



PAPER

Longitudinal relations among exuberance, externalizing behaviors, and attentional bias to reward: the mediating role of effortful control

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Abstract

The present study examined the associations between temperamental exuberance during toddlerhood (20 months), attention bias towards reward at the end of kindergarten (76 months), and externalizing behaviors across the kindergarten year. Moreover, we examined the role of effortful control at 48 months on the relation between early exuberance and attention bias. Attention bias towards reward was positively predicted by exuberance, negatively predicted by effortful control, and positively related to externalizing problems. Finally, the longitudinal path between exuberance and attention bias to reward was mediated by effortful control – such that higher toddler exuberance led to increased attention bias towards reward by way of lower effortful control. These results extend the attention bias and socioemotional functioning literature and have implications for the identification of children at risk for behavioral problems.

Research highlights

- Attention bias has been given a central role in studies supporting cognitive models of psychopathology.
- We show for the first time that attention bias towards reward is associated with toddler temperamental exuberance and externalizing behaviors during kindergarten.
- The relation between early temperament and attention bias towards reward was mediated by effortful control.
- These results extend the attention bias literature and have implications for the identification of children at risk for behavioral problems.

Introduction

Attention bias (AB) – the propensity to selectively attend to environmental cues that are pertinent to the individual's psychological state – selectively facilitates the processing of stimuli in the environment, influencing an

individual's subsequent cognitive and emotional processes. These processes, in turn, shape cognitive representations of the self, others, and the environment (Derryberry & Reed, 1996, 2002; Todd, Cunningham, Anderson & Thompson, 2012). This model has been tested primarily in the anxiety literature. However, there is also analogous evidence supporting the role of AB in reward-related processes, such as addiction and obesity. These data suggest that AB might act as a general mechanism that influences patterns of emotion and behavior broadly, as opposed to being specific to a single class of disorders.

In the current study, we extend the literature examining AB and socioemotional functioning by evaluating how the relation between exuberant temperament in toddlerhood and AB towards reward in early childhood may shape externalizing problems during kindergarten. In addition, we also evaluated the role of effortful control (EC) in the relations with AB based on earlier work in the attention and anxiety literature (Lonigan & Vasey, 2009).

The anxiety-attention literature has found that children and adults with high levels of anxiety or anxiety

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disorders display a bias towards threat (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & van IJzendoorn, 2007). Illustrating the breadth of this relation, Bar-Haim and colleagues' (2007) meta-analysis found the bias pattern across experimental paradigms, experimental conditions, developmental stage, clinically and non-clinically anxious participants, as well as individual anxiety disorders.

Accumulating evidence suggests that bias towards threat contributes to the etiology and maintenance of anxiety (Van Bockstaele, Verschuere, Tibboel, De Houwer, Crombez *et al.*, 2014). Experimental research shows that modifying AB (e.g. reducing the bias) causes changes in thought and behavior (e.g. reduction of anxiety), leading to therapeutic interventions based on AB modification training (Bar-Haim, 2010; Hakamata, Lissek, Bar-Haim, Britton, Fox *et al.*, 2010). The breadth of these findings speaks to the general contribution of AB to the development and maintenance of an individual's psychological state (in this case anxiety) and suggests that the impact of AB may not be limited to specific diagnostic categories.

Indeed, an emerging literature suggests that a bias towards appetitive (reward) cues impacts profiles of approach-related emotions. For example, AB towards drug-related cues has been found among alcohol (Field, Mogg, Zettler & Bradley, 2004), tobacco (Bradley, Mogg, Wright & Field, 2003; Mogg, Field & Bradley, 2005), caffeine (Yeomans, Javaherian, Tovey & Stafford, 2005), and opiate (Lubman, Peters, Mogg, Bradley & Deakin, 2000) users. Similarly, studies have shown higher AB towards food cues in obese and overweight individuals compared to individuals with a healthy weight (e.g. Castellanos, Charboneau, Dietrich, Park, Bradley *et al.*, 2009; Werthmann, Roefs, Nederkoorn, Mogg, Bradley *et al.*, 2011). These biases may play a functional role in supporting continued over-weight by sustaining higher craving and hunger (Kemps & Tiggemann, 2009; Werthmann *et al.*, 2011). Training participants to attend towards or away from food-related cues also modulates food intake (Werthmann, Field, Roefs, Nederkoorn & Jansen, 2014). These findings closely parallel the anxiety literature, implying that AB plays a casual role in shaping broad patterns of emotions and behaviors, most likely building on idiosyncratic patterns of susceptibility (e.g. anxiety vs. drug use vs. obesity).

The present study investigated whether AB contributes to the development of externalizing behaviors. Specific diagnoses such as conduct problems, oppositional/defiant behaviors, and attention deficit hyperactivity disorder (ADHD) are believed to share the temperamental antecedent of behavioral disinhibition or exuberance (Tackett, 2010). Several neurobiological models, such as

Gray's motivational systems (Gray & McNaughton, 2003), suggest that exuberance reflects higher activity towards reward, fueled by pairing a hyperactive behavioral approach system with an underactive behavioral inhibition system (Quay, 1993). Consistent with these theoretical models, early disinhibited or exuberant temperament is a strong predictor of later externalizing problems (e.g. Stifter, Putnam & Jahromi, 2008).

Exuberant temperament is a relatively stable (Fox, Henderson, Rubin, Calkins & Schmidt, 2001), multifaceted construct marked by positive affectivity, impulsivity, and high approach behaviors (Fox *et al.*, 2001) that may be driven by heightened sensitivity to reward (Polak-Toste & Gunnar, 2006). In the broader AB literature, increased attention towards happy faces is most commonly conceptualized as reflecting a bias towards rewarding or appetitive stimuli (e.g. Frewen, Dozois, Joanisse & Neufeld, 2008; Shechner, Britton, Pérez-Edgar, Bar-Haim, Ernst *et al.*, 2012a). Following this theoretical line, the current study examined whether early exuberance is related to AB towards happy faces in early childhood.

To our knowledge, this is the first longitudinal study in children examining early relations between AB towards reward and externalizing behaviors. Indeed, the overall literature examining bias to reward is sparse. Within the internalizing literature, the general finding is that anxious or depressed individuals display a bias away from reward (Shechner *et al.*, 2012a). For example, White and colleagues (in press) reported that children at temperamental risk for anxiety were at increased risk for anxiety if they display a bias away from rewarding stimuli.

Moreover studies training anxious adults to attend towards reward find a reduction in anxiety symptoms, anxious behavior, and anxiety-related physiological reactivity (e.g. Heeren, Reese, McNally & Philippot, 2012). In a similar manner to adults, experiments training clinically anxious children to attend towards reward show significant decreases in anxiety symptoms and fewer children meeting clinical diagnosis post-training (Britton, Bar-Haim, Clementi, Sankin, Chen *et al.*, 2013; Waters, Pittaway, Mogg, Bradley & Pine, 2013). Other studies found that training individuals to attend towards reward increases levels of positive affect (Grafton, Ang & MacLeod, 2012; Taylor, Bomyea & Amir, 2011).

Emerging data suggest that rewarding cues such as happy facial expressions might be preferentially detected and remembered versus other facial expressions such as angry or sad (e.g. Becker, Anderson, Mortensen, Neufeld & Neel, 2011; Juth, Lundqvist, Karlsson & Öhman, 2005), particularly in older individuals (Reed & Carstensen, 2012). Moreover, AB towards reward seems to have a similar time course and underlying neural

mechanisms as AB towards threat (Brosch, Sander, Pourtois & Scherer, 2008). This suggests that positive information, just like negative information, is processed automatically and rapidly (Becker & Srinivasan, 2014). Nevertheless, few studies involving rewarding cues have evaluated whether individual differences in biases towards these cues relate to individual differences in emotionality (e.g. positive affect; Tamir & Robinson, 2007). A recent study in a sample of post-institutionalized children found that individual differences in attention bias towards reward were concurrently related to more social engagement, more prosocial behavior, fewer externalizing disorders, and less social withdrawal (Troller-Renfree, McDermott, Nelson, Zeanah & Fox, 2014). It is unclear how AB towards reward would associate with outcomes in children at risk for externalizing difficulties, as opposed to internalizing concerns. Derryberry and Reed's (1994) study is the only one linking AB towards reward and exuberant temperament in adults, finding that extraverts were slower to disengage from rewarding cues than threatening cues.

EC may moderate the relation between AB towards threat and psychopathology (Lonigan, Vasey, Phillips & Hazen, 2004). EC is generally defined as the ability to voluntarily control behavior by inhibiting a prepotent response in order to perform a subdominant response (Kochanska & Knaack, 2003). Specifically, it is proposed that when stimuli are presented long enough to reach consciousness (e.g. 500 ms), EC can be used to shift attention away from threatening stimuli (Derryberry & Reed, 2002; Lonigan *et al.*, 2004). For example, Lonigan and Vasey (2009) found that AB towards threat was only present in youth with low EC and high fearful temperament. AB was not evident in fearful children with high levels of EC. These data suggest that children may call on EC processes to modify the attention pattern typically seen in anxious children, protecting them from internalizing problems. Moreover, these data highlight the importance of considering how psychological factors, such as emotionality and self-regulation, may interact to predict maladaptive patterns of attention that lead to psychopathology. Because of this, we also evaluated the impact of EC on the relation between exuberance and AB towards reward.

Current study

In sum, the current study extends the developmental AB literature to exuberant temperament and externalizing behaviors. To do this, we evaluated the relations between 20-month exuberant temperament, AB at the end of the kindergarten year, and externalizing behaviors across kindergarten. We hypothesized that there would be a

positive relation between exuberance and AB towards reward. Similarly, we expected a positive relation between AB towards reward and externalizing behaviors. In addition to parallel longitudinal findings from the internalizing literature (Pérez-Edgar, Bar-Haim, McDermott, Chronis-Tuscano, Pine *et al.*, 2010; Pérez-Edgar, Reeb-Sutherland, McDermott, White, Henderson *et al.*, 2011), we looked to see whether AB towards reward moderated the expected relation between exuberance and externalizing behaviors – such that exuberant toddlers would only be at risk for later externalizing problems if they show a bias towards reward. Finally, given that EC has been found to contribute to the relation between temperament and AB, we tested the impact of the child's EC at 48 months on the relation between exuberance and AB towards reward. We expected that there would be a relation between exuberance and AB only for children low in EC. In addition, we tested whether EC mediated the relation between exuberance and externalizing problems.

Methods

Participants

Seventy children (40 boys, Mean_{age} = 76.26 months, *SD*_{age} = 3.9) were evaluated during kindergarten as part of a larger longitudinal study of toddler temperament and socioemotional development. The sample was recruited at 20 months via mailings sent to parents identified by local birth records. Children were oversampled for high fear for the 24-month visit and for high exuberance for the 42-month visit by using the Infant-Toddler Social and Emotional Assessment (ITSEA; Carter, Briggs-Gowan, Jones & Little, 2003) at 20 months. A more detailed description of the recruitment is provided in a previous report (Morales, Beekman, Blandon, Stifter & Buss, 2015). All families consented to participate in the study and the Institutional Review Board approved this study. Families selected for the study based on 20-month screening participated in assessments at 24 months, 36 months, 42 months, 48 months, and several assessments across the kindergarten year. The 20-month, 48-month, and kindergarten assessments were used in the current study.

During the kindergarten spring visit, 70 children completed the dot-probe task. Although the majority of the sample successfully completed the task (91.4%), six children were excluded due to poor performance (< 75% accuracy) and one child was an outlier in reaction times (RTs) to happy faces (> 3 *SD*). The children with poor performance did not differ from the rest of the

sample in any of the study measures (all $t_s < 1.1$; $p_s > .30$; $d_s < .60$) or gender (3 males). Similarly, the sample in the present study did not differ from the larger longitudinal sample in any of the study variables (all $t_s < 1.2$; $p_s > .24$; $d_s < .18$). Of the children in the present study, 60 were Caucasian (85.7%), five were Asian (7.1%), and the rest were other ethnicities (Hispanic, African American, and American Indian). Most of the sample was middle class (Hollingshead mean = 51.3, $SD = 10.54$). Of the 64 children with valid data on the dot-probe, all had temperament data, 59 had externalizing data, and 46 had EC data. The children with EC data did not differ from those without EC data on any of the study measures (all $t_s < 1.8$; $p_s > .25$; $d_s < 0.35$).

Procedures and measures

Twenty-month temperament

Parents reported on their toddler's ($N = 485$; Mean_{age} = 20.1 months; $SD_{age} = 1.3$) socioemotional behaviors by using the ITSEA. The ITSEA is a validated measure of socioemotional problems and competencies composed of 169 items, which are gathered in 20 scales. In this measure, the primary caregiver reported on the child's behavior on a 3-point scale ranging from 0 (Not true/rarely) to 2 (Very true/often). Five scales were selected as indices of temperament (Activity, Impulsivity, Inhibition to Novelty, Sensory Sensitivity, and Attention) as they are believed to reflect emotionality and not competence or maladaptive behaviors. Sample items of the scales include statements like 'is restless and cannot stand still' (Activity; $\alpha = 0.71$), 'gets hurt so often you cannot take your eyes off him/her' (Impulsivity; $\alpha = 0.51$), 'takes a while to feel comfortable in new places' (Inhibition to Novelty; $\alpha = 0.74$), 'plays with toys for more than 5 minutes' (Attention; $\alpha = 0.69$), or 'is bothered by loud noises or bright lights' (Sensory Sensitivity; $\alpha = 0.50$). Even though some of these alphas were low, they are comparable to previous reports using this measure (e.g. Carter *et al.*, 2003).

Principal component analysis with orthogonal rotation (Varimax) was performed using the five ITSEA scales previously mentioned, yielding two factors. All 485 of the screened children (not simply those in the present sample) were used in this analysis in order to avoid selection bias. The Activity and Impulsivity scales loaded positively onto the first factor. The Attention scale loaded negatively onto the first factor. All scales had loadings higher than 0.60. Based on previous work (e.g. Fox *et al.*, 2001), this factor was labeled exuberance. The Inhibition to Novelty and Sensory Sensitivity scales

loaded positively onto the second factor. In line with previous research (e.g. Buss, 2011), this factor was labeled Fear. Factor scores were created for exuberance and fear. Only the exuberant factor was used in the present study. More detail regarding these temperament factors has been previously published (Morales *et al.*, 2015).

Forty-eight-month effortful control

The Effortful Control Factor of the Children's Behavior Questionnaire (CBQ) was used at age 4. The CBQ is a well-validated and widely used questionnaire of child temperament (3- to 7-year-olds; Rothbart, Ahadi, Hershey & Fisher, 2001). The Effortful Control Factor is composed of four scales (Attentional Focusing, Inhibitory Control, Low-Intensity Pleasure, and Perceptual Sensitivity) with scores averaged to calculate the EC score ($\alpha = 0.84$). In this measure, the caregiver is asked to indicate on a 7-point Likert scale ranging from 1 ('extremely untrue of your child') to 7 ('extremely true of your child') how well each statement describes their child's reaction to a given situation in the past 6 months. The scales include items such as 'when drawing or coloring in a book, shows strong concentration' or 'can easily stop an activity when she/he is told to'.

Kindergarten dot-probe task

The dot-probe task was administered at the end of the peer visit during the spring of kindergarten. The task consisted of eight practice trials and 100 experimental trials randomly presented in four blocks of 25 trials. Each trial began with the presentation of a central fixation cross for 500 ms followed by a pair of faces presented side-by-side for 500 ms. One of the faces was replaced by an asterisk, which appeared for 2500 ms. Using a computer mouse, children were asked to indicate, as quickly and accurately as possible, the side of the screen on which the asterisk appeared. The inter-trial interval was 1800 ms. Children were seated 60 cm from a 20-inch LCD color monitor. Stimuli were presented with E-Prime 2.0.

Three combinations of faces were presented: Angry-Neutral (40 trials), Happy-Neutral (40 trials), and Neutral-Neutral (20 trials). Ten different actors (5 male) were used from the NimStim face stimulus set (Tottenham, Tanaka, Leon, McCarry, Nurse *et al.*, 2009). Each face was presented ten times. Congruent trials were those in which the probe replaced the affective face (i.e. angry or happy). Incongruent trials were those in which the probe replaced the neutral face. Response accuracy and reaction times were recorded for each trial.

Table 1 Means, standard deviations, and intercorrelations among gender, exuberance, effortful control, angry bias, happy bias, and externalizing

Variable	Mean	SD	1	2	3	4	5
1 Gender	**	**	–				
2 Exuberance	0.02	0.93	–0.098	–			
3 Effortful Control	5.42	0.58	0.317	–0.356	–		
4 Angry Bias	–7.08	48.79	0.122	0.073	0.024	–	
5 Happy Bias	7.03	37.25	–0.089	0.251	–0.442	–0.048	–
6 Externalizing	0.58	0.15	–0.148	0.476	–0.424	–0.137	0.269

Note: Bolded = $p < .05$. SD = Standard Deviation **Gender = 36 boys and 27 girls. Boys = 0; Girls = 1.

Incorrect dot-probe trials or trials with RTs of less than 150 ms or more than 2000 ms were removed before analyses. In addition, trials that had responses with RTs ± 2.5 SDs from an individual's mean were removed. AB scores to the emotional faces were calculated by subtracting the mean RT for congruent trials from the mean RT for incongruent trials. Positive values denote a bias to the emotional stimuli whereas negative scores indicate a bias away from the emotional stimuli.

Kindergarten externalizing

In the fall and spring of the kindergarten year, mothers reported on the child's socioemotional adjustment during kindergarten by using the MacArthur Health Behavior Questionnaire (HBQ; Armstrong, Goldstein & the MacArthur Working Group on Outcome Assessment, 2003). This measure is designed to assess the physical and mental health and functioning of children (4–8 years old). In the HBQ, the reporter responds on a dichotomous ('yes' or 'no') or 3-point Likert scale of 0 ('never or not true'), 1 ('sometimes or somewhat true'), and 2 ('often or very true'). The current study used the Externalizing Symptoms (31 items) and Attention-Deficit/Hyperactivity Disorder (ADHD) Symptoms (15 items) scales for the evaluation of externalizing behaviors. The externalizing variables were transformed by taking the square root because they did not have a normal distribution. Sample items from these scales are 'has difficulty awaiting turn in games and groups' or 'defiant, talk back to adults' (Externalizing/ADHD Scale). The externalizing composites for fall ($\alpha = 0.922$) and spring ($\alpha = 0.916$) were averaged ($r = 0.71$) to create one measure of externalizing during the kindergarten year.

Statistical analyses

Zero-order correlations were initially employed to evaluate the relation between AB, exuberance, EC, and externalizing behaviors. We then conducted a path

analysis to test the following relations: (1) if AB towards reward mediated or moderated the relation between exuberance and externalizing problems; (2) if EC mediated or moderated the relation between exuberance and AB towards reward; (3) if EC mediated or moderated the relation between exuberance and externalizing problems. All variables were centered before generating the interaction terms.

Results

One sample t -tests revealed no significant differences from zero for either bias towards happy, $t(62) = 1.50$, $p = .14$, $d = 0.38$, or bias towards angry, $t(63) = -1.16$, $p = .25$, $d = -0.27$, across the sample. However, bivariate correlations (Table 1 and Figure 1) revealed that

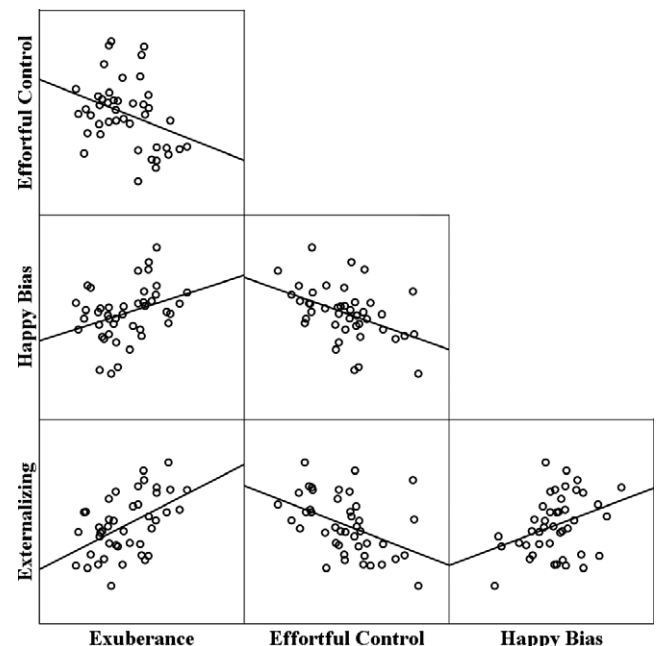


Figure 1 Scatter plot matrix of exuberance, effortful control, attention bias towards happy faces, and externalizing.

Table 2 Unstandardized, standardized, and significance levels for the path analysis presented in Figure 1

Path	Unstandardized estimate	SE	Standardized estimate	<i>p</i>
Gender → EC	0.341	.152	.295	.025
Exuberance → EC	-0.190	.082	-.308	.020
Exuberance → Externalizing	0.065	.019	.403	.001
Exuberance → AB Happy	5.185	4.963	.130	.296
EC → Externalizing	-0.062	.034	-.239	.066
EC → AB Happy	-24.567	8.814	-.380	.005

bias towards happy faces was positively related to exuberance scores, $r(61) = 0.25$, $p = .048$, and externalizing behaviors, $r(57) = 0.27$, $p = .039$, and negatively related to EC, $r(44) = -0.44$, $p = .003$. As expected, exuberance predicted more externalizing behaviors, $r(58) = 0.48$, $p = .001$, and less EC, $r(43) = -0.36$, $p = .016$. EC predicted fewer externalizing problems, $r(42) = -0.42$, $p = .004$. Angry faces did not show any significant relations across any of our core measures, and were therefore not included in further analyses. Finally, girls showed higher EC, $r(43) = 0.32$, $p = .017$, than boys. As such, subsequent analyses controlled for gender.

The path analysis (Table 2 and Figure 2) revealed that none of the interactions were significant, indicating that none of the moderations were present. The relation between AB and externalizing was also not significant, indicating that this mediation relation was not present. These non-significant relations were trimmed from the final model, which had a good fit, $\chi^2(4, N = 64) = 1.21$, $p = .87$, RMSEA = .00, CFI = 1.00. While controlling for the effects of gender, the relation between exuberance and EC was significant, $\beta = -.19$, $p = .020$. The same was true for the path between EC and AB towards happy faces, $\beta = -24.57$, $p = .005$. After accounting for these relations, the path between exuberance and AB towards

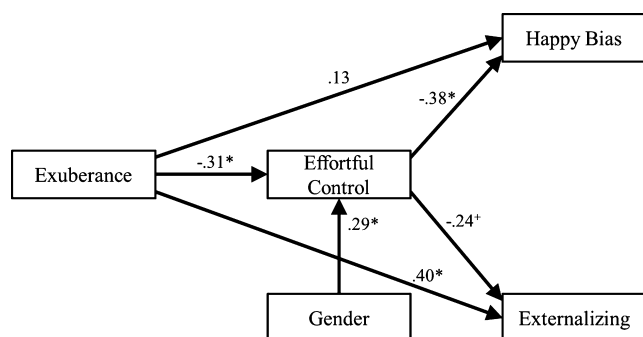
happy faces was no longer significant, indicating a significant mediation of the exuberance–AB relation via EC with an indirect effect estimate of 4.67 ($SE = 2.718$), 95% CIs [0.393, 10.875]. Finally, the path between EC and externalizing was marginally significant, $\beta = -0.062$, $p = .066$, and the direct path between exuberance and externalizing remained significant, $\beta = 0.065$, $p = .001$, indicating a marginally significant partial mediation of the relation between exuberance and externalizing by effortful control with an indirect effect estimate of 0.012 ($SE = 0.009$), 95% CIs [-0.001, 0.032].

Discussion

An emerging literature indicates that AB may play an important role in the etiology of psychopathology (Todd *et al.*, 2012). However, most of this literature has focused on internalizing disorders. This study provides initial evidence suggesting that early exuberance may predispose children to preferentially attend to happy or appetitive stimuli. Results also revealed that the relation between exuberance and AB to happy faces was statistically mediated by EC.

In addition to its novel contributions, this study also replicates existing literature noting a relation between toddler exuberance, EC, and later externalizing behaviors. Consistent with previous findings, exuberant temperament during toddlerhood prospectively predicted lower EC and higher externalizing problems in early childhood (e.g. Putnam & Stifter, 2005; Stifter *et al.*, 2008). In addition, as hypothesized, exuberance in infancy was related to AB towards reward during kindergarten and, concurrently, AB towards reward was related to externalizing behaviors. These findings add to the growing evidence supporting the role of specific patterns of AB to salient environmental stimuli in shaping broad patterns of socioemotional functioning in individuals.

These results may seem contradictory to the existing literature that reports that AB towards reward is associated with positive outcomes (e.g. less anxiety, increased positive affect, prosocial behavior, and social engagement). However, most of these studies have been carried out with selected populations, such as clinically anxious individuals or post-institutionalized children. Since the meaning of affect-biased attention may depend on individual differences in developmental experiences and context, it is not necessarily clear how attention patterns towards reward work to shape outcomes in other populations. This context-dependence is evident in the attention bias literature, in which attention bias towards threat disappears or switches to attentional bias

**Figure 2** Path model with standardized coefficients.* = $p < .05$; + = $p < .10$.

away from threat under contexts of imminent threat (Bar-Haim, Holoshitz, Eldar, Frenkel, Muller *et al.*, 2010; Helfinstein, White, Bar-Haim & Fox, 2008; Shechner, Pelc, Pine, Fox & Bar-Haim, 2012b). Moreover, attention bias to threat may manifest differently across anxiety disorders (Salum, Mogg, Bradley, Gadelha, Pan *et al.*, 2013; Waters, Bradley & Mogg, 2014), across different forms of temperamental fear (Morales, Pérez-Edgar & Buss, 2014; Pérez-Edgar *et al.*, 2011), or anxious and non-anxious populations (O'Toole & Dennis, 2012). In the same vein, it is likely that attention bias towards reward differs in its meaning and manifestation between a population exposed to early deprivation, in which a bias towards reward is associated with positive outcomes (Troller-Renfree *et al.*, 2014), and a normative sample, in which reward is associated with early temperamental exuberance, lower effortful control, and externalizing problems.

Further analyses showed that AB towards reward, although related to both exuberance and externalizing, did not mediate or moderate the relation between exuberance and externalizing behaviors. This suggests that AB is not the mechanism by which exuberance is related to externalizing behaviors. This is unlike findings from the internalizing literature, in which AB has been found not only to be related to fearful temperament (Pérez-Edgar *et al.*, 2010), but to also moderate the relation between early fearful temperament and internalizing behaviors (Pérez-Edgar *et al.*, 2010, 2011).

One possibility is that the relation between exuberance and externalizing behaviors is mediated by other factors that attention bias towards reward does not capture. For instance, bold approach (related to impulsivity), positive affect, and self-regulation (e.g. EC) have been found to interact in infancy to predict externalizing problems in early childhood (Buss, Kiel, Morales & Robinson, 2014). Future studies should consider the additive and interactive roles that these factors may have in predicting externalizing behaviors.

Another noteworthy finding was that the relation between early exuberance and AB was mediated by EC. This concurs with findings in the internalizing literature, where EC moderated the relation between temperament and attention bias (Derryberry & Reed, 2002; Lonigan & Vasey, 2009). Our findings suggest that toddler exuberance and AB to reward are directly associated with lower levels of EC. It is these relations that account for the overall association between early exuberance and AB towards reward. Similarly, the relation between exuberance and externalizing was partially mediated by EC. Although this was only marginally significant, it is compatible with the conceptualizations offered above of exuberance as increased activity in the behavioral

approach system coupled with diminished activity from the behavioral inhibition system (Quay, 1993).

To further support the current findings, future studies should evaluate the impact of experimental manipulations on AB towards reward and their impact on its behavioral correlates by either directly manipulating attention towards reward (Grafton *et al.*, 2012) or by influencing EC. Based on our results, we would expect that efforts to increase EC (e.g. Rueda, Rothbart, McCandliss, Saccomanno & Posner, 2005) would reduce AB towards reward as well as subsequent externalizing behaviors specifically in children at risk for externalizing difficulties.

In conclusion, this is the first study to present evidence for a relation between AB towards reward and exuberant temperament in toddlerhood and externalizing problems during kindergarten. This relation is analogous to the relation found in other disorders, in which AB is related, possibly causally, to disorder-relevant behavior. Moreover, additional analyses found that the path between exuberance and AB is mediated by EC. These findings suggest several interesting lines of research moving beyond the current focus on internalizing difficulties and have implications for our understanding of AB and their relation to individual differences in behavior.

Acknowledgements

This study was supported by the National Institute of Mental Health (R01MH75750 to KAB). A special thank you is extended to the children and families who dedicated their time to this project.

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Received: 4 October 2014

Accepted: 6 April 2015