

# Factors Associated with Success and Failure on the Dimensional Change Card Sort in 2- and 3-year-old children

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## INTRODUCTION

Current literature supports that individual differences in temperament and language are associated with cognitive processes and more specifically, inhibitory control (Wolfe & Bell, 2004). The ability to suppress a prepotent response is just one of many functions associated with prefrontal cortex. In the first few years of life, the prefrontal cortex undergoes substantial development. Specifically, we are interested in inhibitory control and its developmental trajectory in relation to temperament and language.

In this study, we use the Dimensional Change Card Sort (DCCS) task to examine inhibitory control in 2- and 3-year-old children and its relations with temperament and language. The DCCS has been used with preschoolers from 2 through 4 years of age, but it's only at age 4 that the majority of children display inhibitory control during task performance (Diamond, 2005).

## PARTICIPANTS

In our ongoing longitudinal study of cognitive development, we have an original sample consisting of 108 healthy full-term infants. All parents have at least a high school education and the majority of the children are Caucasian. We have seen the children at 5 and 10 months (completed), 2 (completed), 3 (in progress), and 4 years (in progress). For this analysis, our sample included:

- 70 2-year-olds
- 30 3-year-olds

All the data were gathered within 2 months after their birthday.

## METHODS



1) **DCCS:** Requires children to sort pictures on 2 dimensions into 2 baskets with target cards attached (red flower, blue car). First, the child is asked to sort the pictures by color (pre-switch; blue and red) and if they are successful they are asked to sort the pictures by shape (post-switch; flower and car). The sorting order was counterbalanced. Variables of interest were a) whether child understood task and if so, b) number of cards that were sorted correctly on the post-switch. Success was defined as doing 70% or better on post-switch.

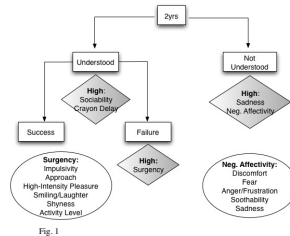
- **Temperament:** We used Rothbart's Early Childhood Behavior Questionnaire (ECBQ) for 2-year-olds and the CBQ for 3-year-olds, designed to assess 18 different temperament scales. We were interested in the temperament factors of Effortful Control, Negative Affectivity, and Surgency. In addition we were also interested in looking at the temperament scales of shyness, sociability and discomfort.
- **Language:** MacArthur-Bates Communicative Development Inventory (MCDI). The following measures were calculated: total number of spoken words (nouns, verbs, pronouns, quantifiers, etc), and grammar. We created an overall language category which represented both number of spoken words and grammar.
- **Inhibitory Control:** Crayon Delay task. Experimenter placed brand-new box of markers and paper on table and told child to wait and not touch. Experimenter left the room for 60 seconds at age 2 and 120 seconds at age 3.

## RESULTS

Because many of our 2-year-olds had difficulty participating in the DCCS task, we looked at measures describing the children who appeared to understand the DCCS relative to those children who appeared to not understand the task. Therefore, we defined "understood the task" as:

- willing to play the game
- attempting to sort at both pre-switch and post-switch phases
- not losing interest during post-switch or not showing bias to one basket during post-switch

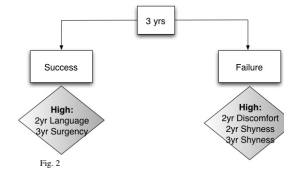
Seventy children from our longitudinal study attempted the task of which 37 actually understood the task. As seen in Fig 1 and Table 1, children who understood the task at age 2 were rated by parents as higher on Sociability (ECBQ), lower on sadness and Negative Affect. In addition, these children demonstrated better inhibitory control in the laboratory on the crayon delay task. Of the 37 who understood the task at age 2, only 7 actually succeeded. Successful children were rated as lower on Surgency than unsuccessful children.



	Understood Task	Not Understood	F	p
2-yr ECBQ sadness	2.58	3.15	8.08	.006
2-yr ECBQ sociability	5.75	5.26	5.08	.027
2-yr ECBQ negative affect	2.76	2.99	4.05	.048
2-yr crayon delay	29.47	17.5	4.25	.043
<i>(only those who understood)</i>				
2-yr ECBQ surgency	5.49	5.79	4.11	.047

Table 1: Factors associated with Understanding/Not Understanding and Success/Failure in 2-year-old DCCS Performance

At age 3, about 1/3 of the children seen thus far, have been successful on post-switch. As seen in Fig 2 and Table 2, these children were rated by parents at age 2 as lower on Discomfort and Shyness. These children also scored higher on language (MCDI) than unsuccessful children at age 3. In addition, the concurrent measures at age 3 show that successful performance is associated with lower ratings of shyness and higher ratings of Surgency.



	Success on Task	Failure on Task	F	p
2-yr ECBQ discomfort	2.13	2.76	5.93	.021
2-yr ECBQ shyness	2.47	3.45	15.19	.001
2-yr MCDI language	630.09	374.68	13.08	.003
3-yr CBQ shyness	2.08	4.13	13.98	.002
3-yr CBQ surgency	14.24	11.64	5.79	.028

Table 2: Factors Associated with Success/Failure in 3-year-old DCCS Performance

## DISCUSSION

For the 2-year-olds, understanding the task was a challenge in itself. Being social and having a temperament that allows for delay of gratification (Crayon Delay task) is intuitive especially when taking into consideration that the children needed to interact and understand what the experimenter was asking of them. Furthermore, having self-control was clearly helpful when needing to sit through a challenging task that is generally above the cognitive capabilities of 2-year-olds. Despite this, success on the task was achieved by a few who were low on Surgency.

For the 3-year-olds, success was best predicted by a having a temperament of Surgency and having low levels of shyness. Thus, being more social and outgoing aids in this inhibitory task. This makes sense when taking into consideration that the DCCS requires children to interact with the experimenter in order to understand the rules and when and how they change. Longitudinally, 3-year-old's success was best predicted by having higher language and less discomfort and shyness.

In summary, these results show the importance of both language and temperament in order to succeed on the DCCS at either 2 or 3 years of age. Clearly for both ages, being shy and having high levels of discomfort greatly impacts performance. On the other hand, Surgency is shown to be only helpful at age 3 but not at age 2. Simple sorting is indeed a challenging task at age 2. When adding the inhibitory component required by the post-switch, the performance predictors we expect to see at ages 3 may be quite different than at age 2. With our longitudinal study still in progress, we expect to gain further insight into the differences in these predictors across developmental.

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