



# Trajectories of behavioral regulation for Taiwanese children from 3.5 to 6 years and relations to math and vocabulary outcomes



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## ABSTRACT

Strong behavioral regulation skills in early childhood have been found to be related to high academic outcomes for Taiwanese children but little is known about the developmental trajectories for behavioral regulation and their relations to academic outcomes. Behavioral regulation was assessed for 192 Taiwanese children across an 18 month period at three time points using a direct assessment (Head–Toes–Knees–Shoulders task). Mean age of the children at the initial time-point was 4.10 years. Results of person-centered analyses indicated two distinct trajectories. One group described as 'Increasing regulators' developed self-regulation at a regular rate throughout the assessment period whereas the second group described as *steady-then-increasing regulators* developed more slowly initially and then their growth rate increased towards the end of the assessment period. Trajectory membership was significantly related to children's age (with relatively older children in the *steady-then-increasing regulator* group), but not to child gender, or mother's education. Being an increasing regulator was significantly related to greater growth in vocabulary skills, but not math skills at the third time point. These findings highlight the use of person-centered analyses to understand unique developmental trajectories for behavioral regulation and relations to academic outcomes.

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## 1. Introduction

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Taiwanese parents have relatively high expectations for their children to regulate their behavior, so children may learn to focus on learning tasks for long periods and to change their behavior in response to the needs of the group (Hsieh, 2004). Previous research in Taiwan suggests that this emphasis on regulation may be warranted, as children with higher behavioral regulation tend to have greater early academic success (Wanless et al., 2011). To date, however, research on behavioral regulation in Taiwan has focused on assessments of this skill at one time point and has not considered patterns of behavioral regulation development over time. In the present study, we chose a person-centered approach to explore empirically derived groups of children with distinct trajectories of development. Specifically, the present study examined behavioral

regulation development in Taiwanese children between 3.5 and 6 years old and relations to math and vocabulary skills.

The majority of research investigating trajectories of behavioral regulation in other countries has taken a variable-centered approach. Two common ways of doing this are by examining predictors of average developmental trajectories, or examining trajectories for subgroups of children that the researcher defined with categories such as gender or socioeconomic status (e.g., McClelland et al., 2007; Wanless, McClelland, Tominey, & Acock, 2011). This approach leaves a great deal of variance unaccounted for, with gender not relating to children's behavioral regulation, and mother's education only relating in some cases (Son, Lee, & Sung, 2013; McClelland et al., 2007; Wanless et al., 2011). This tradition of research is limited in that it assumes we know which factors define unique behavioral regulation trajectory groups (Laursen & Hoff, 2006). In the present study, we aim to supplement this variable-centered line of inquiry by taking a person-centered approach. A person-centered approach examines development holistically, allowing distinct behavioral regulation trajectories to be defined by an organic, multidimensional grouping of child factors (Rhoades, Greenberg, Lanza, & Blair, 2011; Sabol & Pianta, 2012). This approach builds on previous research in other areas of study, in which subgroups of children defined by unique person-centered

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trajectories have been more predictive of outcomes than more commonly studied sociodemographic covariates, such as gender (Werner & Smith, 1992). In other words, trajectories have been shown to have unique predictive ability that has not been considered for behavioral regulation in Taiwan.

### 1.1. Behavioral regulation

In this study, behavioral regulation is conceptualized as the behavioral manifestation of attentional flexibility, working memory, and inhibitory control, which are central processes in executive functioning (Becker, Miao, Duncan, & McClelland, 2014; Best & Miller, 2010; Rimm-Kaufman & Wanless, 2012). Executive function refers to the higher order cognitive processes that support regulation of thoughts and actions, bidirectionally (Blair & Ursache, 2011). As children develop, some thoughts and actions become automatic and behavioral regulation is no longer needed to manage these processes. Before that time, however, as children are acquiring new skills and applying them in new contexts, automaticity has not yet been reached and behavioral regulation is needed (Blair & Ursache, 2011). The present study focuses on the behavioral aspect of self-regulation, in that children rely on executive functioning's cognitive processes to produce a behavioral response to a direct assessment, and are not experiencing heightened emotions. Children use behavioral regulation, for example, when they remember the character they are pretending to be and maintain that role amidst distractions and interactions with others who may not be acknowledging their role. Although we call this skill behavioral regulation, aligning most closely with the developmental psychology literature, it is important to acknowledge that terminology varies dramatically across fields (McClelland, Geldhof, Cameron, Wanless, 2015). Numerous studies across cultures have established a positive relation between the behavioral aspects of self-regulation and outcomes such as math and vocabulary in young children, regardless of the child's gender, culture, or sociodemographic risk factors (McClelland & Wanless, 2012; Størksen, Ellingsen, Wanless, & McClelland, 2014; von Suchodoletz & Gunzenhauser, 2013; von Suchodoletz et al., 2013; Wanless et al., 2013).

There are two main approaches to measuring behavioral regulation in this age group: adult report and direct assessment. Although behavioral regulation scores from both measurement approaches are moderately correlated outside of Asia (teacher ratings and a direct assessment; Matthews, Cameron Ponitz, & Morrison, 2009), this relation has been substantially weaker in previous analyses of the present Taiwanese sample and a Chinese sample (Wanless et al., 2011). This weaker relation and the broad range of items included in teacher reports, suggests that teacher reports may reflect *classroom behavioral regulation*, a broad set of skills allowing children to enact regulatory behaviors in a complex classroom context. Direct assessments are narrower in scope and may reflect *individual behavioral regulation*, the ability to regulate behavior in a one-on-one setting. In the present study, we examined directly assessed individual behavioral regulation because it has been more closely linked to math and vocabulary skills than teacher ratings of classroom behavioral regulation in Taiwan (Wanless et al., 2011).

Direct assessments are available that measure behavioral regulation in one task, tapping the integration of all three components of this skill (working memory, attention, and inhibitory control), or in separate tasks that measure each component. Aggregating scores from separate direct assessments, however, may be problematic, particularly in Asia given that researchers have found low correlations between constructs (Oh & Lewis, 2008). This approach may also be conceptually problematic as behavioral regulation is the culmination of interacting processes at multiple levels (Blair & Raver, 2012). In line with this focus on integration, and previous research in Asia, we assessed children's behavioral manifestation of multiple

regulatory processes (attention, working memory, and inhibitory control) using the Head-Toes-Knees-Shoulders task (HTKS). This task has been used in Taiwan and shown moderate to high correlations with separate direct tests of working memory, attention, and inhibitory control tasks in previous research in China (Lan, Legare, Cameron Ponitz, Li, & Morrison, 2011).

### 1.2. The development of behavioral regulation for 3.5–6 year olds

Children experience a relatively large increase in regulation between 3.5 and 6 years old (Center on the Developing Child at Harvard University, 2011), just as they are experiencing maturational changes and increased demands in school. In terms of maturation, children experience a sudden mastery of the ability to express themselves, by proficiently using full sentences and many grammatical subtleties (Siegler, DeLoache, & Eisenberg, 2011). These new skills enable children to use language to regulate themselves orally and with private speech (Winsler, Fernyhough, & Montero, 2009). In addition, rapid synaptic growth and pruning occurs at this time, particularly in the prefrontal cortex, where activity is associated with behavioral regulation (Diamond, 2013). Given that synaptic and neuronal density in the dorsolateral prefrontal cortex has decreased to almost adult size by age 7, the early years are a highly plastic period of brain development when experience is highly influential (Diamond, 2013).

Just as maturation relates to behavioral regulation skill development, so does a range of daily activities. For example, early school contexts place increased demands on children to focus their attention, process, retain, and apply information (e.g., classroom rules), and inhibit maladaptive behaviors. Children need to regulate themselves to participate in classroom activities and receive positive feedback from teachers and peers. For example, one common early childhood activity, sociodramatic play, promotes increased behavioral regulation (Elias & Berk, 2002). When children pretend to be others they must learn, remember, and abide by the rules of the new identity. For example, pretending to be a cat, means remembering that cats only meow – they do not talk – and inhibiting the impulse to speak. In sum, rapid maturation and increased exposure to early childhood education activities promote a large increase in behavioral regulation between 3.5 and 6 years old.

Research that has examined this increase in behavioral regulation has generally taken a variable-centered approach, examining predictors of average developmental trajectories for a sample of children. For example, McClelland et al. (2007) examined gains in behavioral regulation from the beginning of the preschool year to the end, using a direct assessment with three to five year olds. In this study, gains in behavioral regulation over the school year significantly related to children's higher vocabulary and mathematics skills. Specifically, one standard deviation growth in behavioral regulation positively related to an advantage in vocabulary (3 months) and math (3 weeks). Similarly, research focusing on change in levels of directly assessed effortful control (related to behavioral regulation) during early childhood demonstrated significant predictive utility and individual stability (Kochanska, Coy, & Murray, 2001; Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007). Taken together, children's rate of behavioral regulation development may play an important role in future outcomes.

Although these studies provide a window into behavioral regulation development, the majority used two time points, which constrains development to be linear. Additional studies examined related skills (inhibitory control and self-control) using three time points (Moilanen, Shaw, Dishion, Gardner, & Wilson, 2009; Vazsonyi & Huang, 2010). Adding a third time point was useful to improve the accuracy of estimated trajectories, but the focus on one average trajectory does not address whether multiple trajectories exist. Using person-centered trajectory modeling to identify sub-

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