A Process Model Linking Physiological Arousal and Fear Recognition to Aggression via Guilt in Middle Childhood

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Abstract

Aggression coincides with emotional underarousal in childhood, but we still lack an understanding of how underarousal contributes to aggression. With an ethnically diverse sample of 8-year-olds ($N = 150$), we tested if physiological underarousal and lower fear recognition were indirectly associated with heightened aggression through dampened guilt feelings. Caregivers rated children's aggressive behavior. We assessed children's skin conductance and respiratory sinus arrhythmia while they imagined transgressing norms, and fear recognition with a facial morph task. Children reported guilt or lack thereof after hypothetically transgressing. The interaction of decreasing skin conductance and increasing respiratory sinus arrythmia (i.e., physiological underarousal) and poor fear recognition were indirectly associated with higher aggression through their associations with lower guilt. Emotional underarousal may contribute to aggression by disrupting the normative development of guilt. We discuss strategies to improve social-emotional acuity and reduce aggression in children with blunted physiological arousal and fear recognition.

Keywords: skin conductance, respiratory sinus arrhythmia, fear recognition, guilt, aggression, childhood

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Some aggressive children show dampened physiological arousal and reduced responsivity to distress cues. These irregularities in emotional arousal are thought to play a role in perpetuating aggression from an early age (DeLisi, Umphress, & Vaughn, 2009; Portnoy & Farrington, 2015; Raine, 2013), but the nature of their role is still debated and poorly understood (Portnoy & Farrington, 2015). One possibility is that emotional underarousal disrupts social-emotional capacities, such as the ability to feel guilt or remorse after harming others, en route to influencing aggression. Prior studies have linked dampened physiological reactivity and impaired fear processing to a dearth of guilt-related capacities (Blair, Budhani, Colledge, & Scott, 2005; Colasante, Zuffianò, Haley, & Malti, 2018; Malti, Colasante, Zuffianò, & de Bruine, 2016), and a lack of guilt over wrongdoing is a robust predictor of aggressive and antisocial tendencies (for a meta-analysis, see Malti & Krettenauer, 2013). However, these relations have yet to be tested simultaneously with a model linking emotional underarousal to aggression *through* experiences of guilt. In the present study, we adopted this integrative, process-oriented approach to better understand the roots of childhood aggression.

Emotional Arousal and Aggression in Childhood

Given the severity and chronicity of risks stemming from aggression, developmental psychologists argue that its early intervention is critical (Lochman, Boxmeyer, Andrade, & Muratori, 2018). Biological factors have a significant heritable component and coincide with aggression from toddlerhood to late childhood with negligible drops in effect size over time (Ortiz & Raine, 2004; Raine, 2013). Thus, incorporating biological indicators of emotional underarousal into intervention efforts may improve the early identification of children who are more likely to follow a long-term aggressive trajectory.

Researchers have proposed differential developmental pathways to chronic and severe aggressive behavior (Frick, 2012; Olson & Ip, 2017; Provençal, Booij, & Tremblay, 2015). One core pathway is marked by dysregulation, while the other is characterized by callous-unemotional (CU) traits (Frick, 2012). The dysregulated pathway involves heightened impulsivity, hostile attribution biases, and sensitivity to provocation, whereas the CU pathway involves broad deficits in affect/engagement, fear processing, and care for others. With respect to emotional arousal, the dysregulated and CU pathways roughly translate into overarousal and underarousal, respectively. For the present study, we focused on the underaroused pathway because it has been conceptually and empirically rooted in biological deficits (Frick, 2012), and children on this path are often the most aggressive (Frick & White, 2008). Specifically, we focused on the roles of physiological underarousal and blunted fear recognition rooted in neurobiological deficits.

Physiological underarousal and aggression in childhood. The affective deficits that characterize the underaroused pathway are often reflected physiologically as dampened autonomic nervous system activity (de Wied, van Boxtel, Matthys, & Meeus, 2012). The branches of the autonomic nervous system—the sympathetic and parasympathetic nervous systems—selectively and jointly innervate the body's tissues and organs, rapidly preparing it for challenging situations (Kreibig, 2010). In general, the sympathetic branch prepares the body for activity, whereas the parasympathetic branch is implicated in restorative actions, such as attentional and emotional control. Skin conductance (SC)—the electrical conductivity of skin moisture exuded from the sweat glands—is a reliable indicator of sympathetic activity, with lower SC reflecting lower sympathetic arousal (Dawson, Schell, & Filion, 2007). Respiratory sinus arrhythmia (RSA)—representing the influence of the vagus nerve on the coupling of the respiratory cycle and heart rate—is a common measure of parasympathetic activity. The vagus nerve typically serves as a brake that maintains or slows heart rate. Higher RSA thus reflects greater parasympathetic regulation (Porges, 2011).

Physiology is often measured at rest in the absence of stimuli, which is thought to reflect individual differences in dispositional physiological arousal (Taylor, Eisenberg, & Spinrad, 2015). Children and adolescents with lower resting physiological arousal—specifically in the sympathetic branch measured via SC and heart rate—are more prone to aggression and antisocial behaviors (although the heart is dually innervated and can also reflect parasympathetic influence; Lorber, 2004; Ortiz & Raine, 2004; Portnoy & Farrington, 2015). Children's autonomic activity is also measured in reaction to discrete tasks or stressors to gain a nuanced understanding of their reactive, moment-to-moment physiology in different contexts. Studies examining the link between physiological reactivity and aggression have yielded mixed results (El-Sheikh et al., 2009; Hubbard et al., 2002; Lorber, 2004). This may be because the joint effects of sympathetic and parasympathetic reactivity (e.g., SC x RSA interactions) are rarely considered, and the type of task used to elicit a physiological reaction from children varies considerably across studies.

The sympathetic and parasympathetic branches operate in tandem (El-Sheikh & Erath, 2011). However, studies rarely account for interactions between SC and RSA reactivity, which may partially explain discrepant results between those investigating SC but not RSA and vice versa. Polyvagal theory suggests that RSA (i.e., the brake) modulates sympathetic activity (i.e., the gas); lower RSA permits heightened sympathetic arousal to support mobilization, whereas greater RSA constrains sympathetic arousal to produce a calming effect (Porges, 2011). This interactive approach is also captured by the four reactivity profiles of the autonomic space model (Berntson, Cacioppo, & Quigley, 1991): (1) reciprocal sympathetic activation (increases in SC, decreases in RSA), which produces a net increase in physiological arousal/"fight or flight" response, (2) reciprocal parasympathetic activation (increases in RSA, decreases in SC), which produces a net decrease in physiological arousal/"rest and digest" response, (3) coactivation (increases in SC and RSA), and (4) coinhibition (decreases in SC and RSA). The net arousal outcomes of the latter two profiles are comparatively ambiguous because the sympathetic and parasympathetic branches are not working in concert towards the same physiological outcome (i.e., upregulation or downregulation). The second profile, reciprocal parasympathetic activation, captures the downregulated physiology that is characteristic of aggressive children on the underaroused pathway (Frick, 2012).

Autonomic reactivity studies of childhood aggression have also been mired in the struggle of balancing experimental control with external validity. As a result, the tasks in such studies range from nonsocial (e.g., tracing a star while only looking at the reflection of one's hand in a mirror; El-Sheikh, Hinnant, & Erath, 2011) to social (e.g., interactions with peers or parents; Hastings et al., 2008; Keller & El-Sheikh, 2009). Because aggression often arises from social conflicts (Eisner & Malti, 2015), there has been a recent push to assess children's physiological reactivity in contexts that explicitly involve social conflicts, either real or hypothetical (Moore et al., 2018; Murray-Close et al., 2017). Such assessments may reduce the explanatory gap between children's physiological reactivity and aggression by mitigating task-specific effects.

Fear recognition and aggression in childhood. The underaroused aggressive pathway is also characterized by impaired emotion—particularly fear—processing rooted in the amygdala

(Frick, 2012). The amygdala has been conceptually and empirically tied to fear-specific functions in nonhuman and human samples (DeLisi et al., 2009; LeDoux, 2003). Amygdala hypofunction is thought to be an underlying neurobiological mechanism of fear-specific processing deficits (van Goozen, 2015) and impaired fear processing is regarded as a core emotional deviation of psychopathy (Patrick, 1994).

Numerous studies have linked poor fear processing to underaroused aggressive symptomology in children and adolescents. For example, youth high in psychopathic tendencies showed reduced SC reactivity to fear-inducing stimuli (ages 8–17; Blair, 1999), were less able to recognize fearful vocal affect (ages 11–15; Blair et al., 2005), and were more likely to mistake fearful emotional expressions for other emotions (ages 9–17; Blair, Colledge, Murray, & Mitchell, 2001). One study found that 12-year-olds who had difficulty recognizing fearful faces focused less on the eyes of such faces. Amygdala damage has been linked to the attentional neglect of others' eyes (Adolphs et al., 2005), so the authors concluded that children with amygdala hypofunction fail to attend to emotional cues in their environment that would otherwise deter them from harming others (Dadds, El Masry, Wimalaweera, & Guastella, 2008). Furthermore, 19-year-old violent offenders with CU traits showed a subconscious neural processing disadvantage for fearful—but not other—facial expressions, suggesting that fear processing disadvantages are deeply rooted in an amygdala-mediated mechanism that affects the earliest stages of attention (Jusyte, Mayer, Künzel, Hautzinger, & Schönenberg, 2014). Even in early childhood (i.e., 3- to 5-year-olds), CU traits have been linked to contracted neural responses to fearful faces (Hoyniak et al., 2018). Despite this promising evidence, psychopathy and CU traits are multidimensional constructs with characteristics beyond the behavioral domain

(Marsh, 2013)—whether deficits in fear processing contribute to aggression per se is less clear, especially in community samples.

Overall, emotional underarousal has been implicated in aggressive or related behaviors, but evidence for direct associations between underarousal and aggression is either mixed or lacking. Approaches testing direct links between biological or lower-level factors and aggression typically neglect the complex social-emotional experiences that children navigate en route to behaving aggressively. Accounting for these experiences may provide a more cohesive picture of how underarousal contributes to aggression in childhood. One possibility is that blunted physiology and fear recognition disrupt children's ability to arrive at adaptive emotional responses to social conflicts. Without a strong emotional compass to guide them, such children might be less likely to avoid and more likely to repeat aggressive acts.

Emotional Underarousal, Guilt, and Aggression in Childhood

Guilt is broadly defined as a self-conscious, negative feeling over wrongdoing (Malti, 2016). It requires recognizing and understanding potential or actual harm to others, anticipating or taking responsibility for such harm (Tangney, Stuewig, & Mashek, 2007), and coordinating one's own and others' perspectives (Malti, 2016). A meta-analysis of over 8,000 participants aged 4 through 20 found that guilt feelings were negatively associated with aggressive and antisocial outcomes (Malti & Krettenauer, 2013). Critically evaluating an aggressive act as a violation of one's standards may spur enough inner turmoil to deter children from that act and/or similar transgressions in the future.

Although guilt is frequently operationalized as a feeling of remorse over misbehavior (Tangney et al., 2007), accounting for different types of guilt may be especially important for understanding links to aggression. As early as the preschool years, children differentiate between ethical transgressions entailing the violation of others' rights and wellbeing and nonethical misbehaviors, such as disobeying an authority figure or violating a conventional norm (e.g., social etiquette). Children consider both types of misbehavior to be unacceptable, but they evaluate ethical violations as more wrong than nonethical violations based on concerns about the negative consequences of harm for others. In contrast, children's reasoning about nonethical violations typically revolves around the existence of rules, prohibitions, and the potential for sanctions over misbehavior (see Smetana, Jambon, & Ball, 2014 for an overview). Thus, after harming others, experiencing guilt for ethical reasons pertaining to fairness and/or concern for others' welfare is hypothesized to facilitate reparation and decrease the likelihood of future aggression (Hoffman, 2000; Malti, 2016; Malti, Dys, Colasante, & Peplak, 2017 ; Colasante, Zuffianò, Bae, & Malti, 2014). Guilt experienced in nonethical contexts, however, likely has less relevance for understanding aggression because it is less rooted in the welfare of others.

In support of this view, research conducted with preschoolers in community samples (e.g., Jambon & Smetana, 2018a) as well as adolescent and adult offenders (e.g., Blair, 1997; Blair, Monson, & Frederickson, 2001) has demonstrated that an inability to differentiate the wrongness of ethical versus nonethical norms is associated with higher levels of aggression. These findings appear to generalize to guilt-related emotions as well; Jambon and Smetana (2018b) found that 4- to 7-year-olds who expected to feel more intense negative emotions after ethical versus nonethical transgressions showed faster declines in aggression over time. Focusing on *differences* in children's responses to ethical and nonethical transgressions may also reduce the potential for response biases and social desirability concerns (e.g., expressing strong negative emotions regardless of context). In the current study, we assessed the degree to which children expected to feel more intense guilt after an ethical violation involving harm than after a nonethical violation that merely threatened punishment.

Since guilt plays a significant proximal role in aggressive acts, the extent to which biological or lower-level perceptual factors shape experiences of guilt may explain why such distal factors coincide with aggression. Indeed, developmental studies have linked physiological underarousal to lower levels of guilt. Five- and 8-year-olds whose heart rates accelerated less after hypothetically transgressing went on to anticipate less intense guilt (Malti et al., 2016). Similarly, 8-year-olds who showed greater parasympathetic regulation while engaging in hypothetical transgressions were less likely to report feeling guilty about them (Colasante et al., 2018).

As noted, deficits in fear processing and/or associated amygdala hypofunction have been linked to CU traits in childhood and adolescence (which include a lack of guilt). Numerous studies with adults have also linked impaired fear processing or related deficits to lower levels of morality in general. Psychopathic individuals—who tend to exhibit fear-processing deficits—showed reduced SC reactivity to others' distress cues (Blair, Jones, Clark, & Smith, 1997), which are critical for informing ethical guilt (Hoffman, 2000). Individuals with uncaring traits were less vigilant to fearful but not other faces (White & Delk, 2017); similarly, caring for others' welfare is part and parcel of ethical guilt (Malti, 2016). Finally, those with higher psychopathic tendencies showed reduced amygdala activity while judging fear-evoking statements (e.g., "I could easily hurt you", "You can't protect yourself from me") and were more likely to judge causing fear in others as acceptable (Marsh & Cardinale, 2014). Nonetheless, few if any developmental studies have linked fear- or amygdala-related deficits to guilt specifically.

The Present Study

Evidence for the underarousal–aggression link in childhood is mixed in the case of physiological arousal and lacking in the case of fear processing. Limited evidence suggests that physiological underarousal and poor fear processing are linked to blunted guilt, but the question remains: Do lapses in guilt serve as a translational mechanism linking biological underarousal to aggression in childhood? This question is particularly relevant for middle childhood because children reliably express guilt by 7 or 8 years of age (Arsenio, 2014). Overt aggression is also less likely to be normative in middle childhood (Eisner & Malti, 2015) and thus more likely to be indicative of the underaroused aggressive pathway of interest (Frick, 2012).

To answer this question, we assessed the following in a large and ethnically diverse sample of 8-year-olds: SC and RSA reactivity while transgressing ethical norms, thresholds for detecting fearful facial expressions, feelings of guilt after transgressing ethical versus nonethical norms, and dispositional aggression. We hypothesized that physiological underarousal (i.e., decreases in SC and increases in RSA) while transgressing and poor fear processing (i.e., a higher threshold for detecting fearful facial expressions) would be uniquely associated with higher levels of aggression through lower guilt (i.e., reporting lower levels of ethical versus nonethical guilt). We also controlled for gender in light of previous studies citing gender differences in physiological activity (Eisenberg, Fabes, Schaller, Carlo, & Miller, 1991), fear processing (Lawrence, Campbell, & Skuse, 2015), guilt (Malti & Ongley, 2014), and aggression (Nivette, Eisner, Malti, & Ribeaud, 2014).

Method

Participants

A community sample of 150 eight-year-olds (M_{age} = 8.53, *SD* = .29, 50% female) participated alongside their primary caregivers. They resided in a major Canadian city and were recruited from local community centers, events, and summer camps. The sole exclusion criterion was the presence of an autism spectrum disorder. All children were fluent in English (speaking and comprehension), as were their caregivers (speaking, comprehension, and writing). Caregivers reported their highest level of education with the following breakdown: 44% bachelor's, 23% master's, 19% college, 5% high school, 3% doctoral, 2% apprenticeship/trade level, and 1% no diploma (3% chose not to report). The sample included 17% American, 17% multiethnic, 17% South/Southeast Asian, 12% Western European, 10% East Asian, 5% Central/South American, 4% African, 3% Eastern European, 2% West/Central Asian, and 1% Middle Eastern origins (12% missing/chose not to report). Overall, these distributions were representative of the diverse region from which the sample was drawn (citation withheld for peer review).

Procedure

The researchers' institution granted ethical approval. Children and caregivers attended the laboratory for a 60- to 90-minute session conducted by trained research assistants. Oral assent was obtained from children and written informed consent was obtained from caregivers. Children were outfitted with physiological equipment. Child assessments took place in a designated room while caregivers remained in a waiting area and completed a questionnaire. At study end, caregivers were debriefed while children were awarded an age-appropriate book.

Measures

Physiological arousal. Electrodermal activity and electrocardiogram data were recorded from children at a sampling rate of 2 kHz using a Biopac MP150 data acquisition system and BioNomadix modules (Biopac Systems, Goleta, CA, USA). Electrodermal monitoring electrodes were secured to the tips of the index and ring fingers of each child's nondominant hand.

Electrocardiogram monitoring electrodes were secured slightly below their right clavicle and below their ribs. Leads from the electrodes were connected to modules fastened around their wrist and midsection, respectively, that communicated wirelessly via the MP150 with a computer in an adjacent room running AcqKnowledge 4.2 data acquisition software (Biopac Systems, Goleta, CA, USA). Data were imported to EDA 3.0.25 and HRV 3.0.25 software (Mindware Technologies, Gahanna, OH, USA) for visual inspection, cleaning, and calculations of SC and RSA. The Observer XT (Noldus Information Technology, Leesburg, VA, USA) was used to synchronize physiological recordings with stories directing children to imagine transgressing various norms (see section on guilt below). This allowed us to extract each child's average SC and RSA values for the following standardized intervals: (1) the pretransgression portion of each story and (2) the transgression portion of each story. If more than 20% of an interval required cleaning, it was excluded from analyses (overall rejection rates were 10.6% and 5.3% for SC and RSA, respectively).

Fear recognition. Photographs of a female model posing neutral, happy, sad, fearful, and angry facial expressions were selected from the NimStim Set of Facial Expressions (Tottenham et al., 2009).[1] For each emotion, 10 levels of intensity were depicted in 10% increments from 10% to 100% (see top of Figure 1). These standardized increments were created by morphing emotional faces with a neutral face resulting in 40 emotional faces in total (4 emotions x 10 intensities; citation withheld for peer review). In line with previous studies (citations withheld for peer review), the experimenter introduced a sorting game in which the child helped the people in the photographs by putting them into appropriate houses, which were labeled with corresponding emotion icons (including a neutral icon; see bottom of Figure 1). Children were instructed as

[1] We collected data on children's recognition of various facial expressions to ensure that our findings were specific to fear recognition.

follows: “In one of these houses, people are telling a happy [sad, scary, or angry] story. Can you tell me which one it is?” After the child pointed to the appropriate house for each emotion, the experimenter said, “In one house, people are not telling a story and they are not feeling anything. Can you point it out?” After the child identified the neutral house, the experimenter showed them the pre-shuffled stack of 41 (40 emotional + 1 neutral) faces and said, “Now we have more people here. Your job is to help them find the right house. They can only go to one house if they have the same feeling as people inside of that house.” The experimenter emphasized the possibility of different intensities within the same emotion by saying, “You may notice that many people feel happy, but some feel just a little happy, while others feel very happy. In this game, they all go together. Do the same for the sad, scared, angry, and neutral [or nothing] people.” The experimenter then handed the photographs to the child one by one, allowing them ample time to place each one through a slot in the roof of what they deemed the correct house. The slots were intentionally narrow so the child could not see the photographs they had already placed in each house. We assessed children’s threshold to correctly recognize each target emotion (defined as the intensity level at which they achieved 50% accuracy for recognizing the target emotion). Specifically, we fit a cumulative Gaussian function to the data, resulting in an accuracy score at each intensity level of each emotion, from which we established the respective threshold value (citations withheld for peer review).

Guilt. Children were presented two stories depicting ethical transgressions to obtain desirable objects (i.e., stealing a chocolate bar from another child and pushing another child out of line to get the only remaining lollipop) and a third story depicting a nonethical transgression (i.e., standing up and talking to other students despite everyone being required to remain seated) from the Social-Emotional Responding Task (citation withheld for peer review). Each story was presented on a computer with prerecorded audio clips and visuals depicting a pretransgression portion in which the story context was introduced and a transgression portion in which the transgression was committed. The stories were presented from a first-person perspective to capture children's real-time physiological responding while transgressing. Children were instructed to sit still and face the computer screen while the audio and visuals directed them to imagine themselves engaging with the pretransgression content and committing the transgressions (Figure 2). Audio and visuals were matched to children's respective gender and skin tone as applicable. The stories were randomly presented, delivered at a developmentally appropriate pace, and of roughly equal length. Four questions followed each story. First, children were asked, "How would you feel if you did this?" to assess open-ended anticipated emotions. Children who could not verbalize a codable emotion (e.g., "I don't know") were prompted with the forced choice question, "If you had [committed transgression], would you feel good, bad, or good and bad?" After stating an emotion, children were prompted to explain the reason for the emotion ("Why would you feel [emotion]?"). Emotion intensity ratings were then assessed by asking children to rate how strongly they would feel the emotion on a 3-point scale depicting squares of increasing size (1 [*not strong*] to 3 [*very strong*]). Finally, to account for potential differences in preferences, children were asked how much they liked the desirable objects/outcomes depicted (i.e., chocolate bars, lollipops, and talking to classmates) using the same 3-point scale described above. Preference scores were aggregated across the ethical transgressions ($r = .26$, $p = .001$) and controlled for in all analyses (citation withheld for peer review).

Guilt Coding. Two raters independently coded all emotion and reasoning responses. Disagreements were discussed until a consensus was reached. Anticipated emotions were assigned to one of 11 discrete emotion categories; noncodable responses were assigned to an *other* category. *Bad*, *sad*, *sorry, guilty*, and other guilt-related negative emotions were then assigned a score of 1 (*guilt-related)*, whereas *neutral*, *happy*, and other positive emotions were coded 0 (*not guilt-related*). We included simplified negative feelings like bad and sad to account for children who did not verbalize guilt but were able to name its basic emotional correlates and provide consonant reasoning (citation withheld for peer review). Children's reasoning for each emotion was coded into one of four categories. *Ethical* reasons reflected principles of fairness, justice, or harm, or references to the welfare of others (e.g., "It's not fair to steal", "He'll be sad"). *Sanction-oriented/conventional* reasons reflected censure from authority figures or peers, concerns over anticipated rule violations, or disruptions to group functioning (e.g., "I'll get in trouble by the teacher", "It's against the rules"). *Hedonistic/justifying* responses reflected self-centered benefits or excuses for the behavior (e.g., "I love chocolate", "He didn't want it anyway"). An *unelaborated/other* category was used for all other responses that could not be classified into the main categories (e.g., "Because", "It's bad"). For the ethical transgressions, *guilt-related* emotions with *ethical* reasons were assigned a score of 1 (*ethical guilt)*. For the nonethical transgression, *guilt-related* emotions with *sanction-oriented/conventional* reasons were assigned a score of 1 (*nonethical guilt;* 70% reported ethical guilt in response to the ethical transgressions and 57% reported nonethical guilt in response to the nonethical transgression). All other response combinations for each story were coded 0 (*no guilt*), although responses referencing *other* emotions and/or *unelaborated/other* reasoning (~7%) were coded as missing because it was impossible to determine the presence/absence of guilt from them. We then used intensity ratings from 1 (*not strong ethical/nonethical guilt*) to 3 (*very strong ethical/nonethical guilt*) to add further gradation to guilt responses. Continuous scores were aggregated across the ethical transgressions ($r = .38$, $p < .001$). A recent study with a sample of 1,179 6- to 13-year-olds documented sufficient internal consistency and a one-factor structure for children's emotional responding to ethical transgressions similar to those depicted in the current study (citation withheld for peer review). With respect to validity, previous studies utilizing the same stories and same or similar coding systems as the current study have documented links to an array of antisocial and prosocial behaviors in middle childhood (both concurrently and over time; citations withheld for peer review).

Aggression. Caregivers rated 12 items adapted from Little, Jones, Henrich, and Hawley's (2002) self-report aggression measure on a 7-point scale from 0 (*never*) to 6 (*always*). The items described overt acts of verbal and physical aggression indicative of reactive (e.g., "puts others down if upset or hurt by them/fights back when hurt by someone") and proactive aggression (e.g., "says mean things to others/starts fights to get what he wants"). We constructed a latent variable from all 12 items to represent generalized overt aggression (see Analysis Plan and Online Supplemental Material).

Analysis Plan

We used a latent structural equation modeling approach in Mplus 8.1 (Muthén & Muthén, 1998–2017). First, we created latent difference scores (LDS; McArdle, 2009) for physiological arousal and guilt in line with how we conceptualized them at study outset. For physiological arousal, we modeled children's mean-level changes in SC and RSA (ΔSC and ΔRSA) across the ethical transgressions[2] from pretransgression to transgression (i.e., from before they stole and pushed to while they stole and pushed). Positive and negative scores thus represented increases and decreases in SC/RSA while transgressing, respectively. For guilt, we modeled differences

[2] We focused on physiological reactivity during the ethical transgressions as opposed to the nonethical one because they depicted acts that were more similar to aggression, our outcome of interest.

between the intensity of children's ethical and nonethical guilt (Δguilt), with higher and lower scores representing more and less intense ethical than nonethical guilt, respectively (i.e., feeling more or less guilt after stealing from or pushing another child than after breaking a classroom rule). For aggression, we created three parcels—each containing four similarly worded items—and used them as manifest indicators to estimate a latent variable representing generalized, overt aggression (see Online Supplemental Material).

We then proceeded to build our final structural equation model in stages. All models are depicted in Figure 3. Model 1 accounted for relations between children's physiological arousal, guilt, and aggression. In Model 1a, we tested direct effects between ΔSC/ΔRSA and Δguilt, ΔSC/ΔRSA and aggression, and Δguilt and aggression. We also tested for indirect effects from ΔSC/ΔRSA to aggression via Δguilt to determine if physiological arousal predicted aggression through its association with guilt. In Model 1b, we added the ΔSC x ΔRSA interaction term to represent the interplay of the sympathetic and parasympathetic branches. We also tested for moderated mediation to determine if the interaction of these branches further predicted aggression through its association with guilt. Model 2 accounted for relations between children's fear recognition, guilt, and aggression. Similar to Model 1, we tested for all combinations of direct effects, as well as for the indirect effect from fear recognition to aggression via guilt to determine if children's threshold to detect fearful facial expressions predicted their aggression through their guilt. Finally, we merged Models 1 and 2 to ensure that all effects held in an omnibus model (Model 3). For all models, we relied on χ^2 values, root mean square errors of approximation (RMSEA), comparative fit indices (CFI), and standardized root mean square residuals (SRMR) as indicators of model fit. We used maximum likelihood with standard errors robust to nonnormality as a method of estimation to account for missing data and the skew of our aggression variable (skewness = 1.27, kurtosis = 1.33). We estimated the significance of indirect effects with bias-corrected 95% confidence intervals (CIs) based on 5,000 bootstrapped draws. A CI not containing zero reflected a statistically significant effect (MacKinnon, 2008). We controlled for children's gender and preferences for the desirable objects depicted in the ethical transgressions. To facilitate interpretation, we z-transformed all variables. We also ran supplementary analyses accounting for differences in children's pretransgression physiological arousal during the ethical transgressions and nonethical guilt (i.e., the baselines of the LDS models), pretransgression and reactive physiology during the nonethical transgression, and recognition of emotions other than fear (see Online Supplemental Material).

Results

One univariate outlier on ΔSC was detected and coded as missing (see Online Supplemental Material). Four children were removed because they were missing both physiological and guilt data, resulting in a final sample size of 146. As common for community samples, aggression levels were low on aggregate (Table 1).

LDS Models

We autoregressed children's transgression SC and RSA scores on their respective pretransgression scores, fixed the paths to 1, and fixed the intercepts and variances of the transgression scores to 0. The resulting latent difference scores represented the amount of mean-level change in SC/RSA from pretransgression to transgression (ΔSC/ΔRSA). Most children (84%) decreased in SC from pretransgression to transgression, whereas 16% remained stable or increased. For the same period, approximately 43% of children decreased in RSA, whereas 57% remained stable or increased. We estimated differences in ethical versus nonethical guilt (Δguilt) in a similar manner. On average, children reported more intense ethical guilt than nonethical guilt (Table 1). For all three LDS models (ΔSC, ΔRSA, and Δguilt), we allowed the constructs to covary, included remaining study variables as auxiliaries to aid in the estimation of missing data, and saved the factor scores for use as predictors in subsequent models. Mean-level change and variability in that change were also significant for all scores (*ps* < .016).

Descriptive Statistics and Zero-Order Correlations

Table 1 displays the means, standard deviations, and ranges of study variables, as well as the correlations between them. Notably, children who reported less intense ethical guilt than nonethical guilt were rated as more aggressive by their caregivers and had worse fear recognition.

Model 1: Predicting Aggression from Physiological Arousal and Guilt

Fit statistics for all models are reported in Table A6 of the Online Supplemental Material. Parameter estimates for all models are reported in Table 2. As reported in Table 2 (Model 1a), changes in SC/RSA were not directly associated with guilt or aggression. Lower ethical versus nonethical guilt was associated with higher aggression. ΔSC/ΔRSA were not indirectly linked to aggression through guilt. The interaction of ΔSC x ΔRSA in Model 1b was significant and adding it did not significantly alter the main effects observed in Model 1a. We used simple slopes analyses to explore how ΔSC related to guilt at low and high levels (± 1 *SD*) of ΔRSA (Cohen, Cohen, West, & Aiken, 2003). Sharper declines in SC while transgressing were associated with lower ethical versus nonethical guilt for children who increased (β = .24) but not decreased (β = −.03) in RSA while transgressing. As expected, this finding suggests that physiological underarousal—operationalized as simultaneous decreases in SC and increases in RSA—while transgressing is associated with lower guilt. ΔRSA did not significantly moderate the null association between ΔSC and aggression. Given the significant ΔSC x ΔRSA interaction on guilt, we tested for moderated mediation to determine if it further predicted differences in children's aggression through its link to guilt. The indirect effect of ΔSC on aggression via guilt was significantly moderated by ΔRSA. For children who increased in RSA while transgressing, steeper declines in SC while transgressing were associated with elevated aggression via their dampening effect on Δguilt ($\beta = -.04$). As expected, this suggests that the link between physiological underarousal and heightened aggression is facilitated by lower guilt. For those who decreased in RSA, steeper declines in SC were associated with less aggression via guilt ($\beta = .05$).

To rule out the possibility that these effects reflected general patterns of physiological reactivity rather than physiological reactions to ethical transgressions specifically, we re-ran each of the above models controlling for the effects of physiology during the nonethical story. The results were virtually identical to those reported above. Moreover, changes in physiological arousal during the nonethical story were not significantly associated with Δguilt or aggression. Full details are provided in the Online Supplemental Material.

Model 2: Predicting Aggression from Fear Recognition and Guilt

As reported in Table 2 (Model 2), a higher threshold to detect fear (i.e., blunted fear recognition) was associated with lower ethical guilt than nonethical guilt. Fear recognition was not directly associated with aggression. However, in line with our expectations, poorer fear recognition was associated with elevated aggression through its relation to lower Δguilt.

To rule out the possibility that these effects reflected general emotion recognition deficits as opposed to recognition deficits specific to fear, we re-ran Model 2 with happiness, sadness, and anger recognition included as predictors. This model returned significant effects for fear recognition that were virtually identical to those noted above, whereas no significant effects for the other emotion recognition variables emerged (see the Online Supplemental Material).

Model 3: Predicting Aggression from Physiological Arousal, Fear Recognition, and Guilt

As reported in Table 2, all previous findings held in this omnibus model. Notably, the core hypothesized indirect effects of ΔSC x ΔRSA and fear recognition on aggression through Δguilt remained significant, suggesting that physiological and lower-level perceptual processes are *uniquely* implicated in aggression via guilt.

Discussion

Researchers have theorized that the aggravating effects of emotional underarousal on aggression start early in development (Raine, 2013). However, studies investigating direct associations between underarousal and aggression in childhood have yielded mixed results. Developmental psychopathologists argue that multiple levels of analysis are necessary to fully understand developmental processes (Cicchetti, 1993). We adopted a multi-method, multi-informant approach to test if children's social-emotional capacities linked their emotional arousal and aggressive behavior as a process. Furthermore, we focused on middle childhood—a sensitive time when most, but not all, children begin to reliably anticipate guilt (Arsenio, 2014; Malti, 2016).

Children's physiology was not directly associated with their aggression—only indirectly through their guilt. Those who exhibited physiological underarousal (i.e., decreases in SC and increases in RSA) while transgressing expressed less guilt and, in turn, engaged in more aggression. Children with physiological underarousal may not have engaged with the ethically salient aspects of the transgressions and considered how they violated ethical principles and/or compromised the welfare of the victims (see Colasante et al., 2018; Malti et al., 2016), which are critical steps for mounting a guilt response and avoiding aggression (Malti, 2016). This indirect effect and lack of a direct effect also suggest that accounting for children's physiological arousal in isolation may not sufficiently explain their aggressive tendencies. Social emotions are multifaceted experiences comprised of lower- and higher-order elements, including physiological changes, facial and vocal expressions, cognitive appraisals, and subjective feelings; the coordination of these elements is thought to increase the likelihood of a corresponding behavior (Scherer, 2009). In line with this theorizing, it was only when we accounted for how children's physiological arousal factored into their broader affective and cognitive experiences of guilt that we found a significant (indirect) link to aggression.

Similarly, children's fear recognition and aggression were not directly related, although they were indirectly associated via guilt. Those with blunted fear recognition had lower guilt and, in turn, higher aggression. As in previous related studies (Jusyte et al., 2014; Marsh & Cardinale, 2014; White & Delk, 2017), these effects were exclusive to fear recognition (no effects were found for happiness, sadness, and anger recognition). Children with fear-specific impairments may be less likely to pick up on their victims' distress cues, yet this alone may not necessarily result in such children carrying their intent through to harming others. The extent to which children's deficits in fear recognition factor into them caring less about harming others and expressing less guilt may be an important intermediary process. Although this is the first study to our knowledge linking fear recognition to guilt in children, there is similar evidence suggesting that emotion identification underpins children's tendencies to sympathize with others and behave prosocially towards them (Sette, Colasante, Zava, Baumgartner, & Malti, 2018). Thus, social emotions may serve as translational mechanisms linking biologically based, lower-level emotion recognition abilities to aggression and prosociality—everyday behaviors that are central to healthy social functioning (Crick, 1996). Nonetheless, it is important to note that fear processing is not a one-to-one reflection of amygdala functioning; there may be other non-biological factors that contribute to it (see Dujardin, Bosmans, De Raedt, & Braet, 2015). Future process-oriented studies should consider using electroencephalography or imaging techniques to assess children's amygdala-related activity while they navigate social conflict situations and anticipate guilt.

Direct links between reduced fear processing and heightened psychopathic or CU tendencies in children and adolescents are well established (e.g., Blair et al., 2001; Blair et al., 2005). CU and psychopathy involve aggression, but they are also characterized by a lack of guilt after transgressing and low sympathy for needy others (Frick, 2012). Our findings suggest that fear processing deficits may be primarily associated with social-emotional (rather than aggressive) CU/psychopathic traits. Similar evidence in adults suggests that amygdala dysfunction is more characteristic of CU/psychopathic traits than aggression per se (Blair et al., 1997). Thus, impaired fear processing may be a defining characteristic of individuals with psychopathic or CU tendencies, and the process by which it disrupts the ability to feel guilt (and perhaps other social emotions) may represent a key mechanism driving aggression in such individuals. Although our goal was to parse aggression from CU/psychopathic traits, going one step further to assess differential links between underarousal and aggressive subtypes (e.g., reactive and proactive aggression; see Moore et al., 2018) would be an interesting future avenue, as underarousal may be particularly implicated in "cold-blooded" proactive aggression (Frick, 2012). Reactive and proactive aggression were very highly correlated in our study (r = .82 at the latent level), but there may be greater separation and higher proactive aggression in clinical samples to allow for a more stringent test of this hypothesis.

SC and RSA were not independently associated with guilt and aggression. This corroborates the idea that past discrepant or null relations between children's physiological reactivity and aggression were due, at least in part, to the select assessment of single autonomic branches. As expected, we found a significant interaction between SC and RSA reactivity on aggression, which highlights the importance of investigating the conjoint roles of sympathetic and parasympathetic indicators and aligns with theorizing on the moderating effect of RSA on SC (Porges, 2011). In the current case, increases in RSA (i.e., more brake) may have acted in conjunction with or facilitated decreases in SC (i.e., less gas; collectively referred to as reciprocal parasympathetic activation; Berntson et al., 1991) to produce a net decrease in arousal, thus hampering expressions of guilt and coinciding with higher aggression scores. In contrast, children who showed decreases in SC and RSA were rated lower in aggression via higher guilt. Autonomic coinhibition is thought to reflect passive vigilance (El-Sheikh & Erath, 2011). This type of response may have helped such children optimally engage in the hypothetical transgressions (as opposed to being completely disengaged or fully/anxiously engaged).

Most investigations of physiology–aggression links fail to consider physiological reactivity in contexts with explicit relevance to children's aggressive behavior (see Moore et al., 2018; Murray-Close et al., 2017). We considered children's physiology while they imagined themselves engaging in acts depicting intentional ethical transgressions, which may have increased our likelihood of finding a link to their actual aggressive tendencies. Indeed, further analyses showed that only physiology while stealing from and pushing others was significantly linked to guilt and aggression—physiology while breaking a classroom rule (a nonethical transgression) had no significant bearing on our outcomes of interest.

In a recent study of 11-year-olds, the same pattern of physiological underarousal detected in our study (i.e., decreases in SC and increases in RSA) during an opportunity to aggress predicted an increased likelihood of actually aggressing (Moore et al., 2018). The coherence of results between this study and ours, which each considered physiological activity in (1) both autonomic branches and (2) aggression-centric contexts, suggests that future studies in this area should abide by these criteria to increase the clarity and consistency of findings. Since the current study was limited to two ethical transgressions and one nonethical transgression, future studies should also assess the extent to which our findings generalize with a more thorough assessment of guilt that includes other social conflicts, such as peer exclusion.

To ensure a thorough account of children's guilt-related capacities, we assessed their guilt in ethical versus nonethical contexts. Ethical guilt primarily revolves around the welfare of others, whereas nonethical guilt often revolves around punishment and conventional concerns (Malti, 2016). We provided children with identical three-point scales to rate the intensity of their ethical and nonethical guilt and expected less aggressive (i.e., more ethically sensitive) children to rate their ethical guilt feelings as more intense than their nonethical guilt. This distinction proved fruitful, as emotional underarousal was associated with less intense ethical versus nonethical guilt and, in turn, more aggression. Interestingly, children who reported less guilt over stealing/pushing than over breaking the classroom rule did not necessarily lack guilt on aggregate—some deemed both types of transgressions as similarly worthy of intense guilt. One possibility is that such children were talking the talk and reporting what they thought others expected them to feel—all the while struggling to distinguish one wrong from another and thus reporting negative feelings after harming others that were similar in intensity and scope to their feelings after simply breaking a classroom rule. Indeed, children with underaroused symptomology typically lack the affective ability to feel and care about what other people feel, but are fully capable of cognitively understanding and describing others' feelings (Dadds et al., 2009). Future studies should attempt to analyze such children separately instead of lumping them into the same "nondifferentiating" category as those who lacked guilt on aggregate.

Most 8-year-olds in our sample reported ethical guilt in response to the ethical transgressions (which is less common at younger ages when guilt is still in flux; Colasante et al., 2018). Assessing nonethical guilt as a baseline for ethical guilt may represent a more developmentally appropriate and fine-grained method of identifying those who lack ethical sensitivity beyond middle childhood. Indeed, in line with recent findings indicating that differences between children's emotion ratings after ethical versus nonethical transgressions were more predictive of aggression than their emotion ratings in either context alone (Jambon & Smetana, 2018b), supplemental analyses indicated that our difference score was a more precise correlate of aggression ($r = -.19$, $p < .01$) than ethical guilt alone ($r = -.13$, $p = .08$). Future studies should account for cognitive factors (e.g., social intelligence) that may influence children's ability to discern ethical from nonethical wrongdoing.

Although we focused on normative development in a community sample, our findings suggest some degree of community–clinical continuity in the relations of underarousal, guilt, and aggression. We drew from both normative and clinical literature linking these constructs (e.g., Blair et al., 1997; Malti et al., 2016) and largely clinical theorizing about how they might be related as a process (e.g., Frick, 2012; Malti, 2016). The fact that we documented this process in a typical community sample aligns with the developmental psychopathological perspective that certain developmental processes and mechanisms exist across the normative–clinical continuum, with quantitative rather than qualitive differences separating the two extremes (Cicchetti, 1993). Indeed, a number of studies use person-centered approaches to show that clinical groups of children exhibit exacerbated levels of CU traits that are otherwise present—but not as extreme—in typically developing children (Frick & White, 2008). From this perspective, our findings highlight some promising clinical opportunities.

Physiological tendencies may represent a less viable point of intervention because of their significant heritability (Raine, 2013). Guilt may serve as a more viable point of intervention because of its translational role between lower-level processes and aggression (as our findings suggest), and relative susceptibility to socialization factors (Grusec, Chaparro, Johnston, & Sherman, 2013). Practitioners, educators, and caregivers could facilitate guilt in children with underarousal by intervening in conflict situations, highlighting others' perspectives, pointing out others' distress, and making it clear that the transgressing child is responsible for such distress (Hoffman, 2000). Although fear recognition deficits are also deeply rooted in biology (Jusyte et al., 2014), research with adults suggests that fear recognition can improve with training. Adult violent offenders who underwent training to direct attention to salient regions of facial expressions with varying intensities showed significant pre–post improvements in recognizing such expressions on a separate facial morph task (Schönenberg et al., 2014). On a related—and perhaps more speculative—note, intranasally administered oxytocin significantly improved the fear recognition of adolescents diagnosed with antisocial personality disorder relative to healthy controls (Timmermann et al., 2017). Nonetheless, underarousal and fearlessness can also interfere with socialization goals, as children with these characteristics tend to be disproportionately less receptive to limit setting (Pasalich, Dadds, Hawes, & Brennan, 2011) and harsh parenting (Frick, Ray, Thornton, & Kahn, 2014). Socializing guilt and fear recognition should likely be done with warmth, sensitivity, cooperation, and respect (Kochanska & Murray, 2000). All of these practical implications should still be heeded carefully—we cannot be sure that the findings and implications of this study are applicable to clinical populations.

In sum, both components of emotional underarousal under study—one rooted in autonomic deficits and the other in amygdala hypofunction—were uniquely implicated in difficulties with guilt and aggression. This highlights the importance of taking a holistic biological approach and aligns with recent pushes to account for the roles of brain and body in the development of social emotions and behavior (Kahle & Hastings, 2015). Our findings also underscore the viability of eclectic treatment approaches in clinical child psychology and suggest that extending them to the domain of biology is a promising future direction.

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Online Supplemental Material

I. LDS Models

Descriptive statistics and bivariate correlations between physiology (SC and RSA at pretransgression and transgression, and estimated changes in SC/RSA from pretransgression to transgression) and guilt-related capacities (ethical and nonethical guilt, and estimated differences between ethical and nonethical guilt) are presented in Table A1. Following standard guidelines (McArdle, 2009), we calculated estimated changes in physiology (i.e., ΔSC and ΔRSA) and differences between ethical and nonethical guilt (i.e., Δguilt) using LDS models. For physiology, we regressed SC and RSA scores at transgression onto their respective pretransgression scores and set these autoregressive paths to 1. We then estimated two latent variables representing changes in SC and RSA from pretransgression to transgression. We fixed the intercepts and variances of the SC and RSA transgression variables to 0, and freely estimated the means and variance parameters of the latent change variables—representing the average amount of change and individual variability in change in SC and RSA from pretransgression to transgression. We allowed pretransgression and change physiology scores to covary. We used a similar procedure to calculate differences in ethical and nonethical guilt, and, for both sets of models, we included remaining study variables as auxiliary variables to aid in the estimation of missing data. We saved factor scores for the latent change constructs and inspected them to identify potential abnormalities in the data. This inspection revealed that one participant's observed change in SC from pretransgression to transgression was 7.8 *SD*s above the mean. The ΔSC score for this participant was thus deleted and treated as missing data in all subsequent analyses.

Table A1

Descriptive Statistics and Bivariate Correlations

	Variable	1	2	3	4	5	6	7	8	9	*M* (*SD*)	Range
1.	Ethical pretransgression SC	—									16.81 (6.66)	1.42–36.07
2.	Ethical transgression SC	.99**	—								16.57 (6.57)	1.43–35.56
3.	Ethical ΔSC	−.28**	—	—							−.27 (.32)	−1.19–.86
4.	Ethical pretransgression RSA	−.15	−.15	−.08	—						6.56 (1.11)	2.85–8.66
5.	Ethical transgression RSA	−.04	−.04	−.10	.76**	—					6.72 (1.13)	3.06–9.86
6.	Ethical ΔRSA	.15*	.15*	−.03	−.32**	—	—				.15 (.76)	−1.87–2.35
7.	Ethical Guilt	.03	.03	.11	.04	−.07	.04	—			1.84 (1.10)	0–3
8.	Nonethical Guilt	.00	.01	.21**	−.02	−.06	−.08	.36**	—		1.20 (1.15)	0–3
9.	Δguilt	.03	.02	−.09	.05	−.01	−.09	—	−.57**	—	.65 (1.22)	−2–3

Note. $N = 146$. SC = skin conductance. RSA = respiratory sinus arrhythmia. ΔSC/ΔRSA = changes in skin conductance/respiratory sinus arrhythmia from pretransgression to transgression; positive/negative scores represent increases/decreases in skin conductance/respiratory sinus arrhythmia while transgressing. Δguilt = differences in ethical versus nonethical guilt; positive/negative scores represent more/less intense reports of ethical than nonethical guilt. $^{**}p < .01$. $^{*}p < .05$.

II. Aggression Measurement Model

We averaged items with similar content and wording from the reactive and proactive aggression subscales to create three manifest parcels (Table A2). We then used these items to estimate a one-factor CFA of the latent aggression construct. We used the effects coding method to scale the estimates (Little, 2013). All items loaded strongly onto the latent construct (Table A3).

Table A2

Items Contained in Each Aggression Parcel

Parcel	Reactive Aggression	Proactive Aggression
Parcel 1	fights back when hurt by someone	starts fights to get what he/she wants
	threatens back when threatened by someone	threatens others to get what he/she wants
Parcel 2	if angered by others, hits, kicks, or punches them	hits, kicks, or punches others to get what he/she wants
	puts others down if upset or hurt by them	to get what he/she wants, puts others down
Parcel 3	when hurt by others, gets back at them by saying mean things to them	says mean things to others to get what he/she wants
	hurts others if upset by them	to get what he/she wants, hurts others

Table A3

Parameter Estimates for the Latent Aggression Measurement Model

	b	β	τ	θ
Parcel 1	1.05	.82	.85	.22
Parcel 2	1.02	.94	.60	.06
Parcel 3	.93	.87	.62	.11

Note. b = unstandardized latent factor loadings. β = standardized latent factor loadings. τ = item intercepts. θ = residual item variances.

III. Supplementary Analyses

Table A4

Supplementary Analyses Incorporating LDS Baselines, Nonethical Guilt, and Nonethical Physiology

	Model S1		Model S2		Model S3	
	Δguilt	Aggression	Δguilt	Aggression	Δguilt	Aggression
Ethical ΔSC	.06 [−.08, .19]	.03 [−.14, .20]	.05 [−.09, .19]	.04 [−.13, .21]	.04 [−.10, .17]	.03 [−.14, .20]
Ethical ΔRSA	−.15* [−.28, −.02]	.03 [−.09, .16]	−.15* [−.28, −.03]	.04 [−.08, .16]	−.16* [−.30, −.03]	.01 [−.11, .13]
Ethical ΔSC x ΔRSA	.14* [.02, .26]	.11 [−.02, .25]	.14* [.02, .26]	.12 [−.02, .25]	.13* [.02, .25]	.11 [−.03, .24]
Δguilt	—	−.19** [−.34, −.04]	—	−.19** [−.34, −.05]	—	−.20** [−.35, −.05]
Nonethical guilt	−.54*** [−.66, −.41]	.01 [−.17, .18]	−.54** [−.66, −.41]	.003 [−.17, .18]	−.54*** [−.66, −.41]	−.01 [−.19, .17]
Ethical pretransgression SC	.04 [−.09, .17]	−.11 [−.23, .02]	—	—	—	—
Ethical pretransgression RSA	.02 [−.13, .16]	−.04 [−.18, .11]	—	—	—	—
Nonethical pretransgression SC	—	—	.02 [−.12, .16]	−.12* [−.24, −.002]	—	—
Nonethical pretransgression RSA	—	—	−.01 [−.14, .12]	.03 [−.10, .16]	—	—
Nonethical ΔSC	—	—	—	—	.04 [−.09, .17]	.09 [−.09, .27]
Nonethical ΔRSA	—	—	—	—	.01 [−.15, .17]	−.10 [−.22, .02]
Nonethical ΔSC x ΔRSA	—	—	—	—	−.01 [−.18, .16]	−.01 [−.19, .17]
Gender	−.03 [−.16, .11]	.15 [−.01, .30]	−.02 [−.16, .11]	.17* [.02, .32]	−.02 [−.16, .11]	.14 [−.01, .29]
Preference	.17** [.04, .30]	—	.16* [.04, .29]	—	.17** [.04, .30]	—
Indirect Effects						
Ethical ΔSC x ΔRSA	—	−.03 [−.06, .01]	—	−.03 [−.08, −.001]	—	−.03 [−.08, −.001]
Nonethical ΔSC x ΔRSA	—	—	—	—	—	.01 [−.04, .05]
R^2	.37	.11	.37	.11	.37	.12

Note. Supplementary analyses testing whether the inclusion of nonethical guilt, ethical pretransgression physiology (Model S1), nonethical pretransgression physiology (Model S2), and changes in physiology during the nonethical story (Model S3) altered the main findings. $^{***}p < .001$. $^{**}p < .01$. $^{*}p < .05$.

Table A5

Model S4 Incorporating All Emotion Recognition Variables

	Δguilt	Aggression
Fear recognition	−.24**	−.10
	[−.40, −.09]	[−.23, .03]
Happiness recognition	.07	−.08
	[−.09, .23]	[−.21, .06]
Sadness recognition	−.04	.04
	[−.18, .12]	[−.14, .21]
Anger recognition	−.12	.17**
	[−.25, .02]	[.04, .30]
Δguilt	–	−.18**
		[−.29, −.06]
Gender	−.001	.15*
	[−.15, .15]	[−.003, .31]
Preference	.25***	–
	[.10, .40]	
Indirect Effects		
Fear recognition	–	.04
		[.01, .10]
Happiness recognition	–	−.01
		[−.05, .01]
Sadness recognition	–	.006
		[−.02, .04]
Anger recognition	–	.02
		[−.004, .07]
R^2	.13	.13

Note. Supplementary analyses testing whether the inclusion of all emotion recognition variables altered the main findings. $^{***}p < .001$. $^{**}p < .01$. $^{*}p < .05$.

IV. Fit Statistics

Table A6

Fit Statistics for All Models

Model	χ^2	*df*	*p*	RMSEA	CFI	SRMR
Model 1a	11.36	11	.41	.015 (.000-.089)	.999	.021
Model 1b	13.10	13	.44	.007 (.000-.082)	1.00	.020
Model 2	5.71	9	.77	.000 (.000-.064)	1.00	.017
Model 3	14.40	15	.49	.000 (.000-.075)	1.00	.018
Model S1	14.40	19	.76	.000 (.000-.051)	1.00	.016
Model S2	14.13	19	.78	.000 (.000-.050)	1.00	.016
Model S3	28.77	21	.12	.050 (.000-.092)	.980	.019
Model S4	17.21	15	.31	.032 (.000-.087)	.993	.022

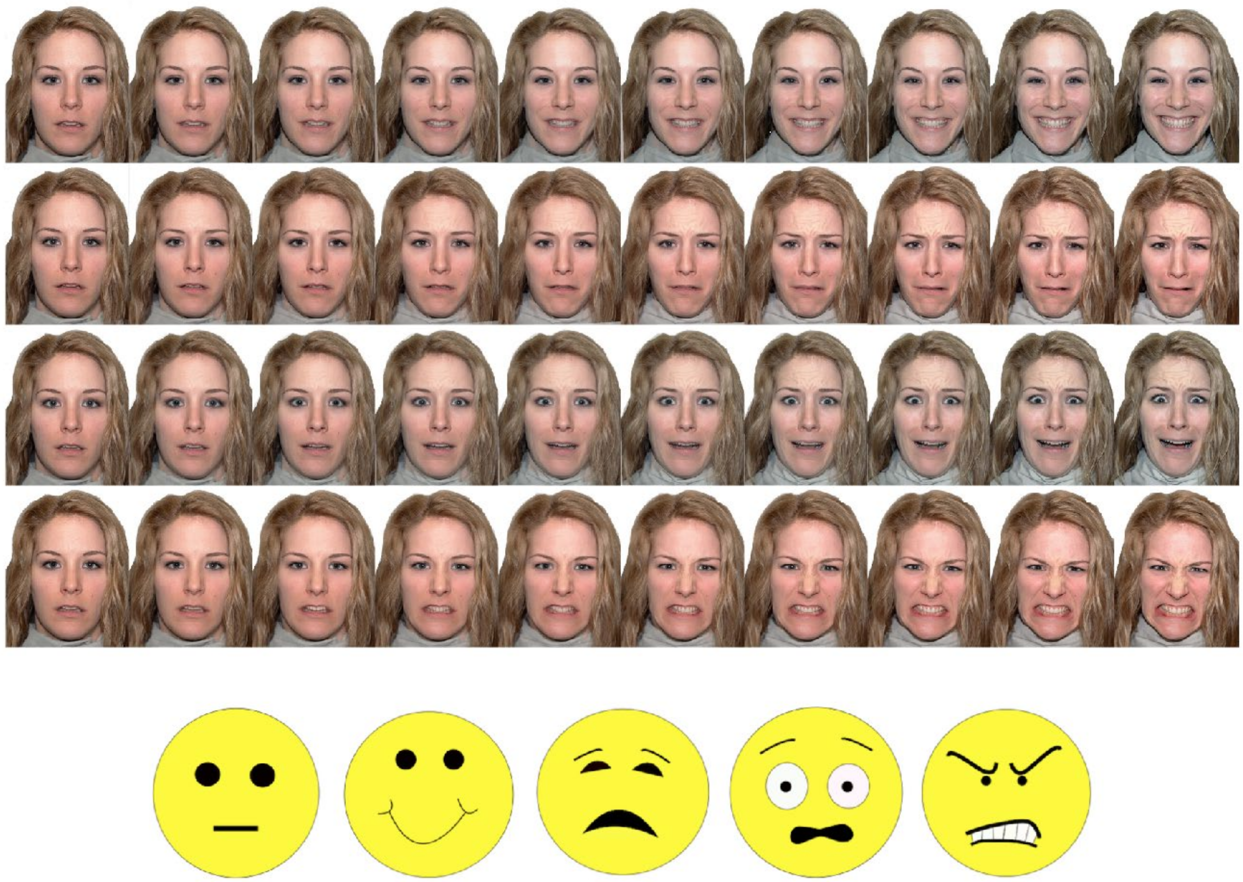

Figure 1. Visuals for emotion recognition task.

Figure 2. Visuals for the pretransgression (left) and transgression (right) portions of the a) chocolate bar, b) lollipop (i.e., ethical transgressions), and c) lunch (i.e., nonethical transgression) stories.

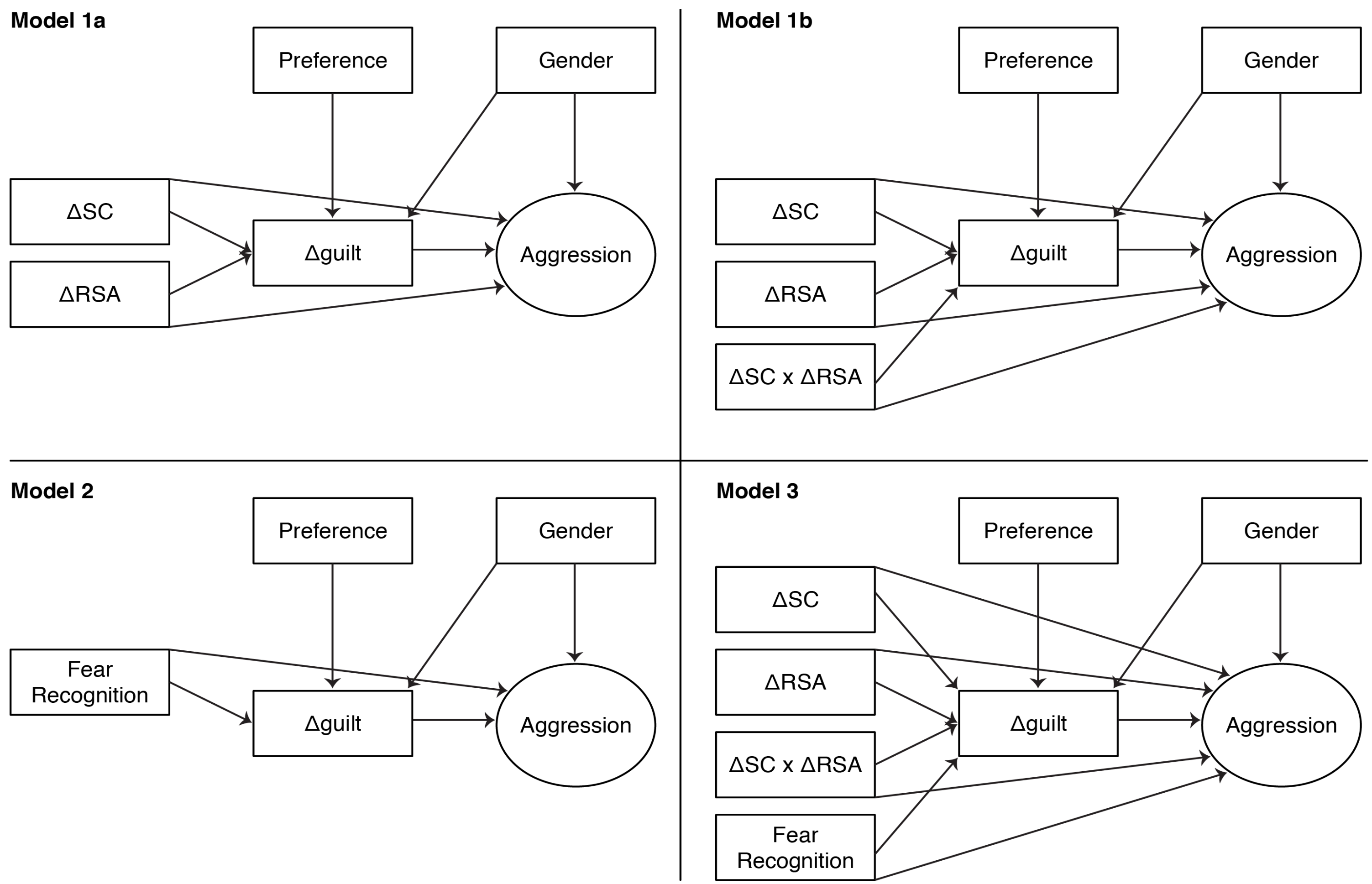

Figure 3. Models linking physiological arousal, fear recognition, guilt, and aggression.