

The Young Child's Cognition

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7.2 Implications and Valorisation

Chapter 2 provides valuable insights for policymakers and educators alike regarding early childhood interventions, as well as creates an understanding of the use of academic achievement tests in kindergarten. Chapters 3, 4, 5 and 6 all focus on assessment in young children in relation to recent technological advances. Whilst Chapter 3 provides insight for educators directly on materials available for purchase, Chapters 4-6 answer more fundamental research questions on a newly developed tool.

7.2.1 The Relation Between Preschool Education and Cognitive Outcomes on Standardized School Tests

The results of Chapter 2 are relevant for policymakers regarding the investments in preschool cognitive interventions. In the Netherlands, there has been ongoing debate about the effectiveness of the VVE program as a whole (Fukkink, Jilink & Oostdam, 2017). The current study adds to this debate as a unique dataset, the OML ('Onderwijsmonitor Limburg'), was used for the analysis. The results yield the strongest relationships between an educational intervention for the children who are part of the target group based on parental education level. They also highlight the difficulty with which target-group children can be reached in survey research. Furthermore, this study shows there was a positive trend for all children receiving additional support in comparison to children who did not receive PEP, even if they were not part of the target group. Thus, findings are relevant in understanding the added-value of educational intervention, not just for target-group children. This is closely related to one of the four dilemmas mentioned by Coppens (2015) about investments made in the Netherlands. If the aim is to close the gap, the intervention should be targeted specifically at children from disadvantaged households. If the aim is to provide richer opportunities, more if not all children should get access to the intervention. Therefore, this study also highlights why it is important to understand cognitive abilities in young children.

7.2.2 The Relation Between Executive Functioning Skills and Programming a Bee-Bot

The study in Chapter 3 poses a clear contribution to the scientific literature on the potential of using programmable toys or robots for young children as an assessment tool. Most applications of similar tools are oriented toward cognitive stimulation, whereas this study takes a different perspective and focuses on assessment. Furthermore, the results are very informative for

schools and educators who utilize or are interested in utilizing Bee-Bots and similar tools, because it is a very approachable tool. The Bee-Bot is a very easy-to-use tool specifically designed for young children and can be purchased by schools themselves. Not only is this type of material appealing and interesting for young children, expanding the potential of its application and increasing the understanding of underlying cognitive concepts is highly valuable. The set-up of the study appealed to many teachers who participated in the study. If they were already in the possession of the Bee-Bot or similar materials, they reported to the researcher that they were interested to know what the materials could actually be used for other than fun exercises with the children. Schools often purchase these materials in line with the increased focus on STEM education (Bybee, 2010), where it is becoming increasingly established that familiarity with programming and robotics concepts from an early age onward is beneficial for skill development. However, deepened knowledge of the potential of these tools has yet to be acquired (Bers, Seddighin, & Sullivan, 2013). Studies such as the current one are steps in this direction and have much support from the educational field.

7.2.3 Development of a Smart Toy as a Measurement of Executive Functioning Skills

Before performing a wider data collection in kindergarteners with a new assessment tool, it is important to perform pre-testing. We pre-tested a Clever Maze (CM). This pre-test allowed for checking whether the material is suitable and safe for children, whether the difficulty level is accurate and the material has appeal to the children. It also provided an opportunity to compare the tool's accuracy as compared to a camera-based approach, thus providing a proof of concept that follow-up studies can be performed.

7.2.4 Children's Executive Functioning: What Can Solving Mazes and Free Play on Clever Maze Reveal?

The two studies described in Chapter 5 and 6 investigated the link between children's performance on traditional EF measures and Clever Maze (CM) assignment and free play outcomes. Taking the findings of Chapter 5 and 6 together, there is an overlap in the EF that are picked up by CM when providing an assignment or when letting children play freely. Specifically problem-solving and working memory skills are used in both situations. Regarding the assessment of cognitive abilities in young children, there is a need for innovative testing materials. Technology provides us with many new possibilities in this regard, as a tool that is smart enough to collect data on its own saves on time and expertise investments. Not

underestimating the value of screen-based assessments or pencil-and-paper assessments, smart toys pose the possibility to collect data on behaviour in real-life, potentially without any hassle of observation. Smart algorithms could be used on the collected data (automatically), providing direct insights into child EF.

In more traditional neuropsychological tests, information on subprocesses of solving tasks are usually discarded to receive an eventual score or outcome. This score is compared to a norm score provided by the test developers. In the current studies, we researched a sample of children developing within the normative range and studied extracted information on the processes of solving the assignments or playing with CM. This line of thinking is highly valuable as it underlines more process-related understanding of abilities and development, rather than an absolute thinking in terms of pass and fail. For instance, becoming faster at solving assignments is also a sign of growth, which is usually not incorporated into pass/fail items.

The idea of testing without testing poses the most innovative question of the thesis. In a world where even fridges are becoming 'smart' and information is continuously collected on human behaviour, technology could be implemented in toys to assess behaviour and skills of children. In the past, the connection between toys and technology has often been pursued to create more interaction between toy and child for commercial purposes, such as Hello Barbie (Mattel), or to enhance cognitive abilities with respect to an intervention, such as L2TOR for second language learning (Belpaeme et al., 2018). The continuous collection of data on children, however, can also provide valuable insights into current skill levels and eventually in developmental trajectories. If sufficient toys in a classroom are smart, such as puzzles, mazes, dolls, blocks and so on, a comprehensive view on EF and other skills may be possible. The central idea is that natural behaviour of the child can unfold without an examiner testing the child in a one-to-one setting and specific tasks having to be completed.

If a tool like CM is present in a classroom, for instance, it is available for repeated use and different maze patterns could be used. The potential combination of this tool with other smart toys can provide a comprehensive insight into child cognitive ability. Developmental patterns could be easily plotted and understood on an individual level. Such 'wild' ideas can initially only take place in the lab of research institutions or controlled data collections in schools with a researcher present and are currently too expensive to create en masse. However,

if well-established by research and repeated studies in multiple age groups, commercial applications of such products in collaboration with researchers and educators could yield highly valuable insights and innovations with low investments.