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Addictive Behaviors 35 (2010) 1148–1151

Contents lists available at ScienceDirect

Addictive Behaviors

Short Communication

Early temperament, propensity for risk-taking and adolescent substance-related problems: A prospective multi-method investigation

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ARTICLE INFO

Keywords:
Behavioral inhibition
Substance-use
Risk-taking
Longitudinal
Adolescence

ABSTRACT

One hundred thirty seven adolescents ($M = 15.3$ yrs, $SD = 1.0$ yr, $n = 72$ girls) were recruited into temperament groups when they were 4 months of age based on reactivity to novel auditory/visual stimuli (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001). Behavioral inhibition was observed across infancy (14 and 24 months). Additionally, self-reported substance-related problems and behavioral risk-taking was assessed during adolescence. High behavioral inhibition increased risk for substance-related problems among boys, whereas high behavioral inhibition protected against substance-related problems among girls, $B = -1.18$, $SE = .48$, 95% CI = −2.13 to −.24; $p < .05$. Additionally, high behavioral inhibition protected lower risk-taking children from adolescent substance-related problems whereas high behavioral inhibition increased risk for substance-related problems among higher risk-taking children, $B = .04$, $SE = .02$, 95% CI = .00 to .08. Findings from this prospective, multi-informant, longitudinal study suggest that risk-taking and gender may interact with temperamental traits to place adolescents at differential risk for substance-related related behavior problems.

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1. Introduction

Temperamental differences assessed as reactivity to novel auditory and visual stimuli can be identified in infants as early as 4 months of age (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001). These differences influence developmental pathways to psychiatric problems; some temperamental traits protect from, and others increase risk for, anxiety, depression, and substance-related problems (Caspi, Moffitt, Newman, & Silva, 1996; Perez-Edgar & Fox, 2005). Considerable research has focused on the temperament trait behavioral inhibition (BI); (Fox, Henderson, Marshall, Nichols, & Ghera, 2005). BI is characterized by heightened negative affect, vigilance, and avoidant responses to novelty, particularly unfamiliar social situations (Kagan, Reznick, & Snidman, 1988; Kagan & Snidman, 1991) as well as distinct physiological patterns of heightened autonomic reactivity and increased stress hormone response (Calkins, Fox, & Marshall, 1996). Behaviorally inhibited children display heightened social reticence to unfamiliar peers and report lower self-esteem and fewer friendships (Fox et al., 2005).

Research also suggests BI may be a risk factor for substance-use problems (Caspi et al., 1996; Hill, Lowers, Locke, Snidman, & Kagan, 1999). This relation however, is complex and progress may be best served by moving beyond the examination of BI in isolation to an examination of interactions among BI, risk-taking propensity, and other variables that may moderate associations with substance-use. Although there are several self-report assessments of risk-taking, more recent behavioral measures provide a great deal of promise. The Balloon Analogue Risk Task (BART) is a behavioral measure of risk-taking propensity related to a range of real-world risk behaviors in youth (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Crowley, Raymond, Mikulich-Gilbertson, Thompson, & Lejuez, 2006; Lejuez, Aklin, Bornovalova, & Moolchan, 2005; Lejuez et al., 2007).

Behaviorally inhibited boys display greater stability of this temperament over time and have more maladaptive outcomes (Degnan & Fox, 2007). Parents find the behaviors associated with BI more salient in their male children and are more over-protective (Fox et al., 2001; Stevenson-Hinde, & Shouldice, 1995), thereby potentially maintaining or exacerbating boys' BI. As inhibited children move into the more

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0306-4603/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.addbeh.2010.07.005

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complex and stressful peer contexts of adolescence, their social reticence may lead to heightened anxiety (Degnan & Fox, 2007) and alcohol related problems (Caspi et al., 1996).

The present paper examined relations between early behavioral measures of temperament and substance-related behavior problems in adolescence. Risk-taking propensity and gender are two theoretically relevant variables that were expected to moderate and further explicate these relations, with the former assessed using a behavioral measure of risk-taking at the time of the assessment of substance-related problems. Specifically, we predicted that high BI in toddlerhood, in conjunction with adolescent propensity for risk-taking, would be associated with substance-related behavior problems, with boys expected to have more substance-related problems at higher levels of BI.

2. Method

2.1. Participants

The current sample included 137 adolescents ($M = 15.3$ yrs, $SD = 1.0$ yr, $n = 72$ girls) from a metropolitan area; these participants were recruited at 4 months based on their reactions (positive/negative affect, motor activity) to novel auditory and visual stimuli ($n = 217$). Details of the screening procedures have been described previously (Calkins et al., 1996; Kagan & Snidman, 1991). Previous work has reported that attrition was not related to 4-month reactivity (Fox et al., 2001). This multi-informant longitudinal design followed participants (95% Caucasian) throughout infancy, childhood, and adolescence.

2.2. Measures

2.2.1. Behavioral inhibition

BI was assessed via responses to novel objects and unfamiliar adults when children were 14 and 24 months of age using standard laboratory procedures (Fox et al., 2001). At 14 months, infants were presented with an unfamiliar room, an adult stranger, and a novel toy/object (robot). BI was computed as the sum of: latency to vocalize, latency to approach toys/stranger/robot, proportion of time spent in proximity to mother, and frequency of negative affect (z-scored, $\alpha = .58$). At 24 months, toddlers were presented with the same stimuli with the addition of an inflatable tunnel to crawl through. BI was computed as the sum of: latency to approach toys/stranger/robot/tunnel and proportion of time spent in proximity to mother (z-scored, $\alpha = .73$). The tasks and coding scheme have been previously described (Calkins et al., 1996; Fox et al., 2001). The mean (standard deviation) of BI at 14 months was .00 (5.05) and at 24 months was .00 (4.32). The BI composites were then averaged ($r = .39$, $p < .001$) to create an overall observed measure of BI across toddlerhood ($M = .01$, $SD = .81$).

2.2.2. Substance-related related behavior problems

The Drug Use Screening Inventory (Tarter, 1990) quantifies adolescents' drug problem severity and associated problems in everyday functioning across 10 domains (15 yes-no items, e.g., "Have you felt that you could not control your alcohol or drug use?"): Substance-use, Behavior Patterns, Health Status, Psychiatric Disorder, Social Competence, Family System, School Performance, Work Adjustment, Peer Relationships, and Leisure and Recreation. Positive answers indicate the presence of problems.

Due to the highly-skewed nature of the data (e.g., Substance-use domain $M = 3.36$, $SD = 9.50$; skew = 1.85, $SE = .21$; kurtosis = 1.45, $SE = .42$), a dichotomous dummy variable was created to indicate whether adolescents had any problems (1 or more problems = 1) in each of the 10 domains. A summed variable (0-to-10) was computed to reflect the number of domains that had at least one problem behavior. Higher scores indicated greater substance-related problem behavior ($M = 6.15$, $SD = 2.17$; skew = −.45, $SE = .21$, kurtosis = −.07, $SE = .42$) which did not vary by gender ($M = 6.45$ girls, $SD = 1.98$; $M = 5.80$ boys, $SD = 2.34$, $t = -1.17$).

2.2.3. Risk-taking propensity

Risk-taking propensity was assessed using the Balloon Analogue Risk Task-youth version (BART-Y) (see Lejuez et al., 2007 for task details). As in previous BART research, we analyzed the adjusted number of pumps across balloons, defined as the average number of pumps on balloons that did not explode (BART score; for a rationale see Lejuez et al., 2002). Assessing reliability, no difference was found in BART score from the first 10 balloon trials to the last 10 balloon trials, t (136) = .08, $p > .05$, and the average correlation across these blocks was .60, $p < .05$ ($M = 37$ pumps, $SD = 12$).

3. Results

There were no significant associations across the predictors. Gender (boys = 1, girls = 2) was not significantly associated with risk-taking propensity ($M = 35.92$ girls, $SD = 12.07$; $M = 38.28$ boys, $SD = 10.94$, $t = 1.20$, $r = -.10$), or BI ($M = .04$ girls, $SD = .79$; $M = -.02$ boys, $SD = .85$, $t = -.39$, $r = .04$), and risk-taking propensity was not significantly associated with BI ($r = -.01$), $p > .05$.

The research hypotheses were partially supported. The three-way gender-by-risk-taking-by-BI interaction did not predict substance-related behavior problems ($B = -.01$, $SE = .04$, 95% CI,−.21 to .83; $p > .05$); however, both two-way interactions were significant. First, as predicted, boys evidenced more substance-related problems at higher levels of BI, whereas girls evidenced more substance-related problems at lower levels of BI (gender*BI interaction; $B = -1.18$, $SE = .48$, 95% CI = −2.13 to −.24; $p < .05$; see Fig. 1). Second, risk-taking was positively related to adolescent substance-use behavior problems among individuals scoring high on BI but not related to substance-use behavior problems among individuals scoring low on BI (risk-taking*BI interaction; $B = .04$, $SE = .02$, 95% CI = .00 to .08; see Fig. 2). There was no main effect for BI ($B = .41$, $SE = .98$, 95% CI = −1.52 to 2.35; $p > .05$), or gender ($B = .65$, $SE = .38$, 95% CI = −.11 to 1.42; $p = .09$) on substance abuse problems, but a main effect was evident for risk-taking propensity ($B = .06$, $SE = .02$, 95% CI = .02 to .09; $p < .05$).

4. Discussion

The risk for developing substance-related problems in adolescence appears to be partially influenced by infant temperament, but

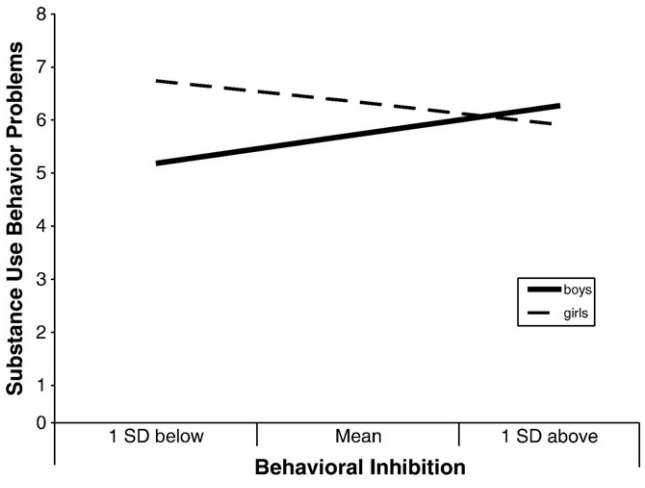

Fig. 1. Substance-related behavior problems in adolescence as a function of infant behavioral inhibition and gender.

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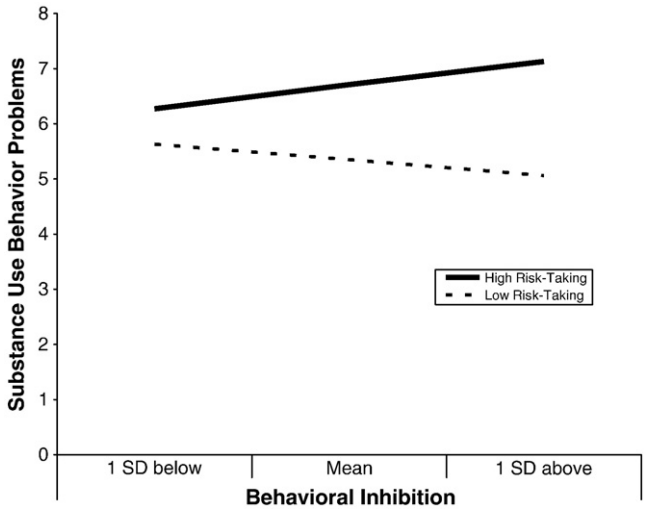

Fig. 2. Substance-related behavior problems in adolescence as a function of infant behavioral inhibition and propensity for risk-taking (one standard deviation above and below the mean).

considering temperament alone does not provide the most robust prediction. Previous mixed findings regarding BI and substance-use may be the result of considering BI in isolation as opposed to in relation to theoretically driven variables. Indeed, BI was positively related to an increased risk for substance-related problems among boys and negatively related among girls, in both cases regardless of risk-taking propensity level. Further, BI was related to an increased risk for substance-related problems among those with higher levels of risk-taking propensity regardless of gender.

These findings extend the previous literature by replicating findings of associations between temperament and substance-use (Caspi et al., 1996; Hill et al., 1999; Wills & Dishion, 2004; Wills et al., 2001). Previous studies have found that both high (Caspi et al., 1996; Hill et al., 1999) and low (Zuckerman, 1993) BI represent two temperament dispositions that place adolescents at an increased risk for substance-related problems. The current findings clarify such potentially contradictory results by showing that the relations between early temperament and later substance-related are moderated separately by gender and risk-taking propensity.

Boys, but not girls, with higher BI were more likely to have substance-related problems in adolescence than their peers. Part of this gender difference may be due to differential socializing effects, which are heightened at the onset of puberty when there is an intensification of gender-related expectations (Feiring, 1999). Boys are expected to take on a dominant or masculine role as they enter puberty, particularly as they navigate opposite sex relationships. The need to socialize and identify with same-age peers is particularly heightened during adolescence, and behaviorally inhibited boys may be at an increased disadvantage as they are less socially skilled (Fox et al., 2001). Adolescents are physiologically more sensitive to the social facilitation effects of alcohol (Spear & Varlinskaya, 2006), and they believe that alcohol will enhance their ability to socialize (Leigh, 1989). Particularly for boys with high BI, substances may be viewed as a means to exude proactive male characteristics (e.g., approach, control) and ease the transition into novel social relationships, including relationships with opposite sex peers.

In contrast, girls with low BI were more at risk for substance-related problems as teenagers. Low BI is associated with greater social competence and social engagement. Children exhibiting this disposition spend significant time interacting with peers and adults in conversation and play (Fox et al., 2001). Characteristics of BI (e.g., fearfulness, anxiety) may be more acceptable for girls (Park, Belsky, Putnam, & Crnic, 1997) and characteristics of low BI (Fox et al., 2001) may be more acceptable for boys. Girls are more likely to be popular, and popularity is associated with the highest levels of substance-use (Pearson et al., 2006). Less inhibited girls may be more likely to be popular, which brings them into social situations in which substances are used.

Finally, risk for substance-use related behavior problems was compounded when both risk-taking propensity and BI were concurrently high. Consistent with past research, propensity for risk-taking is associated with problem behaviors (Crowley et al., 2006; Hunt, Hopko, Bare, Lejuez, & Robinson, 2005; Lejuez et al., 2005), beyond the effects associated with trait level characteristics (Lejuez et al., 2007). Dual emotion-regulation models suggest that trait level characteristics distinguish anxiety-reduction and novelty seeking motivations (Cooper, Frone, Russell, & Mudar, 1995). For behaviorally inhibited adolescents who do not avoid risk (Fox et al., 2005; Maner et al., 2007), substance-related problems risk is elevated. Perhaps behaviorally inhibited low risk-taking adolescents may not attain the same intrinsic rewards as behaviorally inhibited high risk takers (Guyer et al., 2006).

Limitations of the study included a small sample size and limited heterogeneity in terms of race, income, and temperament. Measurement limitations included self-reports on substance-related problems and the unavailability of risk-taking propensity measured in childhood when temperament was assessed. Despite these limitations, the study also has notable advantages, including the use of a long-term (early infancy through adolescence) and multi-method (observational, adolescent questionnaire, and behavioral task) design. Practical implications may include targeted prevention programs towards children with risky temperament characteristics.

Role of funding sources

This work was supported, in part, by National Institute of Mental Health grant R01MH074454 and NICHD R37HD17899 (awarded to Nathan A. Fox).

Contributors

The first author conducted literature searches, the data analysis, and wrote the first draft of the manuscript. The second author is the principal investigator of the grant that funded data collection and supervised overall data collection and analysis and write up of the paper. The third author was involved with the development of the methodology, data analysis and manuscript preparation. The fourth author conducted literature searches and provided summaries of previous research studies. The fifth and sixth authors were involved with the study design, protocol development and implementation, and manuscript review. The seventh author participated in the design of the research and contributed to the final draft of the manuscript. The eighth author was involved in the planning and in the collection of the most recent phases of the study, as well as in the final draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

All authors declare that there are no conflicts of interest.

Acknowledgement

The authors would like to thank the parents and children who participated across the 15 year study period.

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