



## Article

# Social Information-Processing in Children with Adverse Experiences

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**Abstract:** The concept of childhood adversity has been highlighted in the literature, given its relevance and impact on child development. According to the adaptation-based approach, children who develop in adverse environments adapt cognitively and behaviorally to them. The purpose of this study was to investigate possible relationships between adverse experiences and social information processes of threat detection behaviors and hostile attribution bias, in school-aged children. To this end, a non-probabilistic sample of 67 children from 7 to 10 years of age was constituted. We developed three instruments to assess: (1) adverse experiences, (2) threat detection behaviors, and (3) hostile attribution bias. Results reveal that adverse experiences are significantly correlated with and predict threat detection behaviors. However, children with more adverse experiences do not demonstrate a higher hostile attribution bias. This study contributes to the knowledge about how adverse experiences are related to children's social information-processing and functioning, which can have implications for the elaboration of intervention programs.

**Keywords:** threat detection; inhibitory control of threat; hostile attribution bias; face in the crowd effect; adaptation-based



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## 1. Introduction

In the last two decades, the concept of childhood adversity has catalyzed the development of a significant body of research. Aiming at explaining, predicting, and preventing children's developmental difficulties and poor long-term outcomes, based on the knowledge about stressful early life experiences and their biological embedding mechanisms, has proven to be a productive line of research.

The concept of childhood adversity encompasses a variety of situations and events. According to Felitti's seminal work, childhood adversity refers to the exposure, during childhood, to specific types of negative events, involving child maltreatment and household dysfunction [1]. Nevertheless, research has broadened the scope of this concept, including highly stressful life circumstances, of individuals and families, throughout the course of life, as well as the characteristics of their communities [2]. Factors derived from social inequality, and those associated with poverty, were also considered as contextual dimensions.

On the other hand, the operationalization of childhood adversity, first understood as the sum of different types of adversity, the frequency of episodes, or the severity of abuse, started to take into account other relevant dimensions of the phenomena: the duration of adversity, the individual's developmental status, the timing of adverse events or circumstances, the interaction among adversities, risk, protective factors, and pre-existing vulnerabilities [3]. However, given the complexity of the concept of childhood adversity, its rigorous assessment remains a pending issue. Therefore, proxies for adversity such as poverty are often used, especially in biological/neuroscientific research, but a need for more detailed knowledge is recognized [2].

The dominant literature about children from adverse environments is largely based on the deficit model, which states that these children have deficits in several domains, because of genetic and/or environmental factors, that shape their neuroanatomical development and neuronal responses [4–6]. Therefore, these children, many times maltreated and/or poor, exhibit deficits in emotion recognition, language, problem solving, general intelligence and memory capacities, among others [4,7–10]. Additionally, these deficits are frequently associated with academic failure and [4] risk-taking behaviors, such as delinquency and aggressive behaviors [11,12]. Concepts such as cumulative risk [13], toxic stress [14], and allostatic load [15] are rooted in this model [11].

However, the common observation that the outcomes of children exposed to adverse conditions vary considerably, and poor outcomes are not inevitable, stimulated the development of research, based on the resilience approach, that focuses on the processes that make possible a positive adaptation, despite adversity [16]. Typically, theories of resilience adopt a strength-based approach [11], which underlies the bio-social-ecological model. It aims to explain how protective factors—individual and social factors, and relationships—operate to counteract, moderate, or reduce risk factors [17], thus safeguarding individuals from the damaging impact of adverse experiences [2].

Typically, the most common strength-based approaches to resilience tend to focus on the mechanisms by which individuals seek to preserve their functioning, when subjected to highly challenging environments. Otherwise, the evolutionary-developmental models [11] propose focusing on the specific adaptations individuals make, in order to function in these environments throughout their life cycles [11]. The adaptation-based approach stems from a psychological evolutionary-developmental perspective, which defends the position that children who develop in adverse environments adapt cognitively and behaviorally to them [11]. In accordance with this perspective, adverse environments can be characterized as harsh, with high rates of mortality and morbidity (e.g., living in a neighborhood with high crime rates, being a victim of abuse, poverty, etc.), and/or unpredictable, which refers to the lack of knowledge about the possible outcomes for a given situation (e.g., the threat of mistreatment for a victim of violence) or to the uncertainty about the future, that is, the results over time (e.g., how many times one's housing situation will change due to financial difficulties) [19].

The adaptation-based approach is based on the specialization and sensitization hypothesis. The first refers to the development of skills specialized and relevant for adverse environments. The second assumes that these characteristics manifest mainly when individuals are in contexts similar to those in which they acquired them (e.g., stress circumstances) [11]. Thus, not only are these characteristics adapted to that environment (i.e., are relevant), but they are sensitive to it. Associated to this approach is the concept of biological fitness, which argues that these skills are adaptive in the sense that they prioritize the individual's survival and reproduction in that environment, in detriment of their well-being and mental health, as happened with our ancestors [19].

Research findings have supported the adaptation-based approach by demonstrating that individuals with adverse experiences perform better in tasks that demand relevant cognitive skills (e.g., switching between tasks), and worse in tasks that do not (e.g., inhibition capacity), when compared to individuals with fewer of these experiences [20]. While the capacity to shift is relevant for individuals that develop in unpredictable environments, due to the necessity to adapt to different situations, the capacity for inhibition is not, since this can interfere with their need to take advantage of immediate gains [21]. Thus, the enhanced capacity to shift developed to the detriment of the capacity to inhibit. This suggests that the deficit model is not incorrect, but incomplete, as the development of ecologically relevant characteristics for children from adverse environments is missing. Among these enhanced capacities are emotional [22] and procedural [23] learning, empathic accuracy [24], problem solving (e.g., reward oriented) [10], deceit detection [25,26], memory (e.g., for negative events), and cognitive speed and accuracy, among others [11].

Research in the field of social information-processing [27] has also focused on the discrepancies between children with and without adverse experiences [28,29], demonstrating that: (1) abused children differ from non-abused children in terms of threat detection [29], and that (2) children who exhibit aggressive behaviors differ from those who do not in terms of hostile attribution bias [30].

In this article, we intend to explore the cognitive processes of threat detection and hostile attribution bias in school-aged children, including foster children, given their life trajectories marked by harsh circumstances and stressful life events.

### *1.1. Threat Detection Behaviors*

The ability to identify threatening stimuli has been extensively studied in connection to the individual's caregiving experiences. Research findings show that exposure to early adverse experiences, including child maltreatment, enhances the perceptual sensitivity to negative emotions, lowering the threshold for threat detection [31]. Abused children not only have shorter reaction times when detecting threatening expressions (e.g., of fear) compared to children without abuse experiences [32], but they also show greater accuracy in the identification of threat (e.g., of anger) [5,28,33]. This neurodevelopmental mechanism of improved capacity of threat detection could have a protective function [32], as quickly identifying imminent threat would allow for a quick and adequate response, which would enhance their chance for survival. However, chronic hyperactivation of vigilance to threats is associated with higher risk levels for the development of anxiety disorders [33] and aggressive behaviors, transforming the adaptive into the maladaptive in normal social contexts [5] and increasing the risk for psychopathology. As such, better understanding the capacity of threat detection in children from adverse environments is crucial for the optimization of future interventions.

Threat detection is usually assessed through facial recognition of expressions of fear [32] or anger [28], as both may indicate imminent threat (i.e., direct threat with angry faces and threat in the environment with frightened faces) [34]. The development of facial emotion recognition is continuous, with no differences in terms of accuracy from 7 to 10 years of age [35]. The recognition of happiness seems to appear first in development, followed by the recognition of sadness, anger, and, later, expressions of surprise and fear [36]. Another form of threat detection behavior is inhibitory control of threat—i.e., the capacity to inhibit or ignore threatening stimuli [37]. This can be measured through the face in the crowd effect (FICE), where a matrix, composed of threatening distractor faces and a non-threatening target face, is presented [38].

### *1.2. Hostile Attribution Bias*

Hostile attribution bias is defined as the attribution of malicious intent to an agent who performs an ambiguous provocation (i.e., it is not clear whether the provocation was intentional or accidental). Dodge (2006) postulates that the greater tendency to attribute malicious intent to a hypothetical provocateur in an ambiguous situation happens when there is a failure to learn benign attribution (prosocial intention or accidental provocation), after four years of age. This failure can happen due to trauma, insecure attachment, modeling, or neuroanatomic differences [28]. Research has also provided evidence of the association between child maltreatment and hostile attributional bias via initial mental representations of self, others, and relationships developed within the context of parent-child relationships [39].

Following these lines of research, the literature has not yet clarified (1) if children's adverse experiences are associated to higher threat detection and inhibitory control of threat (i.e., threat detection behaviors), nor (2) if the experiences of adversity in childhood are associated with higher hostile attribution bias. In addition, research that supports the adaptive approach is mostly conducted with samples of adult individuals [20,26].

### 1.3. Current Study

Given the gaps of knowledge found in the literature, this study aims at understanding if adverse experiences are associated to the performance of children in instruments of (1) threat detection, (2) inhibitory control of threat, and (3) hostile attribution bias. Furthermore, the goal is to ascertain whether performance in these instruments is predicted by adverse experiences. Based on the literature and the specialization hypothesis, we expect that for the first aim, (H1) adverse experiences are associated with and predict better performance in the threat detection instrument. For the second aim, (H2) adverse experiences are associated with and predict better performance in the inhibitory control of threat instruments. Finally, for the third aim, (H3) adverse experiences are associated with and predict a higher hostile attribution bias. The variables listed above were operationalized as follows: “performance in the threat detection instrument” was assessed through accuracy in the identification of threatening target faces and “performance in the inhibitory control of threat instrument” was assessed through accuracy in the identification of target faces with another emotional expression within a crowd of threatening distractor faces.

## 2. Materials and Methods

### 2.1. Participants

The present study consisted of a purposive sample of 67 Portuguese children (32 female, 35 male), 7 to 10 years of age ( $M = 8.37$ ,  $SD = 0.97$ ), Caucasian, and who attended the 2nd, 3rd, or 4th year of schooling ( $M = 3.01$ ,  $SD = 0.84$ ). These children were selected from foster homes ( $N = 24$ ) in northern Portugal, and from a community sample in Porto (i.e., study centers and a convenience sample). The basis for selecting this sample criteria was the expectation of finding more adverse experiences in children from foster homes than in children from the community, which was confirmed, using Mann–Whitney tests,  $p < 0.001$ . Because children’s intellectual level could affect the variables here studied, we established as an exclusion criterion the presence of cognitive deficit [32].

### 2.2. Materials

For the purpose of this study, four instruments were developed. Of these, two are questionnaires that assess sociodemographic issues and adverse experiences of children, and two are instruments that assess threat detection behaviors (i.e., threat detection and inhibitory control of threat) and hostile attribution bias through visual material and vignettes, respectively.

The Sociodemographic Questionnaire asks about the age, education, socioeconomic level (low = level A support; medium-low = level B support; medium-high = level C support; high = no support), nationality, and institution of the child (i.e., to identify if the child was recruited from a foster home or the community).

The Adverse Experiences Questionnaire assessed children’s adverse experiences and was measured through 10 items. It had a Cronbach’s alpha of 0.60 with the current sample. These items are based on the “Neighborhood Violence Scale” [26] and the short version of the “Adverse Childhood Experiences Questionnaire” (ACE) [1], validated for young people from 13 to 24 years of age and adapted to the Portuguese population [40]. Previous studies report good internal consistency (e.g., Cronbach’s alpha of 0.85) [41] for this measure. These questions were intended to assess: (1) adversity in the neighborhood (“The place where you live has robberies, violence or fights?”); (2) emotional and physical abuse (“Has an adult ever called you mean names, treated you badly or was violent towards you?”); (3) bullying (“Was a child ever mean to you or violent towards you?”); (4) emotional neglect (“Does your family care about you and like you?”); (5) physical neglect (“Have you ever gone to bed hungry because you didn’t have food at home, or go to school feeling very cold or very hot because you didn’t have winter clothes or summer clothes?”); (6) separation or divorce (“Have your parents ever separated or divorced?”); (7) interparental violence (“At home, is there often a lot of fights or violence among adults?”); (8) family socioeconomic level (indirectly assessed through the level of social support, measured in the sociodemographic

questionnaire); (9) mortality and morbidity in the environment (“Have you ever had a person who you liked very much or who you knew become very ill or die?”); (10) own morbidity (“And you, have you ever had or do you have a serious illness?”). The inclusion of these items was based on the questions from ACE that would be adequate to ask a young child and were adapted to be more accessible in language. Items that address adversity in the neighborhood were also sought to be included, through the inclusion of items from the “Neighborhood Violence Scale” [26]. The items were answered using a 4-point Likert scale, regarding the frequency (“1—never”, “4—always”) in items 1, 2, 3, 5, and 7, and intensity (“1—very little”, “4—very much”) in item 4. Items 6, 9, and 10 had a dichotomous answer (“yes”/“no”). In items 9 and 10, the answer “yes” was followed by a question about the number of deaths and serious illnesses. The scoring of items 1, 2, 3, 4, 5, 7, and 8 varied from 0 to 3. The scoring of item 6 was 0 (if the answer was “no”) or 3 (if the answer was “yes”). The scoring of items 9 and 10 was based on the number of deaths or illnesses (e.g., 1 time severely ill or 1 person who died = 1 in score) and considered the higher severity of specific situations for the child (i.e., if the child’s life was at risk during said illness, then another point was added to the score; if the person who died was the child’s mother and/or father, another two points were added to the score). The judgment in scoring was made according to the authors’ clinical experience with children at risk. The total scoring varied from 0 to 36.

Threat Detection Behavior Instruments assessed threat detection and inhibitory control of threat through the face in the crowd effect procedure. For this purpose, NIMH-ChEFS [42] was used, a database of 482 photographs, validated for adults and adolescents, of 52 different children, mostly Caucasian, presenting facial expressions that translate emotions of fear, sadness, happiness, anger, and neutrality. Of these, 16 sets of photographs were selected (i.e., 16 matrixes consisting of 9 photographs each) according to the method adopted in LoBue’s (2009) study to evaluate the face in the crowd effect [43]. Each set contained a similar number of male and female faces, and the position of the 9 photographs for each set was randomized, as was the set’s order of presentation. Of these 16 sets of photographs, (1) 4 assessed threat detection (i.e., each set contained 1 target photograph with a threatening face—angry—and 8 distractor photographs with neutral or happy faces), and (2) 4 assessed inhibitory control of threat (i.e., each set contained 8 distractor photographs with threatening faces—angry—and 1 photograph with a neutral or happy target face) (see Figure 1). The remaining 8 sets were not subject to analysis as they did not have target photographs (i.e., each set contained 9 photographs in which all faces had the same emotional expression—i.e., happiness, neutral, anger, or fear). For threat detection, the sets mentioned in (1) were scored one point when the target face was identified correctly, and scored zero points otherwise (i.e., if the participant said that all photographs had the same emotional expression or identified an incorrect target photograph). For inhibitory control of threat, the sets mentioned in (2) were scored zero points if the participant said that all photographs had the same emotional expression, and scored one point otherwise (i.e., if the participant identified a target face, whether it was correct or incorrect). Thus, a higher score reflected higher threat detection and inhibitory control of threat, varying from zero to eight in total scoring. The instrument initiated with 2 training sets in order to clarify any remaining doubts and to ensure instrument understanding. All photographs were presented on a laptop with a 2.6 GHz Intel i5 processor and a 13-inch screen with a 2560 × 1600 resolution, while the questions and answers were asked orally. The photographs on the first instrument were 4.5 cm (width) × 6.9 cm (height).

Hostile Attribution Bias Instrument assessed hostile attribution bias and consisted of 10 vignettes, two taken and translated from previous studies [44,45] and eight elaborated for the purposes of this study, due to the lack of available vignettes from previous studies. For the elaboration of these vignettes and for these to contain situations that are relevant for school-age children, a focus group was held with 7 students from the 3rd and 4th grades (2 girls and 5 boys). The focus group was asked to report stories in which a colleague did something they did not like in order to gather real situations that could be interpreted

by children as being maliciously provoked. The final 10 vignettes describe hypothetical situations, in which one child is ambiguously provoked by another, as exemplified in the following vignette: "Imagine: you and your classmates are in physical education class. In the middle of class, the teacher decides to play a football game. During the game you manage to catch the ball and start running towards the opposing team's goal. When you reach the middle of the field, a classmate from the other team comes running towards you. Upon reaching you he tries to take the ball from you, but in doing so he gives you a big kick in the legs". At the end of each vignette, two questions were asked: (1) "Why did the provocateur act that way" (direct measure of the hostile attribution bias), and (2) "Do you think your colleague was trying to be mean to you" (indirect measure of hostile attribution bias), as done in previous studies [45,46]. The first question was answered by choosing one of four different options, two of which reflect a benign intention (e.g., "he lost control of his foot because the grass was slippery", "because when he tried to hit the ball, he made a mistake and hit my legs") and the other two a hostile intention (e.g., "so that I would give him the ball and lose the game", "because he was annoyed at not being able to take the ball away from me, so he decided to hurt me"). For the categorization of these four options into benign or hostile intention, an inter-judge agreement was made. This was conducted with 13 judges (1 male, 12 female), from 22 to 27 years of age, attending higher education, and obtained an excellent degree of inter-judge agreement ( $k = 0.91$ ) [47]. The second question was answered using a 4-point likert scale regarding the level of malice in the provocateur's intention. For the direct measure of hostile attribution bias, one point was scored when a hostile option was chosen as an answer for the first question and zero points were scored when a benign option was chosen for the same question. The total scoring of the direct measure was the sum of points, ranging from zero to ten. For the indirect measure, in which each item score ranged from zero (1-Likert) to three (4-point Likert), an average score was calculated (i.e., sum of points divided by the number of items). The total scoring of the indirect measure ranged from zero to three. Hostile attribution bias was measured through the combination of the direct and indirect measure, with a minimum score of 0 and a maximum score of 13. Thus, higher scores indicate higher hostile attribution bias. From the set of 10 vignettes, five contain instrumental provocations (i.e., the provocateur causes physical or material damage to the other child) and the rest are relational provocations (i.e., the provocateur damages the other child's interpersonal relationships, such as his/her reputation). An equivalent number of instrumental and relational vignettes were developed to control for gender effects, where hostile attribution bias tends to score higher in relational provocations for female children, and higher in instrumental provocations for male children [46]. For the categorization of the 10 vignettes into instrumental or relational provocations, an inter-judge agreement was also made with the same judges previously described, obtaining a good degree of agreement ( $k = 0.75$ ) [47].

Because all instruments mentioned above were built for the purpose of this study, a pilot study was conducted with 6 children (5 male, 1 female) from the 1st, 4th, 5th, 6th, and 7th year of schooling and from 7 to 12 years of age ( $M = 9.33$ ;  $SD = 1.86$ ) in order to pre-validate them. During this study, the photographs of the NIMH-ChEFS database were also pre-validated. For this, 20 photographs, 4 of each emotion, were randomly selected and presented to the 6 children of the pilot study. The children were asked to identify the emotion that corresponded to the photo's facial expression. The great majority of these were identified correctly. As such, we proceeded with the use of this database. In addition, during the course of this study, some instruments were adjusted according to the difficulties encountered. A few instructions and items were altered in order to be better understood by the children (e.g., training sets were added to the threat detection instrument). After implementing the experiment with three children, the above-mentioned alterations were made, and the instruments were applied again with the remaining three children. During this second implementation, the participants did not reveal difficulties in understanding the instructions or questions.



**Figure 1.** Masked example of two sets of photographs, from the Threat Detection Behavior Instruments, where: (a) assesses threat detection, through a matrix composed of one target photograph—angry face—and eight distractor photographs—happy faces; and (b) assesses inhibitory control of threat, through a matrix composed of one target photograph—neutral face—and eight distractor photographs—angry faces.

### 2.3. Procedure

After submission to the Ethics Committee of the University of Minho, for appraisal, and attaining the necessary authorizations to carry out the study in foster homes and study centers, sealed envelopes were delivered to the guardian of the child, containing an informed consent form and a sociodemographic questionnaire. The assent of each child for their participation in the study was also obtained. Once informed consent was obtained from guardians, and children's assent and the guardian-reported sociodemographic questionnaire were provided, the administration of the remaining instruments was scheduled for each child.

The implementation of the experiment (i.e., all instruments except the sociodemographic questionnaire) was carried out with the investigator and the child individually and instructions and answers were given orally.

The experiment began with the threat detection behavior instrument. For each set, the child was asked to indicate if all 9 photographs had the same emotional expression or if one of the photographs was different. It was also explained and exemplified that if one of the photographs had a different emotional expression, the child should point it out with his/her finger. The second instrument consisted of the hostile attribution bias instrument. The child was asked to imagine him/herself as the protagonist of the narrated story, after which the two corresponding questions of the vignette were asked. Then, the instrument of adverse experiences was filled out and, in the end, a debriefing session was held. After the experiment was completed, all participants were rewarded with a lollipop. The experiment was done individually in rooms or quiet spaces in order to guarantee privacy and a minimum of interference from extrinsic variables, having an average duration of 40 min each.

## 3. Results

### 3.1. Data Analysis

For data analysis, SPSS Statistics v.24 was used. Descriptive analyses for adverse experiences, performance in the instruments of threat detection and inhibitory control of threat, and performance in the hostile attribution bias instrument were conducted. To test the hypotheses, correlational tests and linear regressions were applied, having verified the necessary assumptions for these analyses. Furthermore, differences between groups were

analyzed to explore the presence of gender differences in hostile attribution bias, according to the category of the vignette (i.e., instrumental or relational provocation), as suggested in the literature.

Kolmogorov–Smirnov tests indicated that the present variables were not normally distributed, excepting hostile attribution bias. As such, Spearman correlations were performed for variables without a normal distribution (i.e., threat detection, inhibitory control of threat, and adverse experiences) and Pearson correlations were performed for hostile attribution bias.

### 3.2. Descriptive Analyses

Descriptive analyses of the adverse experience questionnaire showed that the total score varied between 1 and 20 ( $M = 6.66$ ,  $SD = 4.03$ ). Additionally, hostile attribution bias scores varied between 1.1 and 10.6 ( $M = 6.14$ ,  $SD = 2.66$ ). It was also found that the number of correct answers in the threat detection instrument varied between 1 and 4 ( $M = 3.24$ ,  $SD = 0.87$ ), and in the inhibitory control of threat instrument between 1 and 4 ( $M = 2.97$ ,  $SD = 0.92$ ).

### 3.3. Threat Detection

When analyzing the accuracy of threat detection, a significant positive correlation with adverse experiences,  $r_s = 0.30$ ,  $p = 0.014$ , was found. The model of regression for predicting accuracy in threat detection was also significant  $F(1, 65) = 6.02$ ,  $p = 0.017$ , explaining 9% of the variance,  $R^2 = 0.09$  ( $R^2A = 0.07$ ). Higher accuracy in threat detection was predicted by more adverse experiences,  $\beta = 0.29$ ,  $t = 2.45$ ,  $p = 0.017$ .

### 3.4. Inhibitory Control of Threat

When analyzing inhibitory control of threat, a positive and significant correlation between this and adverse experiences,  $r_s = 0.26$ ,  $p = 0.035$ , was found. The regression model for predicting inhibitory control of threat was significant  $F(1, 65) = 5.85$ ,  $p = 0.018$ , explaining 8% of the variance,  $R^2 = 0.08$  ( $R^2A = 0.07$ ). Greater inhibitory control of threat was predicted by more adverse experiences,  $\beta = 0.29$ ,  $t = 2.42$ ,  $p < 0.018$ .

### 3.5. Hostile Attribution Bias

To perform a Pearson Correlation between hostile attribution bias and adverse experiences, the latter was transformed, through a square root function (sqrt), since it did not present with a normal distribution. After this transformation, adverse experiences had a normal distribution.

When analyzing hostile attribution bias, only a marginally significant and positive correlation between this and adverse experiences was found,  $r_s = 0.21$ ,  $p = 0.088$ .

In regard to gender differences in hostile attribution bias, depending on the category of the vignette (i.e., instrumental or relational provocation), a Mixed Bifactorial ANOVA was carried out. No interaction effect was found between the type of vignette provocation (i.e., instrumental or relational provocation) and the participant's gender,  $F(1, 65) = 0.29$ ,  $p = 0.590$ . Additionally, there were no significant main effects of gender,  $F(1, 65) = 0.05$ ,  $p = 0.832$ , or of the vignette's type of provocation,  $F(1, 65) = 0.67$ ,  $p = 0.417$ .

## 4. Discussion

In the present study, we sought to understand the relationship between adverse experiences and threat detection behaviors—that is, performance in instruments of threat detection and inhibitory control of threat in children. After analyzing the results, adverse experiences were found to be associated with and predict (1) greater accuracy in the identification of threatening target faces, and (2) greater inhibitory control of threatening distractor faces. Thus, results support the first and second hypotheses.

The present findings suggest that the results, supporting the first and second hypotheses, are in line with the results of Damjanovic and colleagues (2014) study [48]. These



findings demonstrate that police officers with more experience, for which an exposure to more adverse experiences (e.g., of violence) is assumed, had higher accuracy in the identification of angry faces and greater inhibitory control of threat through crowds of angry faces. Despite threat detection behaviors not yet having been studied in children through the FICE procedure, the current study seems to replicate previous findings [29,32]. In addition, no research was found for inhibitory control of threat in children with adverse experiences. However, the findings of the present study seem to verify the results found with adults, and therefore, by extension, with children. As expected, and according to the specialization hypothesis, an enhanced capacity for threat detection and threat inhibition is found in children with adverse experiences. These results are interesting as they suggest that adverse experiences can have an impact on, and enhance, relevant capacities, early in development, such as threat detection behaviors, in order to help children adapt to their environment.

Another aim of this study was to comprehend the relationship between adverse experiences and hostile attribution bias in children. The results demonstrate that more adverse experiences are only marginally associated with hostile attribution bias. Thus, results do not support the third hypothesis.

To our knowledge, no existing literature has studied hostile attribution bias in children with adverse experiences. Nonetheless, studies consistently show that hostile attribution bias is correlated to more aggressive behaviors [30,46], which are associated with adverse experiences [49]. However, the present results suggest that adverse life trajectories do not lead to the development of hostile attribution bias. As such, these results do not support the specialization-hypothesis, as identifying malicious intent would have been relevant for children developing in adverse environments. Although this adaptive response was not verified, the non-development of a higher hostile attribution bias could also be a positive outcome for these children, as hostile attribution bias is associated with future behavioral problems [30,46].

Due to the exploratory nature of this study, it presents several limitations and thus these findings should be interpreted with caution, namely regarding: (1) sample size; (2) different conditions during the implementation of the experiment (e.g., the study center was noisier than the foster homes); (3) non counterbalancing of the instruments and respective items; (4) lack of a control group (i.e., children with adverse experiences versus children without adverse experiences), not allowing the exploration of causal effects of adversity on children's threat detection behaviors and hostile attribution bias; and (5) other confounding variables, such as participants' temperament, emotional state, anxiety, psychopathology (i.e., mood and anxiety disorders), and aggressiveness, were not assessed. Moreover, results can be limited by the fragility of the instruments, which were not subject to rigorous validation, and therefore their fidelity and reliability are not known. Thus, it was not possible to assess: (1) the validity of the adverse experiences' questionnaire, although it presented an acceptable internal consistency, considering it is composed of a small number of items; (2) if the narrated situations were truly situations of ambiguous provocation, although response variability was found; or (3) if the photographs used in the threat detection behavior instruments are valid for children. It is also worth noting that, although a pilot study was performed in order to adapt the procedures to the intended goals, the number of participants used was small and they were not in the same age gap as the children of the current study.

Despite the study's various limitations, results seem to partially support the specialization hypothesis of the adaptation-based approach, demonstrating, with caution, that enhanced relevant capacities, such as threat detection behaviors, are related to children with more adverse experiences. These adaptations seem to also be in line with the concept of biological fitness, mentioned by Frankenhuis and colleagues (2016), since threat detection may be a relevant skill for the survival of individuals in adverse environments.

The present study contributes to the growing literature on the adaption-based approach, pointing out the initial stages of social information-processing—that is, threat

detection and inhibitory control of threat, as some of the enhanced capacities related to adverse experiences in childhood. The findings of this study are therefore relevant for a more complete understanding of the functioning and capacities of children that develop in adverse environments, being the first study to investigate threat detection behaviors and hostile attribution bias in these children. Moreover, it highlights the importance of designing interventions that attend to the adaptive functions of the characteristics of children who develop in adverse environments. Gaining knowledge about the initial stages of social-information processing in children from adverse environments can have implications for the development of more effective interventions, especially those targeted at social adjustment, anxiety problems, and aggressive, antisocial, and risk-taking behaviors (e.g., bullying, delinquency, school failure, etc.) [4,11,12,27]. Interventions developed for this purpose, such as the “Good Behavior Game”, have already yielded encouraging results for the reduction of disruptive behaviors in the classroom [50]. We suggest that future research invest in studying the abilities of children who develop in adverse environments and to try thereby to overcome the limitations of the present investigation (e.g., verify these results in a laboratory, with reaction times, a greater sample size, a control group and with previously validated instruments). This way, research can contribute to changing the prevalent perspective of deficit in these children and promote more effective and adjusted intervention programs.

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