

National Survey of Child and Adolescent Well-Being

No. 1: Inhibitory Control Abilities Among Young Children in the Child Welfare System



Findings from the NSCAW Study

methods brief

A high proportion of children reported to the child welfare system (CWS) for maltreatment during infancy have problems regulating their behavior once they enter school.¹ Controlling one's behavior, avoiding acting impulsively, regulating one's emotions, and displaying flexibility have been found to be critical for later school success. In addition, teachers consider crucial specific learning-related social and behavioral skills, such as self-discipline, listening, following directions and routines, cooperating, participating in group activities, communicating, taking responsibility, and acquiring self-help skills that support independence.² Poor learning-related social and behavioral skills are, moreover, the most consistent predictors of referral to special education and of school failure in first grade.³

Many of these skills critical to academic success or failure are determined by higher-order cognitive processes referred to as *executive functions*. Executive functions include inhibitory control (resisting distractions, giving a more considered response, avoiding one's first reaction) and working memory (holding information in mind and working with it), as well as cognitive flexibility (shifting tasks or roles and adapting to change). Poor executive functioning is associated with various problems, including attention-deficit/hyperactivity disorder (ADHD), student dropout, drug use, crime, and teacher burnout.⁴

Purpose of the Brief

This methods brief assesses the usability and validity of two tools to assess one executive function, inhibitory control, within a large survey of CWS-involved children. *Inhibitory control* is defined as the capacity voluntarily to inhibit or regulate prepotent (i.e., strong or automatic) attentional or behavioral responses.^{5,6} Inhibitory control involves the ability to focus on relevant stimuli in the presence of irrelevant stimuli (e.g., to attend to the teacher's instructions in a noisy classroom) and to override strong but inappropriate behavioral tendencies (e.g., to refrain from responding to every command in a game of "Simon says").

Recent neuroimaging studies with older children and adults suggest that regions of the brain's prefrontal cortex subtend these abilities.^{6,8} Furthermore, these studies indicate that inhibitory control abilities and the involved brain regions have a prolonged developmental course that begins in early childhood and continues into adolescence. Behavioral studies show that young children are more susceptible to interference from irrelevant stimuli and inappropriate behavioral tendencies than older children and adults.^{9,10}

Despite the expected developmental improvement in inhibitory control, significant individual differences affect inhibitory control throughout childhood, and these individual differences remain largely stable across time.^{11,12} In other words, children who perform better on inhibitory control tasks at one age tend to do so at older ages. Interestingly, individual differences in inhibitory control abilities have been associated with various socioemotional outcomes. For example, children with better-developed inhibitory control abilities are more likely to comply with explicitly stated rules in unsupervised situations and to behave in socially competent ways at school.^{13,14} Additionally, inhibitory control abilities are positively associated with emerging math and literacy skills in preschool and kindergarten.^{15,16} Conversely, impairments in inhibitory control have been implicated in conduct disorder and ADHD.^{17,18}

This methods brief examines the performance on two computerized inhibitory control tasks of children entering the school system who were reported to the CWS during infancy. To assess the usability and validity of these two tasks in a large survey and as measures for the CWS population, the brief explores the relationships among inhibitory control abilities, age and gender, and behavioral problems. In particular, this brief answers the following questions:

- Do these children perform inhibitory control tasks in expected ways as established in the literature? Specifically, do the children perform more slowly and less accurately when they are required to inhibit strong or automatic attentional and behavioral responses?
- Evincing one underlying executive function process, does a correlation emerge such that better performance on the first task matches better performance on the second task?
- Do expected differences in inhibitory control abilities emerge in terms of age and gender?
- Are the children who perform relatively poorly on the inhibitory control tasks more likely to be reported by their caregivers and teachers as exhibiting behavioral problems?

National Sample of Children Involved in Allegations of Maltreatment

Data from the National Survey of Child and Adolescent Well-Being (NSCAW) are used here to describe the inhibitory control performance of 5- to 6-year-old children who were infants when first involved in CWS investigations. NSCAW is a national longitudinal study of the well-being of 5,501 children aged 14 or younger who had contact with the CWS within a 15-month period starting October 1999.¹⁹ To date, five waves of data collection have been completed, the final one having concluded in 2006. The data collection consisted of interviews or assessments conducted with the children and their current caregivers, teachers, and CWS caseworkers. Both children who remained in the CWS and children who left the system were followed for the entire study period. In the sample, 1,186 children met the criteria of having been younger than 12 months old at Wave 1 and having been 5 or 6 years old at Wave 5.

Characteristics of Children in the Sample

Of the 1,186 eligible children, 859 children were administered at least one of the inhibitory control tasks. (Because this brief focuses on inhibitory control, only this subsample of children is described. All analyses were conducted with unweighted data.) At Wave 5 the average child age was 68 months, with a range of 59 to 83 months. Approximately 79% of the children were in kindergarten; 13%, in first grade. The children were evenly divided between boys and girls. The racial background of the children was 40% Black, 34% White, and 19% Hispanic. According to the baseline interviews with the children's caseworkers, the most serious form of maltreatment alleged was physical neglect for 41% of the children, supervisory neglect for 22% of the children, and physical abuse for 18% of the children. At Wave 5, 54% of the children were living with a biological parent, 25% were living with an adoptive parent, and 5% were living in foster or kinship care.

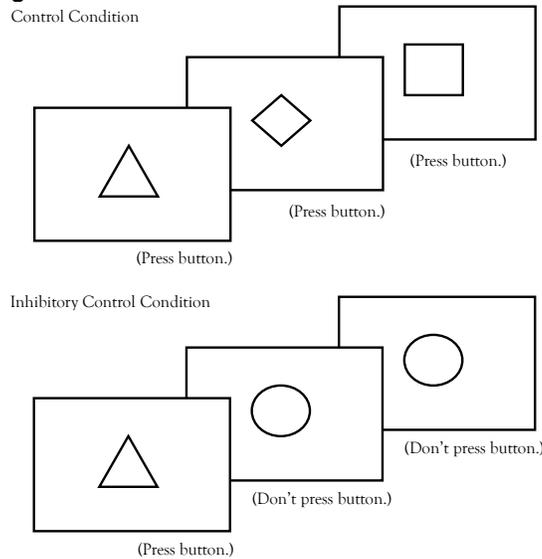
Procedures

The children were asked to complete two computerized inhibitory control tasks that have been previously used with children and adults: the shape go/no-go task and the color flanker task.^{8, 10, 20} Both tasks were presented on laptop computers after NSCAW field representatives had given the children instructions verbally. To ensure comprehension of instructions, the children were asked to complete 8 to 10 practice trials, and then they received performance feedback verbally.

Shape Go/No-Go Task

The shape go/no-go task measures children's ability to respond to target stimuli while inhibiting responses to nontarget stimuli. In the shape go/no-go task, shapes were presented in the center of the screen, individually, for 500 milliseconds, with 1,500 milliseconds between each shape presentation (Figure 1). The children were asked to respond as quickly as possible to every shape (i.e., *target stimuli*) except a circle (i.e., *nontarget stimuli*); they received auditory feedback after each incorrect response. The task included a control condition of 42 trials in which 100% of the stimuli were target stimuli, and an inhibitory control condition of 42 trials in which stimuli were 50% target stimuli and 50% were nontarget stimuli. Percentage of responses that were correct and average reaction time in milliseconds were recorded separately for the control condition and the inhibitory control condition.

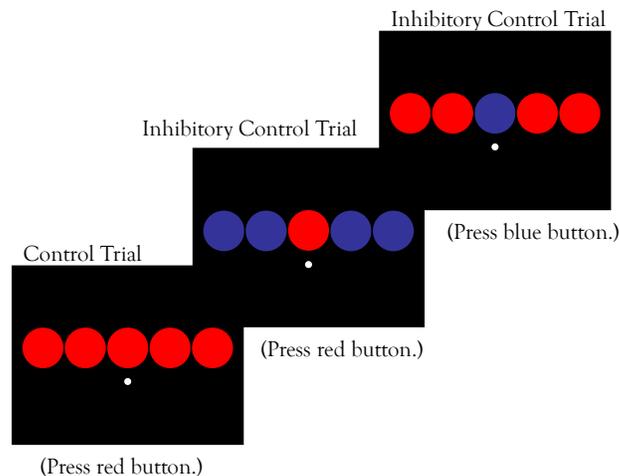
Figure 1. Example of stimuli (with the correct responses in parentheses) in the control condition and in the inhibitory control condition of the shape go/no-go task



Color Flanker Task

The color flanker task was designed to measure children’s ability to attend to relevant stimuli while ignoring irrelevant stimuli and to inhibit strong or automatic behavioral responses in the presence of interference. A small circular fixation point was displayed in the center of the computer screen for the duration of the task. For each trial, a warning cue was presented for 500 milliseconds before a horizontal row of five blue or red circles, with the central circle directly above the fixation point, was shown for 700 milliseconds. The control trials consisted of a row of five blue circles or five red circles, whereas the inhibitory control trials consisted of a central blue circle flanked on each side by two red circles or consisted of a central red circle flanked on each side by two blue circles (Figure 2).

Figure 2. Example of the stimuli (with correct responses in parentheses) in the control condition and in the inhibitory control condition of the color flanker



The children were instructed to press as quickly as possible the button that corresponded with the color of the central circle, regardless of the color of the flanking circles. The children were required to respond within 1,300 milliseconds and were given visual feedback at the end of each trial. The interval between trials randomly varied from zero to 500 milliseconds. The task included three blocks of 60 trials each, with an equal number of control trials and inhibitory control trials. Percentage of responses that were correct and average reaction time in milliseconds were recorded separately for the control condition and the inhibitory control condition.

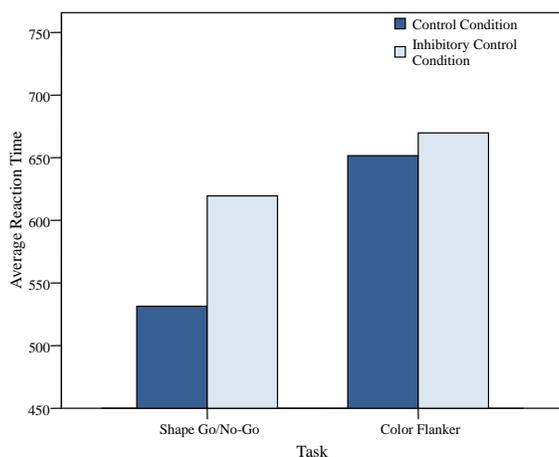
Completion Rate for the Inhibitory Control Tasks

Of the 859 children, 814 were administered the shape go/no-go task. Because of difficulties with comprehension or compliance, 17 children failed to complete the task, and 110 children failed to respond to at least 50% of the target stimuli in the control condition or in the inhibitory control condition; therefore, these children's scores for this task were excluded from analyses. The color flanker task was administered to 790 children, 96 of whom failed to complete at least two of the three blocks for the task and 114 of whom failed to respond to at least 50% of the trials in the control condition or in the inhibitory control condition. These children's scores for this task were excluded from analyses. Overall, 505 children successfully completed both tasks, 182 successfully completed the shape go/no-go task only, and 75 successfully completed the color flanker task only.

Interference Effect on the Inhibitory Control Tasks

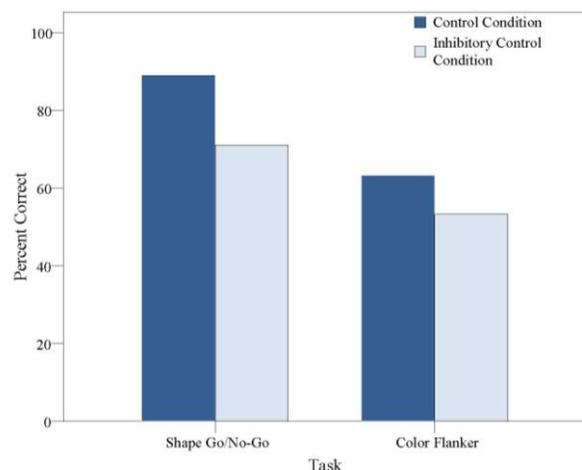
Because of the presence of irrelevant stimuli, children and adults generally experience more difficulty during the inhibitory control condition than during the control condition of both tasks.^{8, 10, 20} This pattern of difficulty, which manifests as slower, less accurate performance, has been referred to as the *interference effect*. The interference effect was observed for both inhibitory control tasks in the current sample: The children showed a slower average reaction time and higher error rate during the inhibitory control condition than they did during the control condition (Figures 3 and 4).

Figure 3. Average reaction time during the control condition and during the inhibitory control condition of the inhibitory control tasks



Note: One-way ANOVAs revealed that the children responded significantly more slowly during the inhibitory control condition than during the control condition of the shape go/no-go task and color flanker task, $F(1, 686) = 454.66, p < .001$, and $F(1, 579) = 66.23, p < .001$, respectively.

Figure 4. Percentage correct during the control condition and during the inhibitory control condition of the inhibitory control tasks

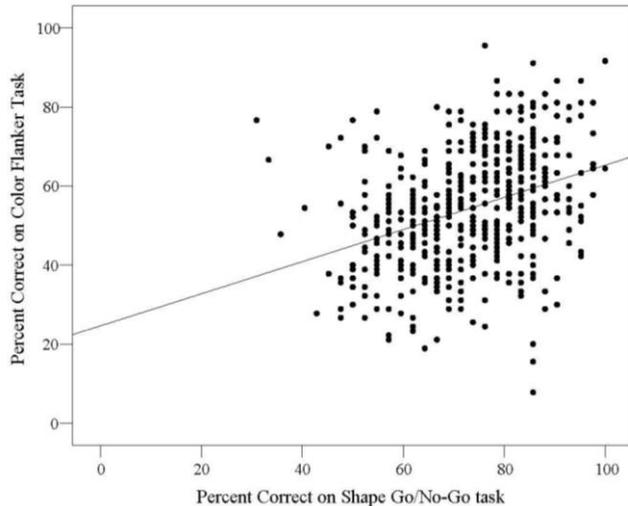


Note: One-way ANOVAs indicated that, for both tasks, the children were significantly less accurate during the inhibitory control condition than during the control condition. $F(1, 686) = 1,284.18, p < .001$, and $F(1, 579) = 601.30, p < .001$, respectively.

Relationship Between the Inhibitory Control Tasks

Although the shape go/no-go task and color flanker task were designed to assess different components of inhibitory control, it was expected that the children's scores on these tasks would be significantly correlated. As seen in Figure 5, the percentage correct during the inhibitory control condition of the shape go/no-go task and the percentage correct during the inhibitory control condition of the color flanker task were correlated: Children who performed better on the shape go/no-go task tended to perform better on the color flanker task.

Figure 5. Relationship between percentages correct for the inhibitory control conditions of the inhibitory control tasks



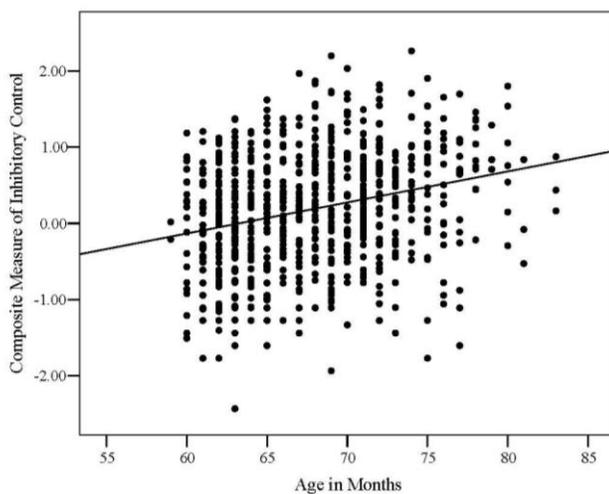
Note: A Pearson product-moment correlation showed that accuracy during the inhibitory control condition of the shape go/no-go task was significantly associated with accuracy during the same condition of the color flanker task, $r(503) = .35, p < .001$.

For a more stable measure of inhibitory control, a composite score was created for each child, using the percentage correct during the inhibitory control condition of the shape go/no-go and of the color flanker task. For this composite score, the children's scores for percentages correct were standardized within each task; the standardized scores were then averaged. Higher scores on the composite measure indicated better inhibitory control abilities.

Age and Gender Differences in Inhibitory Control

Although age range was somewhat restricted in this sample, it was positively related to the composite measure of inhibitory control: The older children outperformed the younger ones (Figure 6).

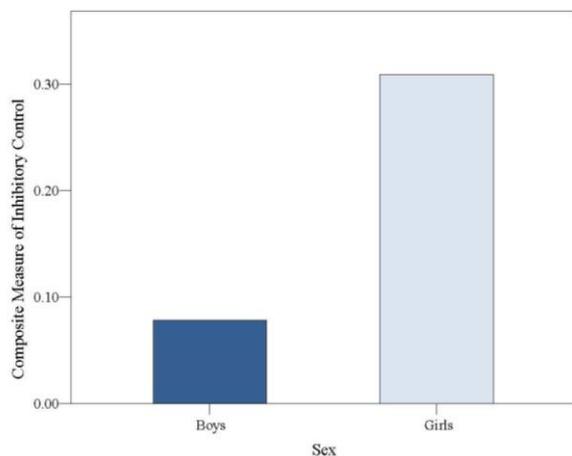
Figure 6. Relationship between age and composite measure of inhibitory control



Note: A Pearson product-moment correlation showed that child age significantly correlated with inhibitory control abilities, $r(760) = .27, p < .001$.

Although gender differences in inhibitory control abilities are not always observed, a recent review suggests moderate differences favoring girls among children between 3 months and 13 years of age.²¹ In the current study, gender was significantly associated with the composite measure of inhibitory control (Figure 7). As in prior research, the girls showed better inhibitory control than the boys.^{6, 9, 10}

Figure 7. Composite measure of inhibitory control for boys and girls

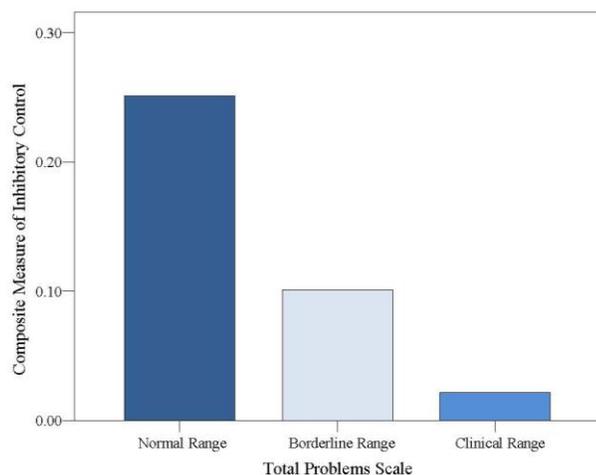


Note: A one-way ANOVA showed girls outperformed boys on the inhibitory control tasks, $F(1, 760) = 18.22, p < .001$.

Relationship Between Inhibitory Control Abilities and Concurrent Behavioral Problems

Children with conduct disorder and ADHD tend to show deficits in inhibitory control abilities.^{17, 18} In the current sample, children's classification on the Total Problems scale of the Child Behavior Checklist completed by the caregivers was related to the composite measure of inhibitory control (Figure 8).²² Specifically, children in the clinical range (i.e., children having significantly elevated internalizing or externalizing behavior problems) performed worse on the inhibitory control tasks than the children in the normal range. In terms of individual syndrome scales, children who performed more poorly on the inhibitory control tasks tended to have higher *T* scores on Social Problems, Thought Problems, Attention Problems, and Aggressive Behavior. A similar pattern of results was observed on the Teacher's Report Form, the teacher version of the Child Behavior Checklist: The Social Problems and Aggressive Behavior *T* scores were modestly related to the composite measure of inhibitory control. Overall, these results confirm previous research, suggesting that children with behavioral problems have difficulties with inhibitory control. The emergence of these expected patterns lends support to the validity of these tasks for assessing this population of children.

Figure 8. Composite measure of inhibitory control for children in the normal range, borderline range, and clinical range on the Child Behavior Checklist Total Problems scale



Note: A one-way ANOVA showed that the children in the normal range displayed better inhibitory control abilities than the children in the clinical range, $F(1, 760) = 5.91, p < .005$. Pearson product-moment correlations showed that inhibitory control abilities were negatively related to specific syndromes as reported by the caregivers and teachers, $r(759) = -.14$ to $-.10, p < .006$, and $r(546) = -.15$ to $-.13, p < .005$, respectively.

Summary

This brief has addressed methods for assessing the inhibitory control abilities of children at the age of school entry who were reported to the CWS for maltreatment during infancy. Several results suggest that these two computerized tasks are feasible for use in a large survey using laptop computers with field interviewer supervision. More than 84% of the children who were administered the shape go/no-go task were able to successfully complete it, and 73% of the children who were administered the color flanker task were able to successfully complete it. This result evinces the usability of these instruments for a majority of children in this population.

In addition to indicating usability, the two tasks yielded results consistent with patterns established in previous behavioral research, demonstrating their validity for use with CWS-involved children. The children showed, for example, a significant interference effect. Moreover, although the two tasks were designed to assess slightly different components of inhibitory control, performances on them were significantly correlated. These results indicate that these tasks may be not only useable but also scientifically valid for exploring developmental trends and individual differences in the inhibitory control abilities of young children involved with the CWS.

Also explored in these trials were associations between the children's inhibitory control abilities and other characteristics, including age, gender, and concurrent behavioral problems. For example, significant differences in inhibitory control abilities emerged by age and gender. In general, the results of these analyses were consistent with prior research—again speaking to the issue of measurement validity for these two computerized tasks.

Notably, inhibitory control abilities were also related to concurrent behavioral difficulties as reported by the children's caregivers and teachers. In particular, children who performed poorly on the inhibitory control tasks were more likely to display social problems, attentional difficulties, and aggressive behaviors than their peers. Although here the association was modest, a recent study has found that strong inhibitory control abilities as assessed in early elementary school were more strongly related to improvements in behavioral problems than poor inhibitory control abilities were related to concurrent behavioral problems.²³ Specifically, children with better inhibitory control abilities demonstrated a decrease in their behavioral problems over a 2-year period. Because of the general, established pattern, the inhibitory control abilities of the children in the current study may predict future behavioral problems and therefore identify these children for intervention.

Tools like the two reviewed here may well prove useful even beyond early identification of behavioral risk for specific children: They may be used to assess the impact of prevention and intervention programs. Although this vein of research is new, some evidence suggests that inhibitory control abilities do respond to intervention. For example, the evaluation of Tools of the Mind, a program for preschoolers that uses 40 executive functioning–promoting activities (telling oneself aloud what one should do, dramatic play, and using aids to facilitate memory and attention) has shown that executive functions can be improved in 4- to 5-year-olds in regular public school classes.⁴ In another study a small sample of typically developing 4-year-olds displayed improved performance on a flanker task after they completed computerized attention-training exercises.²⁴

Even more proactively, a school-based preventive program aimed at reducing behavioral problems and promoting socioemotional competence improved the inhibitory control abilities of children in elementary school.²⁵ The children with better inhibitory control abilities demonstrated fewer behavioral problems afterward. Interestingly, the authors of this study, as well as authors of the intervention studies, argue that programs designed to reduce behavioral problems should explicitly promote the development of inhibitory control abilities. The current review of two tools for assessment of this executive function may therefore have implications for assessing the impact of future interventions to reduce behavioral problems among maltreated children.

Notes

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National Survey of Child and Adolescent Well-Being Methods Brief

Available at: National Data Archive on Child Abuse and Neglect (NDACAN), Cornell University, ndacan@cornell.edu

Administration for Children and Families (ACF, OPRE)

http://www.acf.hhs.gov/programs/opre/abuse_neglect/nscaw/

This is the first in a series of NSCAW methods briefs focused on children who have come in contact with the child welfare system. Additional methods briefs focus on methods to measure salivary cortisol, among other topics.