RUNNING HEAD: EMOTION, SIP, AND AGGRESSION

The association between emotion, social information processing, and aggressive behavior: A systematic review

Danique Smeijers[1], Massil Benbouriche[2,3], and Carlo Garofalo[4]

[1]Forensic Psychiatric Centre Pompestichting, Nijmegen, The Netherlands

[2]Univ. Lille, EA 4072 – PSITEC – Psychologie : Interactions, Temps, Emotions, Cognition, F-59000 Lille, France

[3]National Institute of Forensic Psychiatry Philippe-Pinel, Canada

[4]Tilburg University, Department of Psychology, The Netherlands

Cite as:

Smeijers, Benbouriche, and Garofalo (2020). The association between emotion, social information processing, and aggressive behavior: A systematic review. *European Psychologist*. https://doi.org/10.1027/1016-9040/a000395

Abstract

Aggressive individuals are thought to process social information in such a manner that the likelihood of engaging in aggressive acts increases drastically. Additionally, emotion and emotion regulation skills are implicated in aggressive and violent behavior as well. However, little attention has been paid to the reciprocal relations between emotion and emotion regulation and social information processing (SIP) in explaining aggression. Therefore, the present study systematically examined extant research on the role of emotion and SIP in aggressive behavior. The results supported substantial overlap between emotion and emotion regulation processes and SIP in explaining aggression. Due to the paucity and nature of available studies, no firm conclusion can be drawn about the nature of their reciprocal relationships. However, the integration of cognition and emotion seems a promising avenue of research for explaining the development and manifestation of aggressive behavior, as well as to inform its prevention and treatment. Future research is needed to elucidate the likely intertwined roles of emotion and the entire SIP process in offender or at-risk populations.

Keywords

Social information processing, emotionality, emotion regulation, aggressive behavior

Social Information Processing (SIP) describes how individuals perceive, interpret, and make decisions about social stimuli. Accurate processing of social information is crucial for human interaction and adequate socialization because it allows to understand others' intent, to take into account contextual demands, and to decide how to respond to them. Conversely, inaccurate SIP may lead to a series of unfortunate consequences, ranging from – harmless – social embarrassment (e.g., when committing a faux pas) to aggression (Dodge & Crick, 1990). Specifically, according to the SIP model, aggressive individuals have impairments in processing social information, and more specifically are thought to interpret, perceive and make decisions about social stimuli in such a manner that the likelihood of engaging in aggressive acts would increase.

Arguably the most influential model in explaining aggressive behavior pinpointing deficits in SIP is the model originally proposed by Crick and Dodge (1994). According to this model, hostile schemas based on early experiences are stored in long-term memory and may affect the way social information is processed throughout the development and later in life. Furthermore, social cues that occur in immediate situations are thought to be processed in consecutive steps: 1) encoding of cues; 2) interpretation of cues; 3) goal clarification; 4) generating response alternatives; 5) evaluation of response alternatives and selection of an optimal response; and 6) enactment of the optimal response. The SIP model was developed as a framework that focused on the role of cognition in aggression. However, there have been proposals that the role of emotion and emotion regulation should also be considered in the context of the SIP (e.g., Lemerise & Arsenio, 2000). In the present work, we aimed at taking stock of and integrating these proposals, reviewing the empirical evidence gathered to date, and formulating a comprehensive framework for the role of emotion in the relation between SIP and aggression.

In their integrated model of emotion processes and the SIP model, Lemerise and Arsenio (2000) hypothesized that each step of SIP can be affected by individual differences in emotionality (i.e., trait or state emotional experience)[1] and emotion regulation (see Figure 1). Emotional processes can play an adaptive role by reducing information processing demands to facilitate adaptive goal-directed behavior (Lemerise & Arsenio, 2000). For example, in the presence of a physical threat (e.g., an armed robbery occurs while doing shopping), one's emotional reaction (e.g., fear) may motivate individuals to avoid the threat (e.g., leaving the situation) by focusing their attention to what is most salient (i.e., the threatening situation) regardless of other contextual demands (e.g., finishing the shopping). However, in most daily life circumstances, what is perceived as salient likely differs between individuals, highlighting the importance of the interaction between the individual and a given context.

Notably, when emotions are overwhelming or difficult to regulate, their function can be adverse, as they might increase the demands posed on the individual. Also, current emotional states may influence what is noticed about a social situation, which in turn makes the recollection of emotion-congruent information more likely. For instance, if an individual is in an irritated or aggressive state, he or she will also be more likely to attribute or interpret social stimuli or interactions in a hostile way (Lemerise & Arsenio, 2000). In addition, it is argued that individuals who experience strong emotions might be too overwhelmed and too self-focused to generate a diversity of responses and to evaluate the most appropriate response among many possibilities (Lemerise & Arsenio, 2000). Furthermore, the ability to flexibly display emotions in a way that is appropriate to the context requires control over one's expressivity as well as over one's sensitivity to the situation. Impairments in the control over one's emotional expression and other impairments in emotion regulation abilities might interfere with the assessment of the situation from a different affective and cognitive

[1] Unless specifically noted, we use the term emotionality to denote trait emotional experience.

perspective, for example, taking into consideration others' perspectives or reflecting on one's own values before acting. This may hamper a flexible approach to goal selection for which both internal and contextual factors need to be taken into account. Lemerise and Arsenio (2000) also suggested that the type of goals that will be selected in a given situation can be affected by the intensity of the emotions one is experiencing, and the extent to which s/he is able to regulate emotions. People who are overwhelmed by their emotions (or by their reaction to others' emotions), are more likely to choose avoidant or hostile goals in an attempt to reduce distressing arousal.

Finally, besides one's own emotions, Lemerise and Arsenio (2000) stressed the necessity to encode and interpret others' affective signals. In combination with one's own affective cues, they provide ongoing information about how the social encounter is proceeding. In turn, this information allows us to make subtle adjustments to behavior. Consequently, individuals with deficits in reading and sending affective signals may be dependent on relatively rigid approaches to situations.

The integration of cognition and emotion in the context of SIP does not only seem of importance in explaining the development and maintenance of aggressive behavior, it also has notable clinical relevance. Aggression treatment requires patients not only to gain control over aggressive impulses, but also to behave more pro-socially (Brännström, Kaunitz, Andershed, South, & Smedslund, 2016). This requires patients to alter cognitive distortions but also to learn how to regulate their emotions. The latter also requires patients to be aware of their emotional responses and modulate them taking into account situational demands (Holley, Ewing, Stiver, & Bloch, 2017; Roberton, Daffern, & Bucks, 2012). Overall, we contend that any approach to understanding or treating aggression that focuses exclusively on emotional functioning or exclusively on cognitive functioning will inevitably provide a partial explanation or attempted solution to the burden that aggression poses on society. An

integration of emotional and cognitive processes that can account for both the trait-like disposition to behave aggressively (i.e., as a distal risk factor), and for the state-dependent antecedents of the aggressive episodes (i.e., as a proximal risk factor), seems therefore a necessary way forward to further our understanding of aggression and increase our likelihood to reduce it. Considering the enormous health, social, and economic burden of aggressive behaviors, there is an urgent need to significantly advance our understanding of the factors that cause and sustain the tendencies to exhibit these behaviors. Therefore, the main goal of the current study was to systematically examine extant research on the role of emotion in SIP in the context of aggression.

Methods

Search strategy and included studies

A systematic search was conducted for articles written in English, published before November 2018 and describing the association between social information processing (SIP), emotion and aggressive behavior. PsycINFO (OVID), PubMed and Web of Science were used to search articles with the following keywords: 1) “social information processing”; 2) emotion*; 3) aggress*; 4) offend*; 5) forensic; 6) prison; 7) incarcerated; 8) delinquen*; 9) psychopath*; 10) ASPD; 11) criminal; 12) violen*; 13) violent; 14) inmates; 15) antisocial*; 16) crime. Based on the title, abstract, and full-text, relevant articles were selected based on the following inclusion criteria:

1. Articles should be original research published in peer reviewed journals
2. Articles should be written in English
3. The association between SIP, emotion and aggression should be the main focus of the article.
4. The focus of the articles should not be on the measurement of SIP, emotion, emotion recognition, emotion regulation or aggression

5. The focus of the articles should not be on intervention on SIP, emotion, emotion recognition, emotion regulation or aggression

6. All samples were allowed, such as community samples, undergraduates, offender samples, children, adolescents, and adults

7. Gender was not an exclusion criterion

This initial search yielded 2317 references, of which 1508 were duplicates. The titles of the remaining 809 articles were screened for eligibility, resulting in 38 relevant references. References that were considered non-eligible were excluded because: the focus was only on SIP (n = 143), aggression (n = 166), or emotion (n = 26). Alternatively, they were excluded because the focus was only on the association between emotion and aggression (n = 9), between SIP and emotion (n = 10), or between SIP and aggression (n = 155). Fourteen studies focused on the measurement of either SIP or aggression, and 238 studies were focused on a topic other than SIP/emotion/aggression. Additionally, six references were not written in English, and four were books. Further screening of the abstracts and full-texts resulted in 9 relevant references. The other 29 studies were excluded because full-text screening determined there was no or only an indirect measure of emotion and did therefore not focus on the association between SIP, emotion, and aggression. Subsequently, the searches were supplemented by cross-referencing which yielded 4 extra relevant articles. A flowchart of the article selection is provided in Figure 2. An overview of included studies is presented in Table 1.

Study characteristics

The total sample size was 7433. Eight studies investigated only children, three studies adolescents, one study undergraduate students, and one study adults. Of all selected studies, three included clinical samples, and ten were focused on healthy sample. All studies used vignettes to measure distorted SIP. These vignettes consisted of videos (N = 1), audio's (N =

2), drawings (N = 1), or written stories (N = 8), or a combination of reading aloud and illustrations (N = 1) about hypothetical situations in which a peer acted ambiguous. The participants were subsequently asked to indicate the intention of the peer.

Results

Examination of the studies included highlighted that the core topics of empirical studies on the association between emotion and SIP could be categorized into the following four domains: emotionality, emotion regulation, emotions in others, and gender differences. Therefore, we organized the presentation of the results following these domains.

Emotionality

Eight studies investigated the role of emotionality in SIP processes. In the current review, emotionality is defined as stable individual differences in the typical intensity with which individuals experience their emotions and in the threshold for relatively intense levels of emotional responding (Eisenberg & Fabes, 1992). All studies supported an association between emotional process, SIP components, and aggressive behavior (Chen, Coccaro, & Jacobson, 2012; Choe, Lane, Grabell, & Olson, 2013; Gagnon et al., 2015; Harper, Lemerise, & Caverly, 2010; Laible, Murphy, & Augustine, 2014; Mathieson et al., 2011; Orobio de Castro, Slot, Bosch, Koops, & Veerman, 2003; Orobio de Castro, Verhulp, & Runions, 2012; Wright, 2017). Orobio de Castro et al. (2012) showed that both highly aggressive and non-aggressive comparison boys primarily explained generation and selection of aggressive responses to provocation situations by feeling impelled to act by strong emotions. Whereas both proactive and reactive aggression were associated with emotion-based explanations, only the unique variance in reactive aggression maintained these associations when controlling for the shared variance between reactive and proactive aggression. Moreover, highly aggressive boys more frequently advocated aggression by referring to emotions. Notably, aggression was not exclusively motivated by negative emotions (e.g., rage, anger), but also by positive ones,

albeit more rarely (e.g., because being aggressive is perceived as enjoyable or fun). Further, aggressive boys more often advocated aggression referring to a moral rule that taking revenge is imperative, regardless of its consequences. Some of these revenge-based arguments in favor of aggressive responses included emotional considerations about wanting to cause others' to feel as bad as the aggressor feels (e.g., "Because (...) then I make him sad too", p. 345), hence suggesting an emotional activation was present in the aggressor as well.

Furthermore, it was found that emotionality, inadequate emotion understanding, and emotional distress were associated with increase hostile attribution bias (Choe et al., 2013; Laible et al., 2014; Mathieson et al., 2011; Wright, 2017). Wright (2017) investigated adolescents' attributions for ambiguous face-to-face situations as compared to cyber situations and the association with emotional distress. The results showed that the ambiguous and hypothetical face-to-face social situations triggered more of the self-blame attribution in comparison to the ambiguous and hypothetical cyber social situations. Furthermore, a positive association was found between feelings of anger and hostile attribution biases (both face to face and in cyber context). Feelings of sadness were positively related to hostile attributions as well as self-blame attributions (both face to face and in cyber context). A negative association was found between sadness and neutral attribution (both face to face and in cyber context). Finally, Mathieson et al. (2011) found an interaction effect such that higher levels of the hostile attribution bias were associated with relation aggression when levels of emotional distress were high as well.

Of note, the only study that was based on an adult population also supported moderate associations between negative emotional responses and hostile attribution bias (Chen et al., 2012). In particular, both externalizing (i.e., feeling anger) and internalizing (i.e., feeling embarrassed/upset) emotional responses to hypothetical vignettes were both related to higher levels of hostile attribution bias in the same vignettes. In turn, hostile attribution bias and

anger were positively related to different forms of aggression (physical, verbal, and relational aggression). In contrast, embarrassment was positively related to relational aggression specifically, but negatively to physical, and verbal aggression.

Two studies reported that a negative mood induction had an effect on several SIP components. Orobio de Castro et al. (2003) used a manipulated computer game to induce negative feelings in participants (high/moderate/non aggressive children) during the experiment. The game was simple and straightforward but ended unexpectedly due to an error. Their results showed that the hostile attribution bias increased after the negative affect induction in the highly aggressive group. Harper et al. (2010) induced a negative affect by asking children to remember something that made them so angry that they wanted to yell and stomp his/her feet. Participants in this study were divided in three subgroups: one group was characterized by low levels of social acceptance and high levels of aggression; one group by average levels of social acceptance and low levels of aggression; and third group by high levels of social acceptance and low levels of aggression. Their results showed that such a mood induction did not only increase distortions in the interpretation/encoding SIP step but also influenced the subsequent steps. They found that induced affect influenced children's preferred goals. Specifically, it was found that children who received an angry affect induction focused more on instrumental goals than on social relational goals and that this was associated with their response decision processes for ambiguous provocation vignettes. In turn, children with an instrumental goal orientation had less positive outcome expectancies for competent responses to ambiguous provocation and higher self-efficacy for hostile responses. They also found that children that were low in social acceptance and aggressive were more susceptible to the effects of the mood induction. This pattern of results suggests that discrete emotions are particularly important for the goal clarification step of SIP, and that children's goals may influence the subsequent SIP step of response decision (Harper et al., 2010). Taken

together, the results of above studies suggest a relation between the emotionality, SIP and aggression. More specifically, distorted SIP was found to be positively associated with emotionality and aggression (including both negative and, to a lower extent, positive emotions), and negatively with emotion understanding of others.

Emotion Regulation

Four studies investigated the role of emotion regulation in SIP processes. All four studies confirmed an association between emotion dysregulation and aggressive behavior (Calvete & Orue, 2012; Gagnon, McDuff, Daelman, & Fournier, 2015; Helmsen, Koglin, & Petermann, 2012; Orobio de Castro, Merk, Koops, Veerman, & Bosch, 2005). Furthermore, adaptive emotion regulation was also found to be negatively related to hostile attribution bias, individual's own anger, and aggressive-response generation and approval of aggressive behavior (Orobio de Castro et al., 2005). However, adaptive emotion regulation (e.g., problem solving, distraction, and cognitive strategies) did not moderate the relationship between hostile interpretation and aggressive behavior (Calvete & Orue, 2012; Helmsen et al., 2012). Adaptive emotion regulation was found to moderate the relationship between anger and reactive aggressive behavior (Calvete & Orue, 2012).

Gagnon et al. (2015) reported elevated levels of hostile attribution bias in participants high in negative urgency, which is defined as the inability to inhibit impellent behavioral reactions under the influence of negative emotions. They also found that this relationship was independent of trait aggression and participants' emotional state. Their results also indicated that negative urgency had a unique contribution to the indirect hostile attribution bias (e.g. someone wanted to feel me unimportant), after controlling for aggressiveness, negative emotions, and lack of perseveration. The results of Gagnon et al. (2015) suggest that individuals with high levels of negative urgency are more likely to interpret another person's intentions as hostile in a given situation, and to behave impulsively, which can be potentially

harmful to themselves or others. Taken together, these results suggest that in the context of SIP, emotion regulation strategies act to control emotions particularly when anger is experienced, thereby reducing the probability of aggressive acts. Also, an association seem to exist between emotion regulation and several SIP components.

Emotion in Others

Two studies investigated the effect of the emotions displayed by others. Lemerise, Gregory, and Fredstrom (2005) investigated the effect of the emotion displayed specifically by a provocateur. They found that hostile attributions of intent were more frequent in response to angry provocateurs, and children were friendlier to sad provocateurs than to either happy or angry ones. In addition, asking about the emotion displayed by the provocateur affected children's SIP. Specifically, asking about provocateurs' emotions had the effect of reducing hostile attributions about happy or sad (but not angry) provocateurs. No differences were found between socially rejected–aggressive, rejected–nonaggressive, average–nonaggressive, and popular–non-aggressive children regarding recall of social cues, emotion decoding accuracy, or attributions of intent. However, rejected-aggressive children's problem-solving responses were less friendly when they were not asked about the provocateurs' emotions. Furthermore, another study found that an adequate emotion understanding of others' emotions in general (not specifically related to a provocateur) was associated with reduced levels of the hostile attribution bias (Choe et al., 2013). The results, however, were unrelated to peer aggression. In sum, these studies showed that the emotion displayed by others affects SIP. It, however, did not have a clear association with aggression.

Gender Differences

Only two studies investigated gender differences in SIP-components, emotion, and aggressive behavior (Calvete & Orue, 2012; Wright, 2017). In general, these studies found that boys scored higher than girls on aggressive behavior and anger, but girls scored higher

than boys in sadness. This suggests that when they face the same type of negative situation, boys may tend to experience more anger, whereas girls may tend to experience more sadness (Calvete & Orue, 2012). Girls were also found to show more adaptive strategies of emotion regulation; specifically, they scored higher than boys in searching for solutions and employing cognitive strategies (Calvete & Orue, 2012). The authors suggest that these findings indicate that these gender differences in SIP components and emotion regulation contribute to the higher frequency of aggressive behavior among boys. Boys, indeed, scored higher on reactive as well as proactive aggression. Yet, their results showed that boys scored higher in reactive aggressive behavior partly because they experience more anger and use fewer adaptive strategies of emotion regulation (Calvete & Orue, 2012). In addition, the findings by Wright (2017) showed that girls reported that they generate more hostile and aggressor-blame attributions pertaining to ambiguous and hypothetical face-to-face situations when compared to boys. Wright (2017) also found that girls expected that they would make more self-blame attributions for both face-to-face and cyber situations when compared to boys. Taken together, the above studies suggest that there may be gender differences in the experience of emotions and their role in SIP, and that these differences may explain gender differences in aggressive tendencies and behaviors.

Discussion

The results of the present review suggest that emotion and emotion regulation play a role in SIP and that both may have a joint role in explaining aggressive behavior as well. According to Lemerise and Arsenio (2000), there are at least two reasons why someone's emotion and emotion regulation processes could interfere with SIP. First, state or trait emotionality may influence what is noticed about a social encounter, which in turn make the recollection of mood-congruent information more likely, or it may influenced the way a situation is interpreted. Second, individuals who experience strong emotions might be too

overwhelmed and too self-focused to generate a diversity of responses and to evaluate responses from all possible perspectives. The studies included in the present review investigated some of these associations, and some others as well.

One main cluster of findings from the present review has highlighted the role of both experiencing emotions and perceived distress associated with experiencing certain emotions as factors influencing SIP and in turn increasing the risk for aggressive responses (see Figure 3D). Notably, it appeared that focusing on discrete emotions rather than on emotionality overall may help delineate a more nuanced picture for the role of emotions in SIP. In particular, if broadly speaking negative emotional responses are related to hostile attribution bias, different emotional experiences may explain the distinct behavioral reactions that may occur. For instance, sadness and anger might facilitate internalizing and externalizing responses, respectively. In addition, anger and embarrassment might activate different types of aggressive responses, such as physical and relational aggression, respectively.

Gender differences in the trait disposition to experience these emotions may in turn help understand the well replicated gender differences in aggression. If men are more likely to respond with anger rather than sadness (and *vice versa* for women), it is not surprising that men would then endorse externalizing reactions more often than women, who in contrast tend to show more internalizing symptoms. Finally, it is worth emphasizing that, while negative emotions are the most frequently described to interfere with adequate SIP, several studies highlight that also positive emotions may similarly alter proper SIP and generate aggressive responses. Interestingly, considering not only discrete negative emotions, but also positive emotions, may help explain both reactive and proactive forms of aggression based on interacting emotional and cognitive processes (Aragón, Clark, Dyer, & Bargh, 2015; Howard, 2009).

Lemerise and Arsenio (2000) also suggested that there is a necessity to encode and interpret others' affective signals. Others' affective signals, in combination with one's own emotional state, provide ongoing information about how social encounters proceed, which in turn helps us select the most appropriate response. The current findings seem to provide some preliminary evidence that perceiving anger in others (e.g., in a provocateur) increased distorted SIP. Actively asking about the provocateurs' emotion reduced hostile attributions and reduced aggressive responses when sad or happy was displayed (Lemerise et al., 2005). This may indicate that a conscious reflection may reduce distorted SIP and aggression. However, it is important to note that only one study investigated this mechanism but did not assess a possible mediating/moderating effect in predicting aggressive behavior. As the association between distorted SIP (i.e. hostility biases) and aggressive behavior is thought to be robust (for review see, (De Castro, Veerman, Koops, Bosch, & Monshouwer, 2002; Smeijers, Bulten, & Brazil, Resubmitted; Tuente, Bogaerts, & Veling, 2019) it is of importance to elucidate the direction of the three-way association between distorted SIP, emotional understanding, and aggression. Overall, it appears that emotional understanding may facilitate the SIP (see Figure 2A) stage of selecting appropriate responses to contextual demands; yet, if an individual has difficulty in understanding other's affective states, this could lead to a selection of maladaptive responses, in line with a long tradition of studies on the concepts of metacognition or mentalization (Fonagy, 2003; Garofalo, Velotti, & Zavattini, 2018).

Another cluster of findings from the present systematic review concerns the role of emotion regulation in the SIP stages responsible for interpretation of social cues, response generation, and enactment of aggressive responses. If difficulties in emotion regulation have increasingly been linked to aggression (Garofalo et al., 2018), their role in the interpretation of social cues and response generation has received comparatively less attention. Some of the

studies reviewed here suggested that feeling overwhelmed by emotions and having difficulties engaging in adaptive emotion regulation strategies, could also have an impact on earlier stages of SIP (see Figure 1), hence contributing to aggressive responses not only as a proximal risk factor (e.g., inability to inhibit behavior under strong emotional arousal, or urgency), but also indirectly as a distal risk factor.

Overall, the studies reviewed here tentatively suggest that emotional experiences, emotional understanding, emotion recognition, and emotion regulation may have distinct influences at different stages of SIP, all having direct or indirect relations to aggressive responses (see Figure 3). However, it is unlikely that any of these effects work in isolation. Although none of the studies reviewed tested interaction effects, it is very much likely that emotional experiences and emotion regulation skills have joint effects on distinct phases of SIP (e.g., Garofalo & Velotti, 2017), perhaps with emotional experiences being more prominent at earlier stages, and emotion regulation skills becoming more important in subsequent stages. In addition, emotions and emotion regulation may also act as moderators (Figure 3A) that facilitates an existing tendency to process social information inaccurately (Smeijers et al., Resubmitted) However, due to the nature of the included studies, no firm conclusions can be drawn about the direction of the relationship between emotion, SIP, and aggression.

In increasing the understanding of the role of emotion in SIP, future research should also be focused more on heterogeneous populations. The references included in the current review mainly focused on SIP in children from the general population. Due to this relative over-focus on children, it remains unclear how distorted SIP and its' association with aggression develops over age and what is the role of emotionality in their association. Together with recent systematic reviews (Smeijers et al., Resubmitted; Tuente et al., 2019), the current results highlight the necessity of longitudinal studies. The information that will be provided

by such studies should also be used to revise the current theoretical frameworks to make it applicable to children, adolescents, and adults as well.

Moreover, in reviewing the existing literature, it was surprising that the majority of the references screened did not focus on the integration of cognition and emotion in the understanding of SIP in aggression. This was already observed in a systematic review 11 years ago (Fontaine, 2008) and did not change within this period. Focusing exclusively on cognitive or emotional functioning will inevitably provide a partial explanation for aggressive behavior. Moreover, if studies did focus on the integration between SIP and emotion, they often did not assess the association with aggression. The few studies included in the current review that did focus on this three-way association were correlational in nature. Consequently, it is only known that emotionality plays a role in distorted SIP in aggressive individuals. The exact mechanism behind distorted SIP in aggression, including the role of emotion, however is currently unknown (Smeijers et al., Resubmitted). This is partly due to the fact that previous models to explain the role of SIP deficits in aggression were influential but descriptive. Therefore, recent novel insights (e.g. computational psychiatry; Stephan & Mathys, 2014) should now also be used to formulate explanatory models, by quantifying the latent cognitive processes underlying aggression (e.g., Brazil, van Dongen, Maes, Mars, & Baskin-Sommers, 2018; Smeijers et al., Resubmitted; Wiecki, Poland, & Frank, 2015). Understanding the mechanistic underpinnings of distorted SIP in aggression should be a prerequisite for enhancing our understanding of the development, maintenance, and treatment of aggressive behavior.

Overall, the characteristics of the studies included in the present review highlights an over-representation of studies conducted in children, in healthy samples, and mostly focused on the initial or final stages of SIP (as opposed to its central phases). For the SIP to be an influential model to understand and prevent aggression, more studies seem needed in different

populations and tapping on the whole SIP process. Moreover, in the present review we introduced several possible relationships between emotion, SIP, and aggression. It is important to note that the different relationships are not necessarily mutually exclusive. Additionally, considering the limited number of studies, other relationships should not be excluded. Taken together, the current results highlight the necessity for future research to understand the exact underlying SIP mechanism through which aggression emerges.

References

Asterisks (*) indicate studies included in the systematic review.

Aragón, O. R., Clark, M. S., Dyer, R. L., & Bargh, J. A. (2015). Dimorphous expressions of positive emotion: Displays of both care and aggression in response to cute stimuli. *Psychol Sci, 26*(3), 259-273. doi:10.1177/0956797614561044

Brännström, L., Kaunitz, C., Andershed, A.-K., South, S., & Smedslund, G. (2016). Aggression replacement training (ART) for reducing antisocial behavior in adolescents and adults: A systematic review. *Aggression and Violent Behavior, 27*, 30-41. doi:10.1016/j.avb.2016.02.006

Brazil, I. A., van Dongen, J. D., Maes, J. H., Mars, R., & Baskin-Sommers, A. R. (2018). Classification and treatment of antisocial individuals: From behavior to biocognition. *Neuroscience & Biobehavioral Reviews, 91*, 259-277. doi:10.1016/j.neubiorev.2016.10.010

* Calvete, E., & Orue, I. (2012). The role of emotion regulation in the predictive association between social information processing and aggressive behavior in adolescents. *International Journal of Behavioral Development, 36*(5), 338-347. doi:10.1177/0165025412444079

* Chen, P., Coccaro, E. F., & Jacobson, K. C. (2012). Hostile attributional bias, negative emotional responding, and aggression in adults: moderating effects of gender and impulsivity. *Aggress Behav, 38*(1), 47-63. doi:10.1002/ab.21407

* Choe, D. E., Lane, J. D., Grabell, A. S., & Olson, S. L. (2013). Developmental precursors of young school-age children's hostile attribution bias. *Developmental Psychology, 49*(12), 2245. doi:10.1037/a0032293

Crick, N. R., & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological bulletin, 115*(1), 74. doi:10.1037/0033-2909.115.1.74

Eisenberg, N., & Fabes, R. A. (1992). Emotion, regulation, and the development of social competence. In M. S. Clark (Ed.), *Review of personality and social psychology* (Vol. 14, pp. 119-150). Thousand Oaks, CA, US: Sage Publications, Inc.

Fonagy, P. (2003). Towards a developmental understanding of violence. *The British Journal of Psychiatry, 183*(3), 190-192. doi:10.1192/bjp.183.3.190

Fontaine, R. G. (2008). On-line social decision making and antisocial behavior: Some essential but neglected issues. *Clin Psychol Rev, 28*(1), 17-35. doi:10.1016/j.cpr.2007.09.004

* Gagnon, J., McDuff, P., Daelman, S., & Fournier, S. (2015). Is hostile attributional bias associated with negative urgency and impulsive behaviors? A social-cognitive conceptualization of impulsivity. *Personality and Individual Differences, 72*, 18-23. doi:10.1016/j.paid.2014.08.011

Garofalo, C., & Velotti, P. (2017). Negative emotionality and aggression in violent offenders: The moderating role of emotion dysregulation. *Journal of Criminal Justice, 51*, 9-16. doi:10.1016/j.jcrimjus.2017.05.015

Garofalo, C., Velotti, P., & Zavattini, G. C. (2018). Emotion regulation and aggression: The incremental contribution of alexithymia, impulsivity, and emotion dysregulation facets. *Psychology of Violence, 8*(4), 470-483. doi:10.1037/vio0000141

* Harper, B. D., Lemerise, E. A., & Caverly, S. L. (2010). The effect of induced mood on children's social information processing: Goal clarification and response decision. *Journal of Abnormal Child Psychology, 38*(5), 575-586. doi:10.1007/s10802-009-9356-7

* Helmsen, J., Koglin, U., & Petermann, F. (2012). Emotion regulation and aggressive behavior in preschoolers: The mediating role of social information processing. *Child Psychiatry & Human Development, 43*(1), 87-101. doi:10.1007/s10578-011-0252-3

Holley, S. R., Ewing, S. T., Stiver, J. T., & Bloch, L. (2017). The Relationship Between Emotion Regulation, Executive Functioning, and Aggressive Behaviors. *J Interpers Violence, 32*(11), 1692-1707. doi:10.1177/0886260515592619

Howard, R. (2009). The neurobiology of affective dyscontrol: Implications for understanding 'dangerous and severe personality disorder'. In M. McMurran & R. Howard (Eds.), *Personality, personality disorder and violence: An evidence based approach* (pp. 157-174). Chichester: John Wiley & Sons.

* Laible, D. J., Murphy, T. P., & Augustine, M. (2014). Adolescents' aggressive and prosocial behaviors: Links with social information processing, negative emotionality, moral affect, and moral cognition. *The Journal of genetic psychology, 175*(3), 270-286. doi:10.1080/00221325.2014.885878

Lemerise, E. A., & Arsenio, W. F. (2000). An integrated model of emotion processes and cognition in social information processing. *Child development, 71*(1), 107-118. doi:10.1111/1467-8624.00124

* Lemerise, E. A., Gregory, D. S., & Fredstrom, B. K. (2005). The influence of provocateurs' emotion displays on the social information processing of children varying in social adjustment and age. *Journal of experimental child psychology, 90*(4), 344-366. doi:10.1016/j.jecp.2004.12.003

* Mathieson, L. C., Murray-Close, D., Crick, N. R., Woods, K. E., Zimmer-Gembeck, M., Geiger, T. C., & Morales, J. R. (2011). Hostile intent attributions and relational aggression: The moderating roles of emotional sensitivity, gender, and victimization. *Journal of Abnormal Child Psychology, 39*(7), 977. doi:10.1007/s10802-011-9515-5

Orobio de Castro, B. O., Veerman, J. W., Koops, W., Bosch, J. D., & Monshouwer, H. J. (2002). Hostile attribution of intent and aggressive behavior: A meta-analysis. *Child development, 73*(3), 916-934. doi:0.1111/1467-8624.00447

* Orobio de Castro, B., Slot, N. W., Bosch, J. D., Koops, W., & Veerman, J. W. (2003). Negative feelings exacerbate hostile attributions of intent in highly aggressive boys. *Journal of Clinical Child and Adolescent Psychology, 32*(1), 56-65.

* Orobio de Castro, B., Merk, W., Koops, W., Veerman, J. W., & Bosch, J. D. (2005). Emotions in social information processing and their relations with reactive and proactive aggression in referred aggressive boys. *Journal of Clinical Child and Adolescent Psychology, 34*(1), 105-116. doi:10.1207/s15374424jccp3401_10

* Orobio de Castro, B. O., Verhulp, E. E., & Runions, K. (2012). Rage and revenge: Highly aggressive boys' explanations for their responses to ambiguous provocation. *European Journal of Developmental Psychology, 9*(3), 331-350. doi:10.1080/17405629.2012.680304

Roberton, T., Daffern, M., & Bucks, R. S. (2012). Emotion regulation and aggression. *Aggression and Violent Behavior, 17*(1), 72-82. doi:doi.org/10.1016/j.avb.2011.09.006

Smeijers, D., Bulten, B. H., & Brazil, I. A. (Resubmitted). Computations of Hostile Biases (CHB) model; Grounding hostility biases in a unified neuroscientific framework. *Clinical Psychological Review*.

Stephan, K. E., & Mathys, C. (2014). Computational approaches to psychiatry. *Current opinion in neurobiology, 25*, 85-92. doi:10.1016/j.conb.2013.12.007

Tuente, S. K., Bogaerts, S., & Veling, W. (2019). Hostile attribution bias and aggression in adults-a systematic review. *Aggression and Violent Behavior*. doi:10.1016/j.avb.2019.01.009

Wiecki, T. V., Poland, J., & Frank, M. J. (2015). Model-based cognitive neuroscience approaches to computational psychiatry: clustering and classification. *Clinical Psychological Science, 3*(3), 378-399. doi:10.1177/2167702614565359

* Wright, M. F. (2017). Adolescents' emotional distress and attributions for face-to-face and cyber victimization: longitudinal linkages to later aggression. *Journal of Applied Developmental Psychology, 48*, 1-13. doi:10.1016/j.appdev.2016.11.002

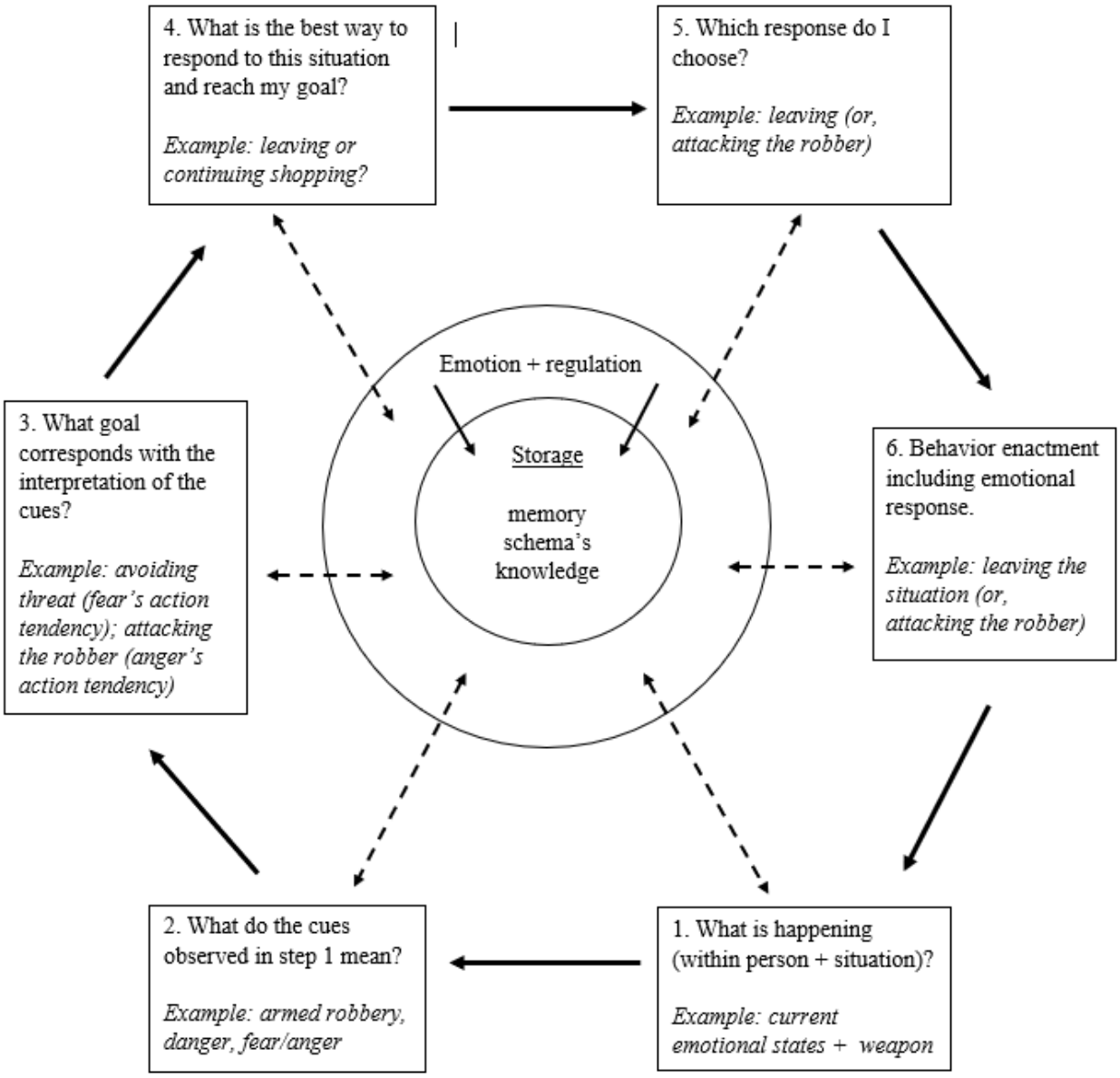


Figure 1. A graphical depiction of the SIP model's steps integrated with potential role of emotion processes as proposed by Lemerise and Arsenio (2000).

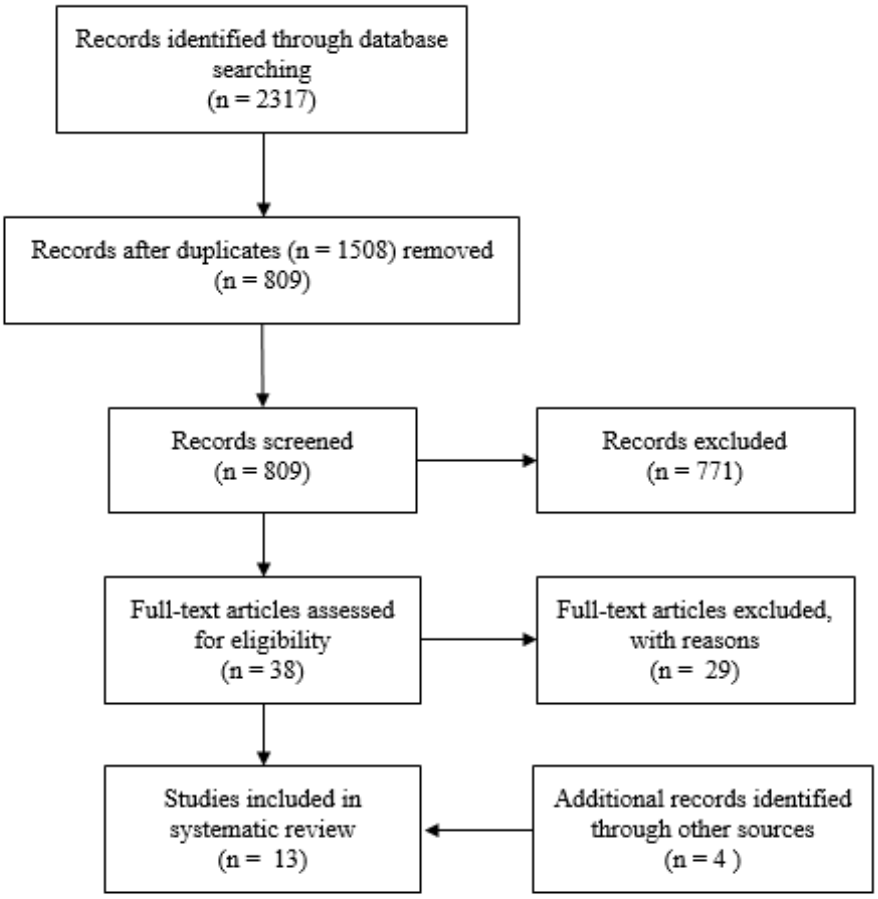
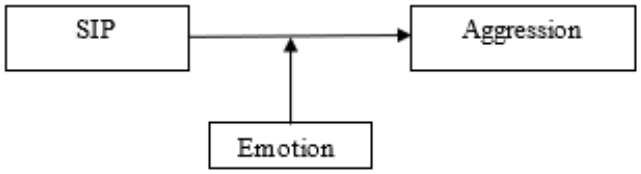


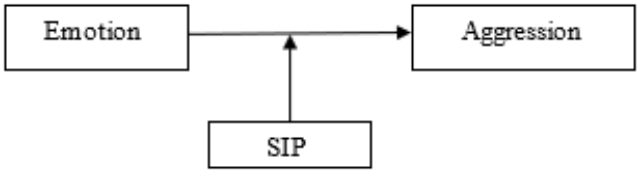
Figure 2. Flowchart of the systematic review study selection process (adapted from Moher et al., 2009).

Table 1. *Overview included studies*

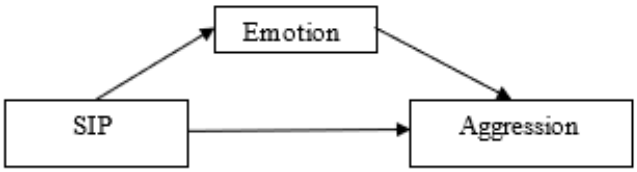
Author	Which emotion part	SIP step	SIP measure	Population	Country	N
Calvete et al. (2012)	Emotion regulation + emotion attribution	Encoding, interpretation, enactment	Vignettes, written	General population, adolescents	Spain	1125
Chen et al. (2012)	Negative emotional responding	Encoding, interpretation, enactment	Vignettes, written	General population, adults	USA	2749
Choe et al. (2013)	Emotion in others	Encoding, interpretation	Vignettes, written	General population, children	USA	231
Gagnon et al. (2015)	Negative urgency	Encoding, interpretation	Vignettes, written	General population, undergraduate students	Canada	170
Harper et al. (2010)	Induced mood	Encoding, interpretation, goal clarification, response decision	Vignettes, drawing	General population, children	USA	480
Helmsen et al. (2012)	Emotion regulation	Encoding, interpretation, enactment	Vignettes, drawing	General population, children	Germany	193
Laible et al. (2014)	Emotionality + moral affect	Encoding, interpretation	Vignettes, written	General population, adolescents	USA	148
Lemerise et al. (2005)	Emotion in others	Encoding, interpretation, enactment	Vignettes, video	General population, children	USA	626
Mathieson et al. (2011)	Emotional sensitivity	Encoding, interpretation, enactment	Vignettes, written	General population, children	USA	635
Orobio de Castro et al. (2012)	Emotionality	Response construction, response selection	Vignettes, written	General population, children + referred aggressive children	The Netherlands	82
Orobio de Castro et al. (2005)	Emotion regulation + emotion attribution	Encoding, interpretation, enactment	Vignettes, audio	General population, children + referred aggressive children	The Netherlands	84
Orobio de Castro et al. (2003)	Mood induction	Encoding, interpretation	Vignettes, audio	Highly, moderate and non-aggressive children	The Netherlands	57
Wright (2017)	Emotional distress	Encoding, interpretation	Vignettes, written	General population, adolescents	Czech Republic	853



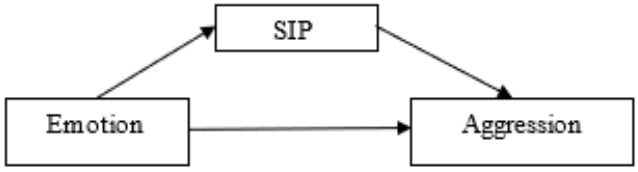
A. Emotion as a moderator between SIP and Aggression



B. SIP as a moderator between Emotion and Aggression



C. Emotion as a mediator between SIP and Aggression



D. SIP as a mediator between Emotion and Aggression

Figure 3. Main Conceptual Models of SIP-Emotion-Aggression Relationship.

Note: SIP = Social Information Processing; Models C and D accept direct and indirect effects of the main predictor; Models C and D do not exclude possible moderators (e.g., gender).