Memory and Executive Function Development in Baby 12-24 Months: A Screening Method by Mothers

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Abstract– **The development of memory and executive function in infants is significant for the development of the same aspects at a later stage** since during this stage of development, infants are actively developing their core executive function and memory skills**. However, research on these two aspects in infants aged 12-24 months in the Indonesian context is still rare. Furthermore, the availability of screening instruments that can be used by mothers to monitor the development of the two aspects is limited. This study aims to develop a method of screening on memory development and executive function that mothers can use for their babies aged 12-24 months. By knowing their child's development in the domain-specific exhibited by the Deferred imitation (DI) task and the A-not-B task, mothers can better understand and obtain feedback regarding their child's development milestones, particularly memory development and executive function. Mothers (N=21) who were involved in this study, filled in pre and post-tests on memory and executive function development, received training to conduct screening by carrying out those 2 tasks to their babies. The mothers were asked to fill in the maternal responsiveness scale to find out the extent of the mother's response rate during interactions with their babies and to see the relationship between their responsiveness and the results of the screening. This study employed a *within-subject pre-and posttest* design. Data were analysed both quantitatively and qualitatively. Qualitative data were gathered through Focus Group Discussion to explore the experiences of mothers when conducting tasks and screening on their babies. The results of this study indicate that the screening method can help maternal participants identify the emergence of memory abilities and executive skills. The screening method used is quite easy and can be carried out by the participants in daily life. However, they need to read the module several times to understand the procedures. Additional analysis showed that maternal responsiveness was associated with a child's better ability to shift from condition A to condition B, but did not confirm an association with DI.**

Keywords: memory development, executive function, maternal responsiveness, screening method

I. INTRODUCTION

Human development in the early years of life has a fundamental role in the subsequent stages of development until adulthood. At this time, stimulation from the environment significantly affects the connections between neurons, affecting various domains of human development (Martorell et al., 2014). This period is commonly referred to as the golden period or the golden age in the human lifespan. This significant golden period has encouraged previous researchers to study how to examine children's growth and development to achieve optimal quality of human resources.

In the first years of life, children experience rapid development both physiologically and psychologically. Physiologically, the child's brain undergoes very rapid formation of synapses and myelination until it reaches 80-90% of the adult brain volume at the age of two years (Knickmeyer et al., 2008). Along with the growth of the child's brain, several psychological aspects also experience

rapid development in the first two years of life, such as sensorimotor, cognitive, and socio-emotional abilities. In contrast to sensorimotor function, which has reached maturity in the first two years of life, cognitive and socio-emotional functions continue to develop through the maturation process until late adolescence (Courage & Howe, 2002). Even so, research in recent decades has found that infants from the age of 3 months have indicated development in their cognitive aspects, namely attention (Holmes, 2011). Maintaining and controlling attention is a crucial ability developed from infancy to support other cognitive developments, such as updating and creating mental representations of memory and executive skills. The ability is also crucial to facilitate children's flexibility to make attention shift from one setting to another (Michel, Wronski, Pauen, Daum & Hoehl, 2019).

Memory plays a vital role in everyday human life in various activities and tasks. Experts divide memory into several systems, including long-term memory (Goldstein, 2015; Matlin, 2013). Long-term memory is the system that is responsible for storing information for a long period of time. This memory system is a kind of information archive about past events, similar to an archive of knowledge that we have learned and accumulated throughout life (Goldstein, 2015; Matlin, 2013). Experts categorise term memory into two types, namely explicit memory or conscious memory and implicit memory or unconscious memory (Matlin, 2013; Goldstein, 2015). This study focuses on the subdivision of explicit memory, namely episodic memory.

Schacter (1996) explains how memories can be formed and stored in the brain. In particular, he explained that episodic memory is stored when memory traces. In remembering, especially in the encoding process, the brain that receives information will form, modify, and strengthen the connecting pathways between neurons. These paths are referred to as memory traces which contain records of information that has been learned. If a person has a solid connecting pathway between neurons, then his ability to store and recall information that has been stored will be better. Thus, processing information will make knowledge stored in long-term memory which can change the structure of the neurons' connections.

Neurons' connections are formed very rapidly at the beginning of human life and peak until the age of 3 years where the brain develops up to 90 percent (Gabbard, 1996). Any information from the environment will enter through the five human senses and then form connections between neurons (Santrock, 2016). Thus humans need to be stimulated from infants because it will affect memory development at the following stages (Martorell, et al., 2014). Research on this memory was initially carried out on adults with neurological problems, but currently, there are many studies of long-term memory in children (Dehn, 2010; Heimann & Meltzoff, 1996; Heimann et al., 2017).

Studies about episodic memory in infants were carried out by measuring deferred imitation (Heimann & Meltzoff, 1996; Heimann et.al, 2017). Deferred imitation is a reproduction of behaviour that has been observed after some time has passed. Since the behaviour no longer occurs because it has passed, deferred imitation allows the stored behaviour symbol to be recalled. Deferred imitation is considered an essential milestone in the realm of children's cognitive development. According to Piaget, deferred imitation represents one of the critical endpoints of the sensorimotor period. This capacity is vital for the next stage of development, which is related to symbolic thinking skills and pre-operational development (Piaget, 1999). It is also in sync with symbolic play skills and perceives higher-order object permanence (Piaget, 1999). Piaget believes that we cannot measure the deferred memory of children under 18 months of age because they do not yet have adequate capacity to store mental representations.

However, recent research has shown that children under 18 months of age can imitate after the adult behaviour shown has passed (Meltzof & Moore, 1994; Heimann & Meltzoff, 1996; Heimann et al., 2017). Deferred imitation is a complex thing that develops even from 6 to 9 months (Bauer, 2002). This capability indicates the baby's ability to remember even after time has passed. At the age of 18 months, which will occur later in childhood amnesia, children can remember in a certain period up to

several weeks. So the view of Piaget (1999), which says that children under the age of 18 months, do not have the ability to store information in the long-term memory system, is refuted (Eacot, 1999).

Thus, it is essential to know the ability of young children to store information in the realm of declarative memory. Without declarative memory in early childhood, we will not be able to remember events in early life that form the basis for processing information at later stages of development (Eacot, 1999).

Besides deferred imitation, there is another fundamental skill that develops during infancy, called executive function. A higher-order cognitive function supports self-regulation processes and underlies one's behaviour to achieve goals (Cuevas & Bell, 2014). Executive function refers to a term that describes higher-order cognitive processes such as planning, attention, problem-solving, coordination, choosing between options, suppression of internal and external drives, and various other cognitive processes (Diamond, 2006). In other words, the executive function can facilitate a person's ability to display goal-oriented behaviour, maintain focus and motivation to make decisions or actions by planning, and adapt flexibly to changing contexts that occur in the surrounding environment.

Executive function is closely related to the prefrontal cortex development, which begins to develop rapidly in early childhood (Carlson, Zelazo, & Faja, 2013). In addition, executive function, higher-order cognitive processing, also involves different brain tissues and parts, such as the basal ganglia, thalamus, anterior cingulate cortex, cerebellum, and other cortex areas outside the frontal lobes. In the frontal lobe, each area also has a different role in facilitating executive function. The dorsolateral prefrontal cortex (DLPFC) is often associated with working memory performance. The superomedial prefrontal cortex plays a role in supporting sustained attention. While the ventral prefrontal cortex (VPFC), which consists of orbitofrontal and ventromedial, plays a role in inhibitory control behaviour, selecting appropriate social responses, and sensitivity to reward and punishment (Suchy, 2009).

Although the frontal lobe development that underlies the performance of the executive function is believed to have only reached maturation towards the early adult stage, several studies have found that executive function has developed since infancy. Diamond (2006) explains that at the age of 8 months, babies have shown the ability to control inhibition so that they can ignore distractions or irrelevant information and maintain information related to the ongoing situation. This development is supported by mental representation, facilitating the transition from infancy to early childhood (Miller & Marcovitch, 2015).

During childhood, executive function is associated with school readiness (Blair & Peters, 2003) and academic performance (St. Clair-Thompson & Gathercole, 2006). Deficits in executive function are associated with the appearance of early developmental disorders such as, for example, attention deficit and hyperactivity disorders, autism spectrum disorders. The development of EC is strongly influenced by environmental factors, both negative influences, such as poverty, and positive influences, such as care that is sensitive to children's needs (Diamond, 2016). The executive function, which is sensitive to environmental influences, has implications, as explained by Diamond (2016), about the need for early intervention, especially in children from at-risk environments or those from families with low socioeconomic levels. Therefore, providing executive function developmental screening skills to mothers with low socioeconomic backgrounds will significantly benefit the child's development.

The early years of human development are the most important stages that determine development quality at later stages. At this time, especially at the age of 12-24 months, the mother plays a crucial role in monitoring and helping the baby achieve optimal development through the interaction between mother and child. In the interaction between mother and child, the mother is expected to carry out her role as the primary caregiver and become her child's main socialisation agent (Owen, 2005). As the

main significant person for the baby, it is important for the mother to recognise her ability to understand what the baby is thinking and feeling, which then underlies the response given by the mother to her baby. The ability to understand and respond to this baby is the foundation of the mother-infant relationship that consistently affects the baby's cognitive and socioemotional development (Yatziv, Kessler, & Atzaba-Poria, 2018).

Mother responsiveness is essential in the stimulation of optimal baby development. It describes the behaviour of mothers who are responsive and appropriate in responding to the behaviour of the actions of their babies (Bornstein & Tamis-Lemonda, 1997). By the response from the mother to the actions or situations experienced by the baby, the baby will feel safe and develop a secure attachment relationship and learn to self-regulate (Leerkes & Qu, 2017). The behavioural response shown by the mother to the actions or activities carried out by the baby triggers the baby's learning process that his actions have consequences or influences on the surrounding environment.

Mother responsiveness is important for development in the early stages of life and can also support a child's cognitive skills in later stages of development. Mother responsiveness is related to the literacy development or language skills in early childhood, which then supports the development of children's cognitive skills that can be developed through social interaction (Paavola, Kunnari, & Moilanen, 2005; Prime, Wade, & Gonzales, 2019). Children raised with responsive maternal care will have better control abilities and delay gratification (Cheng, Lu, Archer, & Wang, 2018). For example, children who receive responsive maternal care will be better able to establish a secure attachment relationship with their mother, which plays an important role in the child's ability to explore the surrounding environment as part of the child's learning process to train cognitive and socioemotional abilities. So, in addition to predicting children's literacy and learning abilities in general (Taylor, Anthony, Aghara, Smith & Landry, 2008), Mother responsiveness is also believed to prevent the emergence of problematic behaviours (Leerkes & Qu, 2017).

Based on the previous explanation, mothers, as the primary caregivers who have a significant influence in the lives of children, can be involved in monitoring their child's growth and development. Genetic factors strongly influence the development of connections between neurons in the fetus. However, when a child is born in the world, his early brain development is also influenced by the stimulation he receives through the five senses originating in his environment (Nelson, 2013; Santrock, 2014).

Several measurements of infant development have been widely used, one of which is the Bayley Scale of Infant and Toddler Development test to assess delays in motor, cognitive and language development in infants aged 1-42 months. The test is considered less able to explain specifically the skills or domains that can be associated with the provision of treatment or intervention (Brito et al., 2019).

This research aimed to study the method of screening the development of memory and executive function of infants aged 12-24 months by mothers. Additionally, this study also aimed to understand mothers' experiences during implementing the screening tools. In contrast to previous studies that examined the development of Deferred imitation and executive function, which were mostly carried out in the laboratory and administered by the research team, in this study, the mother carried out the administration of screening at home. Another difference of this study compared to previous studies is the use of screening aids by using objects around the house instead of using sophisticated tools. By knowing about their child's development in specific domains, mothers can better understand and obtain feedback regarding their child's developmental milestones and then be followed up by appropriate early intervention as needed.

II. METHODS

Design and Analysis

Design and Analysis

This research method used mixed methods research that combines elements of quantitative research and qualitative research to answer the research aims. For the quantitative part, a within-subject pre- and post-test design was employed. Demographic data from participants were processed by descriptive statistical analysis to see the distribution and normality of the data. Following, parametric statistical techniques were used to see conclusions that can be drawn from the results of the pre-and post-test stages, scores on the Maternal Responsiveness Scale measurement, as well as results on the screening tasks given to children. Meanwhile, for the qualitative part, data were gathered through Focus Group Discussions to explore the experiences of mothers when conducting tasks and screening their babies. Thematic analysis was employed to gain insights from the mothers' report.

Participant

The inclusion criteria for participants in this study were initially mothers with an education background of senior high school level or higher, coming from families with middle-low socioeconomic status, aged 20-35 years, having no history of severe neurological or developmental disorders, and having typically developing children aged 12-24 months. Participant selection was carried out through purposive and snowball sampling techniques. Prospective participants were asked to fill out an online pre-screening form that includes information about personal and demographic data, medical history, and consent to participate in a series of research processes. The recruitment process, however, afforded 21 mothers aged 21-40 years, with diverse education levels (junior high school to Master degree), as well as socio-economic status which is grouped into three categories, namely low, medium and high. Furthermore, there were 22 baby participants aged 12-25 months without a history of neurological or developmental disorders.

Measurements on Mother

Measuring mothers' understanding memory and executive function development

Pre and post-tests were conducted to measure the mother's knowledge about the development of memory and executive function skills in infants 12-24 months. Questions on the pretest-posttest measurement consisted of questions related to memory development, executive function abilities and DI and A not B game tasks

Measuring Maternal Responsiveness

Measurement of maternal responsiveness was conducted using the Maternal Responsiveness Scale questionnaire (Leerkes & Qu, 2017) which was adapted into Indonesian. The questionnaire is a self-report and contains 48 statements that describe mother behaviors to their babies based on the dimensions of responsiveness (25 statements), delayed responsiveness (11 statements), and non-responsiveness (13 statements). The results of this questionnaire are seen from the total Likert scale selected from the number 1 (never) to 5 (always).

Measurements on Babies

Measuring Deferred imitation (DI task)

In this screening, there are three activities developed from experiments conducted by Heimann & Meltzoff (1996) and Heimann et al. (2017): heading a box, moving objects, and stepping on a rubber toy. These three activities use objects that are around the house that are easily obtained and affordable by mothers. The experiment was conducted three times using three different objects, which were completely new and had never been seen by the baby. Mothers were asked to demonstrate with each object three times in 20 seconds. Following this, the mother invited the child to do other activities for 10 minutes before giving the object to the baby. If the baby could take the initiative to repeat the

action demonstrated by the mother on the object within 30 seconds after touching the object, then the baby was considered to have developed his/her memory skills.

Measuring Executive Function (A not B task)

The A-not-B task was originally developed by Piaget with the aim of looking at the search strategies babies use to find an object hidden in front of them. Several follow-up studies using this task have also found that the search strategy can describe the development of executive skills (EF) in infants (Frossman & Bohlin, 2014). To carry out this task, two containers that have the same colour and shape characteristics were used, as well as one object that can be hidden in both containers. In administering it, this task was divided into experiments A and B. The child was positioned sitting in the middle facing between two closed containers. Experiment A was carried out four times, where the mother as the experimenter would display an object to her baby and then place it in a closed container at a location point in front of the child. Then, after a pause of at least 6 seconds, the mother asks her child "Where is that object?". After experiment B was carried out twice with a similar mechanism to experiment A. Only, the mother would hide the object in another container that had the same shape and characteristics, but at a different location point (next to the location point in experiment A). If the baby was able to pick up the object at the correct location on Experiment B, then the baby was judged to have developed executive skills.

III. RESULTS AND DISCUSSION

Measurement on Babies

Measurement of memory ability in infants was carried out using the Deferred Imitation task, while executive skills were carried out with the A not B task.

Deferred Imitation (DI) Tasks

The DI task measures infant memory development skills (Heimann, Edorsson, Sundqvist, & Koch, 2017). The baby's performance was measured by looking at the baby's initiative to repeat the actions previously demonstrated by the mother on the target object within 30 seconds after touching the object. Infants who get score 1 (success) have developed their memory skills. If they bring up the initiative, they get a score of 0 if the behaviour does not appear. Four raters assessed the DI task separately to obtain more objective data in this task. The reliability coefficient of the score from the interrater is 0.947, which indicates high consistency.

In this study, 21 mothers practiced three activities that measured DI and videotaped them. However, not all videos submitted were complete. There are 58 activities videos, consisting of 21 heading the box activity, 19 moving objects activity, and 18 stepping on rubber toys activity. Based on observations, all children involved in this game have joint attention abilities so that the game activities carried out can be continued for the scoring process.

Based on the scoring result, some of the children appeared to have developed their DI skills. 24% (5 of 21 children) successfully carried out the task of heading the box, 63% (12 of 19 children) succeeded in carrying out the task of moving objects, and 33% (6 of 18 children) successfully performed the task of stepping on a rubber toy.

Table 1. Deferred Imitation task score data

Task name	Number of trials	The percentage that successful (score 1)
Heading box	21	24%
Move things	19	63%
Stepping on a rubber toy	18	33%

Of the 58 activity videos available, eight children (14%) who get a score of 0 cannot be taken for granted as having the ability to do DI tasks because they performed as expected before being given an example. Thus, even though these eight children were able to show how to perform as exemplified by their mother, it did not mean they were able to show the memory ability from the learning process. Several children performed the expected behavior, consisting of a child who headed the box, four children who moved objects, and three children who stepped on a rubber toy before being given an example by their mother. Based on the body parts used naturally, the most popular body parts used are the hands, the feet, followed by the least familiar forehead. Based on this data, the use of the forehead is the purest. Children more naturally use hands and feet to explore their environment. However, this does not mean that moving objects and stepping on rubber toys cannot be used to screen the development of DI in children. In conclusion, these three activities can still be used as DI screening activities as long as in the initial phase of the game (baseline), the children do not show the expected performance before being given an example.

A not B Tasks

Task A not B (Frossman & Bohlin, 2014) is a search strategy that can describe the development of executive skills in infants. The assessment on this task is judged from the baby's performance in looking and reaching. The assessment of looking is seen from the baby's performance which directs the gaze directly to the correct hiding location after the mother says "where is the toy?". Furthermore, the assessment of reaching is evaluated from the behavioural response of the baby whether to reach the bowl at the correct hiding location using his hands.

To obtain a more objective assessment in this task, three raters assess the child's behaviour during tasks A not B separately. The scoring results of these three raters were then analyzed to see the interrater reliability index, which resulted in a Cronbach alpha coefficient of 0.91. Based on this index, it can be said that the scores produced by these three raters have a satisfactory internal consistency (Taber, 2018). That way, the score assessment of the three raters is sufficient.

The following is a description of the baby's performance data on task A not B.

Table 2. A not B score

Data	Indeks	Persentase
Score 0	9	40%
1	7	31.8%
2	6	27.2%
Mean	0.87 (*SE* = 0.178)	

Based on Table 3, it was evident that almost half (40%) of the sample did not manage to find the toy hidden in the correct bowl in both conditions A and B due to several reasons; failure in giving instructions to the baby, failure in shooting the video, incompatibility with the method taught in the module, and the baby's inability to find the toy in the correct place in condition A (thus indicating there was no switching process from condition A to B). Furthermore, although a total of 31.8% of infants were able to find toys that were hidden in condition A, they were unable to switch to condition B. To sum up, only 27.2% of infants were able to switch from condition A to B.

Additional analysis

The data of 22 mother-infant pairs were used in the additional analysis. Given the type of the scores obtained from the A-not-B and DI tasks and concern over the normality of the data, non-parametric statistics were employed to yield correlations coefficients among variables. After conducting Spearman's correlation analysis, the SPSS produces the following Spearman's correlation output:

Table 1.1 Spearman's Correlation Analysis on Maternal Responsiveness Scale, A-not-B, and DI tasks

Correlations

			MRS	A-not-B	DI
Spearman's rho	MRS	Correlation Coefficient	1.000	0.482*	-0.348
		Sig. (1-tailed)	.	0.012	0.056
		N	22	22	22
	A-not-B	Correlation Coefficient	0.482*	1.000	0.071
		Sig. (1-tailed)	0.012	.	0.376
		N	22	22	22
	DI	Correlation Coefficient	-0.348	0.071	1.000
		Sig. (1-tailed)	0.056	0.376	.
		N	22	22	22

** Correlation is significant at the 0.05 level (1-tailed)*

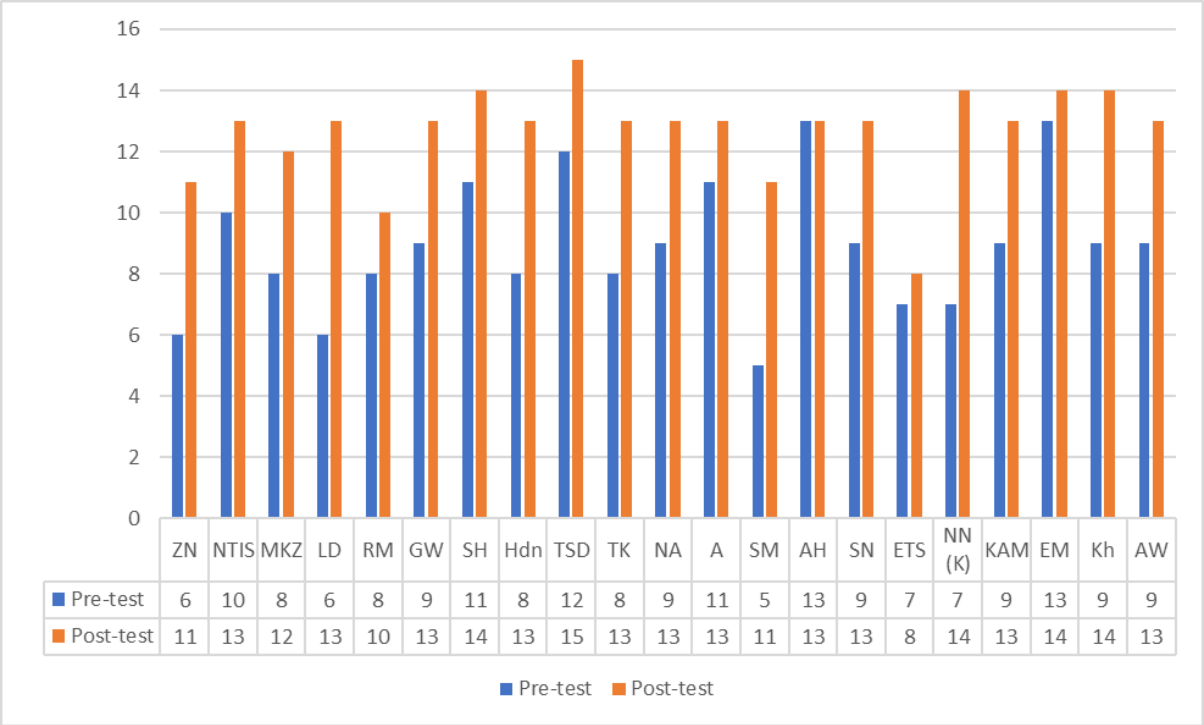
According to Table 2.3, there was a significant positive correlation between the Maternal Responsiveness Scale score and A-not-B task score ($r_s = 0.482$, $p > 0.05$). This result showed that the more responsive maternal care during the first years of life would lead to the child's better ability in performing mental shifting from A to B condition, which also indicated the development of executive function in infants. Our finding confirmed the results of previous studies that the quality of mother-infant interaction plays an important role in the development of cognitive skills, namely the executive function. Mother's responsive behaviour during mother-infant interactions would stimulate the learning process in infants while also feeling secure in the relationship with their primary caregiver. A secure relationship with their primary caregiver would optimize their ability to hold a mental representation of the objects that gained their interest. Thus, the infants would be able to learn about the consequences and influences of others' behaviour and their own behaviour and learn to manage a strategy to fulfil their needs despite the situation.

However, the findings of the present study could not confirm the relationship between the child's performance DI task and the Maternal Responsiveness Scale. One explanation would be that the

infants' memory had not reached maturity in maintaining long-term memories yet. Although infants may already be able to maintain working memory, long-term memory would require a more complex organization of memory storage and retrieval of information. In addition, the tasks used in this study involved objects that might have been familiar to the infants before the data collection, so that the child might have been accustomed to the way of using the objects and did not actually imitate the behaviour displayed during the tasks.

Mother's pretest and posttest results

The pretest on the understanding of memory abilities and executive function skills in infants was done by the mother before the training. After the training, the mother then did the posttest. The following is a graph of the results of the pre-test and post-test by the mother participants.



	ZN	NTIS	MKZ	LD	RM	GW	SH	Hdn	TSD	TK	NA	A	SM	AH	SN	ETS	NN (K)	KAM	EM	Kh	AW
Pre-test	6	10	8	6	8	9	11	8	12	8	9	11	5	13	9	7	7	9	13	9	9
Post-test	11	13	12	13	10	13	14	13	15	13	13	13	11	13	13	8	14	13	14	14	13

The pretest and posttest scores were analyzed using paired sample t-test analysis. Paired sample t-test analysis was used to compare the mean of the group of mothers who were research participants who had been measured in different timescales. The results of the paired sample t-test analysis showed that there was a significant difference between mothers' understanding before the training (M=8.90; SD=2.189) and after the training (M=12.67; SD=1.56), t(20)=-9.227; p<0.001.

Mothers' experiences of screening tasks

In addition to using a quantitative approach, qualitative analysis was also carried out on the data that were collected through focus group discussions involving 19 mothers. Data collection through focus group discussions was carried out to explore the experiences of mothers during conducting screening tasks for their babies. Thematic analysis resulted in 7 themes as follows:

Theme	Findings
Understanding of memory development	• Understand that events in the early years will impact on a later stage • Simple games are useful for sharpening children's memory and executive functions • Demonstrating is more practical since they stick to the child's memory more than words.
Understanding of executive function abilities	• It is important to pay attention to children's executive abilities because they are useful for children's lives • Simple games are useful for sharpening children's executive functions
Maternal screening skills	• In imitating something children see, children need time to do it again • Joint attention games are important for children in conditioning whether they pay attention in carrying out activities • Play is not only children's play, but parents also need to participate • The ability of how mothers provide stimulation to children is important
Advantages of the screening method	• Quite easy to demonstrate or share with other mothers because the materials used in the module are easy to obtain • Can be implemented by others.
Challenges of the screening method	• No one helps to record video • Child's condition (mood, health, boredom) • It takes many reads to understand the module because of the many steps in the game • Need a strong will to overcome obstacles in providing stimulus to children
Benefits gained	• mothers know that children can imitate the behavior of mothers and adults • Instilling habits in children depends on parents or adults around, because parents do and provide examples that children will imitate later • giving examples of behavior and direction to children can be a stimulus for child development • Knowing the child's ability is a lesson for mothers in accompanying their children • Through training increase understanding of the importance of executive function and stimulation abilities in children's development • A lot of stimulation around us that we don't see or seem trivial • Feel guilty with the child because the child needs a mother no matter how small

Facilitator's Observations on Mother's Screening Behavior

The screening method carried out by mothers was based on the module and video tutorials provided at the beginning of the training. In the module given to maternal participants, there are several procedures that mothers must carry out when conducting screening at their respective homes. The procedures direct the mothers to follow steps that must be met. The results of observations on maternal behaviour indicate that the screening method described in the module and video tutorial is effective to provide mothers with an understanding of the techniques for screening. Although several methods of explaining and assisting the mother participants were implemented, some participants still performed errors in carrying out the screening procedure. Based on the facilitators' observations, it was found that some of the procedures written in the module were not implemented according to the directions. Some of the participants' mothers had errors in carrying out the procedure, such as having too close a distance between mother, baby, and the screening tool, the mother did not pause between the time of giving the sample and immediately asked the baby to practice it. In addition to errors in

the procedure, some mothers also had errors in implementing the instructions in the training module. Screening that should be done by the mother but on one of the participants was carried out by the grandmother of the baby. Another error found by the facilitator was that the atmosphere in screening infants had disturbances, such as the presence of older siblings during screening, older siblings helping to play games, and a less conducive atmosphere (eg noise from television or road noise). Some mistakes made by mothers during screening are understandable because the implementation of this screening has only been learned by mothers and was something new that they have never done before. The results of these observations provide feedback to researchers about the parts in the module that still need improvement or more detailed briefing for mothers.

III. CONCLUSION AND RECOMMENDATION

This study shows that the development of a screening method with a module, video tutorials, as well as supporting activities in the form of training and mentoring for mothers can increase mothers' understanding of infant's memory abilities and executive function skills, as well as equip mothers with screening skills. This study concludes that this screening method can be carried out easily by mothers independently in their setting. However, the implementation of this screening method has reflections for the application of this method in the future, such as being disciplined in carrying out the procedures described in the screening module, mothers can minimize interference from other parties when the screening process is carried out (e.g. invite children to play) in a separate room), and mothers can consult the results of their screening to professionals, such as paediatricians, child psychologists etc. if mothers find inappropriate responses displayed by their children when the screening process is carried out. The study also concluded that better maternal responses during mother-infant interactions would result in better development of executive function in the first two years of life. Future research can create different types of games that can be done as a measurement of the baby's ability. Furthermore, given the limitations of our study, we suggest that future studies will ensure the novelty of the task used during the DI task and recruit more mothers-infants to increase the representativeness of the data.

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REFERENCES

Blair, C., & Peters, R. (2003). Physiological and neurocognitive correlates of adaptive behavior in preschool among children in Head Start. *Developmental Neuropsychology*, *24*(1), 479-497. doi: 10.1207/S15326942DN2401_04

Bornstein, M., & Tamis-Lemonda, C. (1997). Maternal responsiveness and infant mental abilities: Specific predictive relations. *Infant Behavior And Development, 20*(3), 283-296. doi: 10.1016/s0163-6383(97)90001-1

Brito, N. H., Fifer, W. P., Amso, D., Barr, R., Bell, M. A., Calkins, S., Flynn, A., Montgomery-Downs, H. E., Oakes, L. M., Richards, J. E., Samuelson, L. M., & Colombo, J. (2019). Beyond the Bayley:

Neurocognitive assessments of development during infancy and toddlerhood. *Developmental Neuropsychology*, *44*(2), 220–247. doi: 10.1080/87565641.2018.1564310

Carlson, S. M., Zelazo, P. D., Faja, S. (2013). Executive Function. Dalam P. D. Zelazo (Ed.), *The Oxford handbook of developmental psychology*, Vol. 1 (hal. 706-743). New York: Oxford University Press.

Cheng, N., Lu, S., Archer, M., & Wang, Z. (2018). Quality of Maternal Parenting of 9-Month-Old Infants Predicts Executive Function Performance at 2 and 3 Years of Age. *Frontiers In Psychology, 8*. doi: 10.3389/fpsyg.2017.02293

Courage, M., & Howe, M. (2002). From infant to child: The dynamics of cognitive change in the second year of life. *Psychological Bulletin*, *128*(2), 250-277. doi: 10.1037/0033-2909.128.2.250

Cuevas, K., & Bell, M. A. (2014). Infant attention and early childhood executive function. *Child development*, *85*(2), 397-404.

Diamond, A. (2006). The early development of executive functions. Dalam E. Bialystok, & F. I. M. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (hal. 70-95). New York: Oxford University Press.

Diamond, A. (2016). *Why improving and assessing executive functions early in life is critical*. In J. A. Griffin, P. McCardle, & L. S. Freund (Eds.), *Executive function in preschool-age children: Integrating measurement, neurodevelopment, and translational research* (p. 11–43). American Psychological Association. doi: 10.1037/14797-002

Eascott, M.J. (1999). Memory for the Events. *Current Direction in psychological Science, 8*(2), 46-49.

Heimann, M. & Meltzoff. (1996). Deferred imitation in 9 and 14 month-old infants: a longitudinal study of a Swedish sample. *British Journal of Developmental Psychology*, *14*(1), 55-64. doi: 10.1111/j.2044-835X.1996.tb00693.x

Goldstein, E. B. (2015). *Cognitive Psychology: Connecting Mind, Research, and Everyday Experience, 4th Edition*. Stamford: Cengage learning.

Heimann, M., Edorsson, A., Sundqvist, A., & Koch, F. (2017). Thirteen- to sixteen-months old infants are able to imitate a novel act from memory in both unfamiliar and familiar settings but do not show evidence of rational inferential processes. *Frontiers In Psychology*, *8*. doi: 10.3389/fpsyg.2017.02186

Holmes, J. (2011). Baby brain: training executive control in infancy. *Current Biology*, *21*(18), R684-R685.

Johansson, M., Forssman, L., & Bohlin, G. (2014). Individual differences in 10-month-olds' performance on the A-not-B task. *Scandinavian Journal Of Psychology*, *55*(2), 130-135. doi: 10.1111/sjop.12109

Knickmeyer, R., Gouttard, S., Kang, C., Evans, D., Wilber, K., & Smith, J. et al. (2008). A Structural MRI Study of Human Brain Development from Birth to 2 Years. *Journal Of Neuroscience*, *28*(47), 12176-12182. doi: 10.1523/jneurosci.3479-08.2008

Leerkes, E., & Qu, J. (2017). The Maternal (Non) Responsiveness Questionnaire: Initial factor structure and validation. *Infant And Child Development*, *26*(3), e1992. doi: 10.1002/icd.1992

Matlin, M. J. (2013). *Cognition,* 8th ed. Hoboken: John Wiley and Sons.

Martorell, G., Papalia, D.E., & Feldman, R.D. (2014). *A child's world, infancy to adolescence*, 13th edition. New York: McGraw Hill Education.

Michel, C., Wronski, C., Pauen, S., Daum, M., & Hoehl, S. (2019). Infants' object processing is guided specifically by social cues. *Neuropsychologia*, *126*, 54-61. doi: 10.1016/j.neuropsychologia.2017.05.022

Miller, S., & Marcovitch, S. (2015). Examining executive function in the second year of life: Coherence, stability, and relations to joint attention and language. *Developmental Psychology*, 51(1), 101-114. doi: 10.1037/a0038359

Nelson, C.A. (2013). Brain development and behavior. In A. M. Rudolph, C. Rudolph, L. First, G. Lister, & A.A. Gershon (Eds). *Rudolph's Pediatrics* (22th ed). New York: McGraw Hill

Owens, R.E, Jr. (2005). *Language Development: An Introduction* (6th ed.) Boston: Allyn & Bacon.

Paavola, L., Kunnari, S., & Moilanen, I. (2005). Maternal responsiveness and infant intentional communication: implications for the early communicative and linguistic development. *Child: Care, Health And Development, 31*(6), 727-735. doi: 10.1111/j.1365-2214.2005.00566.x

Piaget, J. (1999). *Play, dreams, and imitation in childhood*. London: Routledge (originally published in 1951).

Prime, H., Wade, M., & Gonzalez, A. (2020). The link between maternal and child verbal abilities: An indirect effect through maternal responsiveness. *Developmental Science, 23*(3). doi: 10.1111/desc.12907

Santrock, J.W. (2016). *A topical approach to life-span development, eight edition*. New York: McGraw Hill Education.

St Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *Quarterly journal of experimental psychology*, *59*(4), 745-759.

Suchy, Y. (2009). Executive functioning: Overview assessment an research issues for non- neuropsychologists. *Annals of Behavioral Medicine, 37*(2), 106-116. doi: 10.1007/s12160-009-9097-4

Taylor, H., Anthony, J., Aghara, R., Smith, K., & Landry, S. (2008). The Interaction of Early Maternal Responsiveness and Children's Cognitive Abilities on Later Decoding and Reading Comprehension Skills. *Early Education And Development*, *19*(1), 188-207. doi: 10.1080/10409280701839304

Yatziv, T., Kessler, Y., & Atzaba-Poria, N. (2018). What's going on in my baby's mind? Mothers' executive functions contribute to individual differences in maternal mentalization during mother-infant interactions. *PloS one*, *13*(11), e0207869.