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Two types of behavioral inhibition: Relations to effortful control and attention in school children

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ABSTRACT

This study aimed to examine the relationship of two types of behavioral inhibition, social inhibition and nonsocial inhibition, to effortful control and attention in 7–9-year olds. Social and nonsocial inhibition and effortful control were assessed by questionnaires. The child version of the Attention Network Task was used to measure attention including alerting, orienting and executive attention. Results indicated that in girls, social inhibition was negatively related to effortful control and alerting, while nonsocial inhibition was positively related to orienting; there was an interaction between social and nonsocial inhibition in predicting executive attention in boys. Thus, it is of great significance to differentiate social and nonsocial inhibition when examining the association between behavioral inhibition and effortful control and attention in school-age children.

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1. Introduction

Since behavioral inhibition was introduced by Kagan, Reznick, and Snidman (1987,1988) and Kagan, Reznick, and Snidman (1988), it has received much attention due to its influence on children's later development. Behavioral inhibition has been defined as a biologically based and early-appearing temperament trait characterized by showing shyness, fear, or anxiety in response to novel or challenging situations (Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan et al., 1988). Recently, behavioral inhibition has been suggested to have two components, social and nonsocial inhibition (Kochanska, 1991; Kochanska & Radke-Yarrow, 1992; Muris & Dietvorst, 2006). Social inhibition mainly describes withdrawal or cautious behaviors in response to novel social situations, whereas nonsocial inhibition refers to inhibited behaviors in response to unfamiliar nonsocial provoking events. Empirical studies have indicated that these two types of behavioral inhibition are related to distinct physiological responses and differ in predicting children's later social behaviors, supporting the contention that social and nonsocial inhibition are independent from each other (Kertes et al., 2009; Kochanska, 1991).

In contrast to Kagan's temperament model of behavioral inhibition (Kagan et al., 1987, 1988), Rothbart and colleagues have developed another temperament model comprised of reactive and regulatory dimensions (Derryberry & Rothbart, 1997; Rothbart, Sheese, & Posner, 2007). The reactive dimension has two factors: extraversion and negative affect. Behavioral inhibition pertains to the factor of negative affect and has important self-regulatory features (Rothbart et al., 2007). For example, after behavioral inhibition develops between the ages of 6 and 12 months, some infants show discomfort and distress toward novel objects instead of approaching them without apprehension, which is a defensive mechanism that may protect infants from potential risks (Rothbart, Sheese, Rueda, & Posner, 2011). By the end of the first year, the regulatory dimension of temperament begins to emerge and has been labeled as effortful control, which refers to the ability to carry out a subdominant response by inhibiting a dominant response (Rothbart et al., 2007). Whereas effortful control, in the prefrontal cortex, allows children to flexibly and voluntarily regulate their behaviors and emotions, behavioral inhibition is more reactive and based on limbic arousal (Aksan & Kochanska, 2004; Nigg, 2000).

Recently, a wide range of studies has demonstrated that behavioral inhibition is a risk factor for the development of social anxiety disorders (Chronis-Tuscano et al., 2009; Hirshfeld-Becker et al., 2007; Muris, Meesters, & Spinder, 2003; Reeb-Sutherland et al., 2009). Effortful control mechanisms in the prefrontal cortex could regulate children's behavioral inhibition toward novel stimuli by suppressing activation of the limbic system (Rothbart et al., 2011). Due to the regulatory role of effortful control, it may serve to reduce the anxiety caused by behavioral inhibition (Degnan &

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Fox, 2007), and thus training effortful control may reduce highly inhibited children's psychopathology and social development problems (Fox et al., 2005; White, Helfinstein, Reeb-Sutherland, Degan, & Fox, 2009). To accomplish this goal, it is necessary to understand how behavioral inhibition and effortful control interact with each other.

Although behavioral inhibition is related to effortful control because the prefrontal cortex and the limbic system have regulatory influences on each other (Nigg, 2000; White et al., 2009), no clear consensus has been reached on this relationship. Some researchers claim that highly inhibited children are low on effortful control because their overactive limbic system may suppress the activation of the prefrontal cortex (Fox et al., 2005). In support of this view, Eisenberg, Shepard, Fabes, Murphy, and Guthrie (1998) found that teacher-reported shyness was negatively correlated with attention shifting and focusing, both contemporaneously and across time, in school children. Eisenberg and colleagues measured attention shifting and focusing by the effortful control subscales of the Children Behavioral Questionnaire (Rothbart, Ellis, Rueda, & Posner, 2003). Similarly, Muris and Dietvorst (2006) found that 10-year-old children with high social inhibition demonstrated a lower level of attentional control, compared to their counterparts with low social inhibition. A longitudinal study indicated that children who showed increased fear reactivity towards novel people during infancy tended to demonstrate relatively impaired attention control ability later (Hill-Soderlund & Braungart-Rieker, 2008).

In contrast, behavioral inhibition may foster the development of effortful control because highly inhibited children's limbic arousal could activate the prefrontal cortex to appraise novelty and threat cues from the environment, and this activation pattern could be generalized to contexts without any novel information as children develop (Aksan & Kochanska, 2004; Nigg, 2000). Consistent with this hypothesis, both parental reports and laboratory observation of behavioral inhibition in 5-year-olds were positively associated with executive inhibition as measured by a computer task (Thorell, Bohlin, & Rydell, 2004). In addition, a longitudinal study using observational methods indicated that fearfulness in response to novel people and situations in 2–3-year-olds exerted a positive influence on later inhibitory control ability (Aksan & Kochanska, 2004). Similarly, Kochanska and Knaack (2003) have reported a positive relationship between fearfulness and effortful control as rated by parents.

Although prior studies have provided strong support for the association between behavioral inhibition and effortful control, it is still unclear why previous research is inconsistent in this association. One possible reason is that previous studies have rarely differentiated social and nonsocial inhibition, which have been suggested to be relatively independent and different in their correlations with physiological responses and the development of social behaviors (Dyson, Klein, Olino, Dougherty, & Durbin, 2011; Kertes et al., 2009; Kochanska, 1991; Kochanska & Radke-Yarrow, 1992). As such, in our cross-sectional study, we aimed to separately explore the relationship of social and nonsocial inhibition to effortful control in 7–9-year-olds.

In the present study, we went further to test the association between social and nonsocial inhibition and multiple facets of attention, which have been shown to interact with temperament (Garon, Bryson, & Smith, 2008; Rothbart et al., 2003, 2007). Posner and Rothbart (Posner & Rothbart, 2007; Rothbart et al., 2007) have articulated the interaction between temperament and attention within their model, which suggests that attention functions are executed by three separable networks: alerting, orienting and executive attention. Alerting is involuntary and refers to using a warning cue to improve response readiness in order to deal with high-priority information. Orienting includes voluntary and involuntary aspects of attention, and refers to selecting information from sensory input. Executive attention is voluntary and pertains to the ability to monitor and resolve conflict information. This model suggests that caregivers support infants' self-regulation by manipulating their orienting, and infants also gradually develop some orienting-related behaviors to regulate themselves (Harman, Rothbart, & Posner, 1997; Rothbart et al., 2011). Furthermore, although previous studies have suggested that executive attention and effortful control are independent from each other both conceptually and empirically, the correlation between these two measures has been reported (Gerardi-Caulton, 2000; Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000). This correlation may indicate that executive attention underlies the development of effortful control (Rothbart et al., 2007).

The relationship of effortful control to behavioral inhibition and executive attention leads to the question of whether behavioral inhibition is associated with multiple components of attention. For instance, it has been reported that when compared to uninhibited participants, young adults who were extremely inhibited in childhood show a higher level of alertness to novel versus familiar faces due to enhanced amygdala activity (Schwartz, Wright, Shin, Kagan, & Rauch, 2003). It has also been hypothesized that behaviorally inhibited children automatically direct their attention toward cues with threatening information and then have difficulty in voluntarily orienting away from such stimuli (Fox et al., 2005). Consistent with this hypothesis, it has been found that individuals with high behavioral inhibition in childhood show attention bias to threat (Pérez-Edgar et al., 2010). Additionally, nonsocial inhibition was found to be positively related to executive attention in preschool children (Sheese, Rothbart, Posner, White, & Fraundorf, 2008). However, researchers have not explored how behavioral inhibition is related to alerting and orienting elicited by neutral stimuli. It is also unclear whether social and nonsocial inhibition are differentially related to the three attentional networks. Another aim of the current study was to provide insight into understanding these two questions.

To measure the three attention networks, we used the child version of Attention Network Test (ANT), which was designed according to the adult version of ANT (Rueda et al., 2004). This test assesses alerting, orienting and executive attention by comparing the reaction time differences between distinct conditions (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Use of the adult version of ANT has suggested that these attention networks are not only independent from each other in reaction-time studies, but also associated with different neural circuits (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Fan et al., 2002, 2007; Niogi, Mukherjee, Ghajar, & McCandliss, 2010). Some findings in adults have been replicated in children by using the child version of ANT (Hrabok, Kerns, & Müller, 2007; Mezzacappa, 2004; Rueda et al., 2004; Simonds, Kieras, Rueda, & Rothbart, 2007). For example, Rueda et al. (2004) have found that the three attention networks are not only independent from each other, but also show distinct developmental patterns in children. Overall, previous studies have demonstrated that the child version of ANT is child-friendly and effective in measuring the three attentional networks.

In sum, we tested how social and nonsocial inhibition were related to effortful control and attention in the current study. Social and nonsocial inhibition were hypothesized to be differently related to effortful control and attention for two reasons. First, social inhibition was negatively related to attentional control in school children (Muris & Dietvorst, 2006). Muris and Dietvorst conjectured that children with high social inhibition tend to withdraw from social situations, and thus have less opportunity to practice their self-regulation skills. In contrast, Sheese and colleagues have found the positive link between nonsocial inhibition and executive attention in preschool children, suggesting nonsocial inhibition is a measure of self-regulation (Sheese et al., 2008). Second, social

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