemplary behavior and had his picture taken with classmates, something Auggie had been hesitant to do previously (Guarisco & Freeman, 2015). In this research, Guarisco and Freeman (2015) asked 80 6^{th}-grade students to complete the IRI as a pre-assessment for empathy before beginning the 6-week empathy-based curriculum. Students were prompted with a writing response prior to starting the novel in which they explained what 'normal' meant to them. Throughout the novel, Auggie's teacher had his class complete similar writing exercises. Reflecting this behavior for participants of the study increased cognitive transportation where students felt more invested in the characters' lives

(Guarisco & Freeman, 2015). In the curriculum, the empathy-building activities included ones where students discussed the importance in distinguishing physical and emotional traits (Guarisco & Freeman, 2015). At the end of this program, students were retested with the *IRI*, where researchers hypothesized at least one of the empathy subscale scores would increase from pre- to post-testing. Based on reported results, three of the four subscales of the *IRI* increased; the greatest increase was in perspective-taking with an almost 6% difference from pre- to post-test (Guarisco & Freeman, 2015). The fantasy scale, which assesses the respondents' tendencies to be transported into the feelings and behaviors of characters in a story, had a 5% increase in scores pre- to post-testing (Davis, 1984).

Guarisco and Freeman (2015) reported each of the subscale increases were statistically significant and no differences between males and females existed. Unfortunately, the researchers did not provide effect sizes nor the data to calculate these values, so these increases may or may not be meaningful. The results do however, provide evidence for the cognitive transportation theory, where students reported feeling as though they were more likely to adopt the point of view of another than they did prior to reading or receiving empathy training (Busselle & Bilandzic, 2009; Guarisco & Freeman, 2015).

This study was one of the first of its kind to combine efforts between educators and behavioral scientists. Other collaborations have involved mental health workers and childcare professionals (Man-Ging et al., 2015). Childcare workers were presented with fictional biographies of children who had experienced sexual trauma. The goal of the study was to increase empathy in childcare workers and to aid in the prevention of future traumatic assaults. With the addition of academic resources and an online training program, childcare workers' empathy scores on the *IRI* increased from pre- to post-test. Prevention abilities were highly correlated with empathy scores, suggesting higher knowledge of threatening situations increases the awareness of another's feelings (Man-Ging et al., 2015).

More recent research has used similar methods to discuss racism (Gonzalez, Steele, & Baron, 2016). Using a reading program, older children's implicit racism was decreased, suggesting developmental differences exist between age groups. Both this and the earlier story of Auggie allow children to take the point of view of an out-group member, which increases empathy and feelings of inclusion (Guarisco & Freeman, 2015). Future research should focus on collaborative efforts between educators and scientists to teach students about the difficulties minority groups face. Empathy-enriched curriculums may even one day be used in career trainings, especially with the mass shootings reported daily (Djikic et al., 2013; Gonzalez et al., 2016; Johnson et al., 2013).

Your Brain on Books

These effects of reading are not purely psychological. Neuroscientists have confirmed actual neurological structural changes that occur while reading (Berns, Blaine, Prietula, & Pye, 2013; Keller & Just, 2009; Phillips, 2015). In Keller and Just's (2010) work, for example, children who had completed a 100-hour reading program had a statistically significant increase in white matter. White matter is the subway system of the brain; it carries communication signals throughout the brain. Increases in white matter allow for faster communication between regions, supporting a more efficient brain (Keller & Just, 2009).

Additional research has found increased connectivity throughout the brain in areas affecting reading comprehension and language development (Berns et al., 2013; Keller & Just, 2009; Mårtensson et al., 2012). Embodied cognition is the theory that cognition evolves from other areas of the body, not just the brain. Semantics are the branch of linguistics concerned with meaning and the logic needed to find such meaning. When the two areas are combined, embodied semantics represents the acquisition of logic and meaning through interactions between the human body and the outside world (Mårtensson et al., 2012).

Berns's et al. (2013) experiment with colleagues found embodied semantics in sensorimotor regions significantly increased. They found these changes to be long-term, present even after the conclusion of a reading program. The story chosen for participants in this experiment was *Pompeii*: *A Novel*, by Robert Harris. This story is unique because it features real-life events surrounding the eruption of the famous volcano (Berns et al., 2013). While the story itself is non-fiction, the author writes the novel as a fictional narrative, embellishing characters' lives and accounts of the catastrophic event.

Other structural changes occur in areas that support learning, such as the fronto-temporal cortex of the left hemisphere. Students in a foreign language class underwent brain imaging tests to evaluate how reading books in another language affected their brains (Mårtensson et al., 2012). The fMRI images showed statistical increases in areas associated with learning new material and areas required for spatial navigation. While studying a foreign language can be taxing and difficult, this study demonstrates the importance of immersion in books in order to strengthen learning. These neural changes make overall learning less challenging and prime the brain for furthering knowledge (Mårtensson et al., 2012).

The furthering of such knowledge requires increased blood flow throughout the brain (Keller & Just, 2009). When reading for college courses, many students wholly admit to simply scanning reading materials rather than reading with intent to learn (Phillips, 2015). An English literature professor was interested in evaluating these different learning methods. Using fMRI scanners, Patricia Phillips (2015) gave excerpts from Jane Austen's novel, *Mansfield Park*, instructing participants to either read intently as if they were studying for an exam or to skim the novel.

Phillips's (2015) choice of novel was controversial due to the criticism *Mansfield Park* has received in recent years. Most reviewers of the book find the main characters to be unlikeable and difficult to relate to. This is contrasted to the many novels that have been proven to increase empathy due to perspective-taking and emotional transference. If readers could not "feel" themselves in the novel, the effects of reading may be negligible (Busselle & Bilandzic, 2009).

However, the critical reading of the novel did increase blood flow and neural activity in the frontal lobe and those associated with language (Phillips, 2015). The frontal lobe is especially associated with executive functioning, including self-regulation and emotional development (Buckholdt, Parra, & Jobe-Shields, 2014; Ikezawa, Corbera, & Wexler, 2014). The ability to self-regulate one's feelings is central to engaging in prosocial and socially acceptable behavior. Without this capacity, humans lack impulse control and act out in society, creating a distracting environment for themselves and others (Blair & Lee, 2013; Wildenger & McIntyre, 2012).

Prosocial Behavior and Reading

Each of the studies presented utilized existing stories from the literature in order assess effects on the brain or empathic response; few have attempted to create their own stories. In a landmark study by Dan Johnson (2012), he evaluated the relationships between empathy, prosocial behavior, and fear. Participants in the study were university students who read a story written and developed by Stephanie Schmidt Johnson (2012). The story was written to meet criteria that it should be comprehended and enjoyable to a large audience. A young boy witnesses his parents fighting and depicts a fearful home environment. Prosocial behavior was assessed using a validated measure where a researcher drops pens near the participants then records whether they help pick them up. Another group was also given a task for emotional expression, where faces were presented to participants who then rated how emotional the expressions made them feel (Johnson, 2012).

Results supported previous work whereby emotional transportation predicted increases in affective empathy (Johnson, 2012; Busselle & Bilandzic, 2009). Additionally, participants given the expression task were more biased towards faces that expressed fear or fright. Taken together these results favor suggestions indicating imagery and character-rich stories have positive effects not just on cognitive perspective taking but also on affective empathy. Participants further expressed empathy for those perceived as being frightened, reflecting feelings of the protagonist in the story. In line with the results by Berns et al. (2013), Johnson et al. (2013) also found students who were instructed to generate imagery across multiple sensory domains performed more positively on a measure of emotional transportation. Those asked to focus on semantic meanings of the text and students selected to read for leisure were less likely to perform prosocial actions and had statistically significant decreases in affective empathy (Johnson, 2013).

Implications for both studies conducted by Johnson (2012; Johnson et al., 2013) support the consistent, firm findings that reading has a profound effect on empathy, behavior, and neurological structure. Future research should focus on different methods to enhance empathy, ones that are not self-reported, along with physiological measures which evaluate sympathetic and parasympathetic responses to emotion (Bal & Veltkamp, 2013; Chen et al., 2015). Luckily, recent advances in understanding neurological hormones and chemical changes have made testing this connection between neuroscience, reading, and empathy very possible (Barraza, McCullough, Churchland, & Mendez, 2013; Lukas & Neumann, 2011; Luo et al., 2015).

Oxytocin: The Endogenous System

What is Oxytocin?

Oxytocin is a neuropeptide, naturally occurring in mammals (Alves, Fielder, Ghabriel, Sawyer, & Buisman-Pijlman, 2014; Bartz, Zaki, Bolger, & Ochsner, 2011; Van IJzendoorn & Bakermans-Kranenburg, 2012). The hypothalamic paraventricular produces oxytocin in the magnocelluar neurons. It is eventually released into the circulatory system and throughout the central nervous system (CNS). It is expelled alongside vasopressin, an antidiuretic hormone, which regulates retention of water throughout the body (Van IJzendoorn & Bakermans-Kranenburg, 2012). Oxytocin also has uses as a hormone, signaling lactation in new mothers (Alves et al., 2015). Because of its similarity to vasopressin, oxytocin administration during labor can cause the body to retain more water, rarely resulting in water intoxication. Despite this infrequent interaction, oxytocin is regularly used in medical and experimental settings (Alves et al., 2014; Van IJzendoorn & Bakersmans-Kranenburg, 2012).

Across mammalian species, oxytocin naturally excites lactation (Bakermans-Kranenburg, van Ikzendoorn, Riem, Tops, & Alink, 2011). This evolutionary purpose extends beyond means of feeding. By breastfeeding or nursing a newborn, the child is held close to the mother; in humans this process encourages skin-to-skin contact. This contact is especially important just after birth and calms the baby's temperature and autonomic response system (Carthy et al., 2010). Skin-to-skin exchanges are crucial in early pair-bonding between a mother and her child. These social experiences early in life provide the foundation for emotional development and future relationships (Kindsvatter & Geroski, 2014). When children have a secure attachment with their caregiver, they are more likely to succeed in school, relationships, and effectively manage stress (Bakermans-Kranenburg et al., 2011; Buckholdt et al., 2014; Wildenger & McIntyre, 2012; Vrticka & Vuilleumier, 2012). Secure children develop healthy stress response systems and engage in more prosocial behavior (Riem, Bakermans-Kranenburg, Huffmeijer, & van Ijzendoorn, 2013a; Witvliet et al., 2015).

The Moral Molecule

Bartz et al. (2010) suggested oxytocin is not a universal enhancer for prosocial behavior, but is based on individual differences present in cognitive empathy. In men scoring high on an assessment designed to measure autism symptoms, oxytocin administered intranasally improved empathic accuracy on an emotion recognition task. The task involved watching an unknown person describe emotional events. Participants rated what they thought the target felt throughout the video. Those who scored low on the Autism Spectrum Quotient (AQ) experienced no reported effects from the oxytocin (Bartz et al., 2010). When given a placebo, high scorers on the AQ performed poorly. Implications for the study are encouraging for those with diminished sociability, but does little for healthy adults.

People with autism perform poorly when tasks identifying social expressions, which is an important skill for appropriate social contact (Baron-Cohen et al., 2001; Dapretto, Davies, & Pfeifer, 2006; Holt et al., 2014). The raising and lowering of eyebrows is recognized as a signal to invite another person for greetings. Someone who does not do this action may be a threat or a person uninterested in engaging in conversation. Without the ability to recognize these unconscious human behaviors, people may be rejected by their peers or deemed “socially awkward” among young peers (Baron-Cohen et al., 2001). These basic human responses exhibit a social bond within species to signal familiarity and shared existence. These delayed behaviors can be mimicked in someone with severe trauma (Holt et al., 2014; Preston, 2013).

Van IJzendoorn and Bakermans-Kranenburg (2011) found different results when analyzing studies that tested intranasal oxytocin on in-group and out-group trust. They found that emotional perception during a facial recognition task occurred in participants reporting healthy spousal relationships. These participants were more likely to change behavior toward unknown in-group members, resulting in higher expressions of trust. Oxytocin had no effect on out-group trust for any participants (Van IJzendoorn & Bakermans-Kranenburg, 2011). Another study evaluated the gene expression of oxytocin on in-group biases (Luo et al., 2015). There were few genetic differences explaining why some participants were more empathic toward group members than others. However, they did find a relationship between culture and oxytocin gene expression. This gene-culture interaction predicted greater empathic responses than culture or genes by themselves (Luo et al., 2015). Taken together, both studies indicate a need to view participants holistically. Taking background and culture into account can greatly impact the efficacy of oxytocin as a chemical for empathy (Alves et al., 2014; Bartz et al., 2010; McCullough, Churchland, & Mendez, 2013; Riem et al., 2013a).

In much of the oxytocin research thus far, conflicting results appear throughout (Churchland, 2011; McCullough et al., 2013). Authors note the importance of replication studies and the inclusion of effect sizes to accurately explain the effects of this ‘moral molecule’ (Zak, 2004). Paul Zak’s now infamous landmark paper on oxytocin portrays the hormone as a chemical that induces generosity toward others. A collaborative study with Zak (2011) examined the effects of oxytocin on charitable behavior (Barraza et al., 2011). The drug itself was not significantly associated with donating money, but when donation did occur, donations were 50% higher when participants were administered oxytocin compared to a control group.

Even more surprising was that increase in monetary donations occurred in the absence of benefit to the donor (Barraza et al., 2011). As discussed above, often charitable decisions come from cost-benefit analyses where donators reflect on how their actions will benefit themselves (Kirman & Teschl, 2010; Oceja et al., 2009; Zak, 2004). The charities to which participants were told they were donating were designed to be neutral as to not arouse emotional attachment to the charitable causes (Barraza et al., 2011). These findings indicate oxytocin promotes increases in altruism even without emotional cues.

Neurological Implications

Oxytocin production moderates changes in the brain regions associated with self-referential processing and affection (Riem et al., 2013a; Riem et al., 2013b). Riem et al. (2013b) studied the effects of intranasal oxytocin on the brain’s emotional network. When oxytocin was administered intranasally, participants had positive connectivity in the posterior cingulate cortex (PCC) and the brainstem. The PCC along with the amygdala are strongly associated with emotional processing. Increased connectivity facilitates emotional cognition and the processing of external emotional signals (Riem et al., 2013a). There was negative connectivity in adults who received a placebo. The effects of the intranasal oxytocin were more prevalent in participants who came from a supportive parenting environment (Riem et al., 2013a; 2013b).

This so-called Matthew effect proposes that individuals who come from an advantaged background gain the most from interventions such as these, while those disadvantaged stand to gain nothing (Bakermans-Kranenburg et al., 2011). Bakermans-Kranenburg et al. (2011) acknowledged this effect in their oxytocin study where females were administered oxytocin intranasally then tasked with listening to recordings of infants crying or laughing while gripping a force dynamometer. Participants who reported little harsh discipline in their childhood lessened their grips when they heard infants crying. These effects were greater in the oxytocin group than those who received the placebo. Further, participants who reported high levels of harsh discipline had no change in force when listening to infant recording or when administered the oxytocin or placebo (Bakermans-Kranenburg et al., 2011). Bakermans-Kranenburg et al. (2011) and Riem et al. (2013a; 2013b) both agree the context of past experiences determine how oxytocin affects human behavior.

The foundational oxytocin system created by parent-child bonding continues to respond to social interactions throughout the lifespan (Alves et al., 2014). This circular system causes oxytocin to increase throughout the brain when interacting with others. Because the brain likes the influx of this hormone, the person is motivated to continue making social connections.

Oxytocin works on the reward circuitry, creating feelings of calmness and euphoria, particularly after sexual activity. Lukas and Neumann (2011) proposed dysfunction of the oxytocin system is associated with social disorders, such as autism. When given intranasally oxytocin decreases social inhibitions, promoting prosocial behavior. These results support the use of oxytocin in treating those with psychopathology such as post-traumatic stress disorder (PTSD), anxiety, and depression (Frijing et al., 2014; McQuaid et al., 2013; Olff, 2012; Olff et al., 2014).

Trauma and the Stress Response System

A traumatic event is one which poses potentially life-threatening harm (Olff, 2012; Olff et al., 2014). It can be something witnessed, but the overall subjective response to the event greatly activates the stress response system. Stress is not simply a psychological response to an adverse event, but it also involves a very intricate biological system (Kindsvatter & Geroski, 2014). People who experienced stress generally have increased heart rates, dilated lungs, reduced appetites, and increases in glucose. These physiological responses to stress occur due to a trigger from the amygdala in the limbic system sending a signal to the hypothalamus (Kindsvatter & Geroski, 2014).

The hypothalamus controls many of the involuntary functions exhibited by the autonomic nervous system (ANS; Alves et al., 2014). The ANS is comprised of the sympathetic and parasympathetic nervous systems. The sympathetic nervous system is commonly known for its flight-or-fight response (Carthy et al., 2010). This evolutionary response system enacts physiological symptoms, triggering a person to either engage or retreat in a stressful situation. When a person endures continued stress, the sympathetic nervous system must act in overdrive as a defense mechanism to protect an individual from long-term negative effects

(Rodrigues, Saslow, Garcia, John, & Keltner, 2009). Unfortunately, despite the body's natural instinct to protect itself, long-term exposure to either stress or adverse conditions can have a severely detrimental effect on the person's body and psyche (Carthy et al., 2010).

In addition to triggering physiological symptoms, the sympathetic system also stimulates the adrenal glands to produce adrenaline (also known as epinephrine; Kindsvatter & Geroski, 2014). The adrenaline further activates the hypothalamic-pituitary-adrenal (HPA) axis (Carthy et al., 2010). With continued exposure to the stressful situation, the HPA begins to release stress hormones, which causes the pituitary gland to express cortisol (Alves et al., 2014). Finally, after the threat passes, cortisol levels begin to decrease. Trauma occurs as a result of inadequate recovery in the stress response, long after the impending threat has passed (Olff, 2012; Rodrigues et al., 2009). Increases of cortisol levels have been linked to obesity, depression, and other mental illnesses, making this regulatory system even more essential for maintaining a healthy lifestyle (Kindsvatter & Geroski, 2014).

Olff (2012; Olff et al., 2014) claims psychosocial care is the most important aspect of the healing process for trauma victims. This connection makes the use of oxytocin as a treatment option very appealing to trauma specialists. Oxytocin allows a person to recover from a stressful event. When released, oxytocin creates that feeling of elation, calming the stress response and interacting with brain systems regulating pleasure and reward. This explains the need for social exposure throughout trauma recovery (Frijing et al., 2014; Olff, 2012; Olff et al., 2014).

Process-Person-Context-Time Model

Putting it all Together

The importance of both fiction and increasing levels of oxytocin as a mechanism to increase empathetic responses is supported by the association of these interventions with the components in the Process-Person-Context-Time model (PPCT). Trauma victims' biological drive for social exposure can be explained using components within this model (Bronfenbrenner, 2005; Campbell, Dworkin, & Cabral, 2009). Processes are interactions with either people or objects and contribute to how individuals make sense of their worlds and how each person fits into society (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006). The experience of trauma and the subsequent changes in oxytocin and cortisol production can impact engagement in prosocial and moral behavioral processes associated with empathic behavior.

The role of Person acknowledges that people differ in terms of personality, attitudes and beliefs, and even physiological responses (Riggins-Caspers, Cadoret, Knutson, & Langbehn, 2003). When interacting with others, trauma victims receive implicit or explicit cues on how they respond to the event. Individual differences in the oxytocin system can inhibit or produce a greater need for social interactions (McQuaid et al., 2015). Thus, depending on the person's physiological responses, bonding capacity, and how one responds to stress can greatly impact the quality of social interactions.

Further impacting engagement in empathic behavior is the role of environmental Context (Tudge, Mokrova, Hatfield, & Karnik, 2009). For example, events that occur within the microsystem, which is defined as the environment where individuals spend most of their time such as home or the workplace, can either result in positive or negative responses to stress depending upon Person. The second level, mesosystem, emerges as a person spends more time in other microsystems (Trudge et al., 2009). If someone has experienced trauma, resources or treatment available at home will affect the response or engagement at school or work, and vice versa. The context in which a traumatic event occurs affects an individual's response to trauma. If the trauma occurred within the family, there can be adverse reactions within the individual's home. Similarly, the mesosystem may be more affected if a non-family related trauma occurred where adverse reactions exist outside of the family context (Bartz, Zaki, Bolger, & Ochsner, 2011).

An individual whose partner's work schedule provides a great deal of stress is likely to feel the effects of the partner's stress even though the two do not have the same schedule, resulting in influences on the individual's exosystem (Riggins-Caspers et al., 2003). Particularly if the individual's stress response system is hypersensitive as a result of trauma, repeated stress may develop, causing an avoidance to social interactions. This, in turn, could increase or decrease oxytocin production (Bartz et al., 2011). The macrosystem includes things such as altruism, moral behavior, and compassion toward others, equally affected if trauma has occurred. And finally, Time refers to the occurrence of any traumatic event or social interaction throughout someone's daily life, and the extent to which these events influence a particular behavior, such as reclusion, occur on a consistent basis (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006).

Discussion

As read consistently throughout the oxytocin literature, the social effects of oxytocin are dependent upon a person's context (Bartz et al., 2011; Olff, 2012; Van IJzendoorn &

Bakermans-Kranenburg, 2012). There is a great need for an interactionist model to explain how exogenous oxytocin can benefit the socially impaired (Bartz et al., 2011). Intranasal oxytocin can have a positive effect in reducing stress, creating feelings of trust, and in the motivation for altruism; these effects are not universal (Churchland, 2011; McCollough et al., 2013). The effects of oxytocin on autism symptoms were different from those experienced in in-group/out-group assessments. Likewise, oxytocin encourages emotional processing in some, but calms the stress response system in others (Olff, 2012; Rodrigues et al., 2009). While many authors have claimed oxytocin research produces conflicting results, it is this interactionist point of view which clarifies the confusion that this wonder hormone is a one size fits all solution. By taking into account the context and background of each individual, researchers can find more effective means for explaining and treating behavior (Olff, 2012; Olff et al., 2014).

Oxytocin and reading have both shown to increase empathic and prosocial behavior by altering brain chemistry (Alves et al., 2014; Frijling et al., 2014). While both of these mechanisms have shown similar outcomes, they do so through different physiological pathways (Berns et al., 2013; Van IJzendoorn & Bakermans-Kranenburg, 2012). Further, it is unclear whether reading would have the same effects as oxytocin in calming the stress response system. There have also been few, if any, studies which test how oxytocin affects the three described components of empathy. There is an additional need to address how individual context affects a person's ability to be transferred into a narrative. These questions and others can be addressed with future research, by combining the psychological and behavioral foundations of empathy and its effects on physiological systems.

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