



Exploring key cognitive indicators for practical use by parents in community setting

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Introduction

Cognition is the mental process individuals use to acquire and process information. It includes perception, memory, and thought, and is impacted by biological, environmental, experiential, social, and motivational variables. Changes in quality or stages are used to characterize the cognitive development process. Each stage is distinct,

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Abstract

The identification of child development milestones, specifically cognitive abilities, requires parental/caregiver awareness and knowledge. With the existence of multiple cognitive abilities such as attention and focus, memory, language, psychomotor skills, logic, reasoning, decision-making, problem-solving, social/emotional, there are multiple indicators to measure children's cognitive abilities. Pediatricians are the most knowledgeable and trusted authority to routinely screen and monitor the development of healthy children. Therefore, it is crucial that parents understand their children's developmental milestones so if they encounter anomalies, they can immediately consult with the professionals. This review compiles recently published research and current knowledge to examine potential key indicators of cognitive development in infants and children that can be utilized by parents and communities in an easily understood manner.

Keywords: indicator, cognitive abilities, children more than one year old

arranged sequentially, and builds upon the stages that came before it. Due to the biological basis of this structure, this theory asserts that cognitive capacities and developmental processes are universal, including all members of a given species regardless of their cultural or historical background.¹

Jean Piaget (1896-1980) introduced the most widely recognized theory of cognitive development. Piaget postulated four phases of mental organization to characterize the development from infancy to cognitive maturity: sensorimotor, pre-operations, concrete operations, and formal operations. Two mechanisms govern cognitive development: organization and adaptability. Organization refers to the stages of

development and how they unfold over time, whereas adaptation refers to the process by which children's thought processes become increasingly aligned with characteristics of their environment.^{1,2}

The development of cognitive abilities is the foundation of intelligence. The dictionary defines the ability to learn, understand and deal with something new as intelligence. Intelligence is a broad concept that encompasses a wide range of factors and is still only partially understood. The most successful attempts to quantify this concept have been made using standardized intelligence tests to measure multiple areas such as problem-solving, language, attention, memory, and information processing in one test.³

In terms of clinical developmental screening tools, pediatricians now have various options to utilize, such as the Parents Evaluation of Developmental Status (PEDS) and the Denver-II Screening test, which are both available to them. Specifically designed for pediatricians to use in the office, the Bayley Scales of Infant Development and The Capute Scales is a promising test that assesses a child's cognitive function and language skills. Each screening instrument has its own set of advantages and disadvantages.^{4,5} For the early detection of developmental delays, screening such as Denver-II and PEDS are widely utilized by health care professionals and utilized in several primary care facilities.

Research has demonstrated the critical importance of parents' and caregivers' knowledge and expectations on a child's cognitive development. Miller (1988) is the first to assert that parental beliefs are positively associated with parental childrearing practices and the development of children.⁶ A recent study also demonstrated that parents with superior parenting knowledge, parenting practices, and parent-child interactions significantly influence the cognitive, linguistic, and motor development of their children. On the other hand, multiple studies have demonstrated that parents are the first institution to screen a child for developmental risks, particularly cognitive development. So, it's essential for parents to be aware and knowledgeable in watching out for their child developmental issues so they can be addressed by professionals.⁷⁻⁹ Therefore, it is

necessary to introduce parent-friendly cognitive indicators to increase parents' and caregivers' understanding of which aspects of a child's development deviate from those of children of the same age. In this article, we explored potential key indicators of cognitive development in infants and children that can be communicated to communities/parents/caregivers and are easily understood by them.

Methods

This article introduce a parent-friendly cognitive key indicators in infants and children to help parents, caregiver and professionals to understand child's development in easy to digest manner. This literature review was prepared by looking for relevant papers and articles published in many electronic databases such as Pubmed and Medline between 2017 and 2022. Variants of "cognitive function" "cognitive domain" "children development" "development measurement" "infants" "children" were included in the research terms. Further papers were found, either in English or Indonesian, through manual search from the manual references cited in the corresponding reviews.

Discussion

Piaget's developmental theory

According to Piaget, human cognitive development occurs in four stages. *First*, the sensorimotor stage lasts from birth to approximately two years of age. The baby develops an understanding of the world during this stage by coordinating sensory experiences such as sight and sound with physical, motoric actions.⁶ At the beginning of this stage, infants exhibit only a reflex behaviour pattern. Two-year-old children are able to produce complex sensorimotor patterns and use primitive symbols at the end of the sensorimotor stage.⁷ *Second*, preoperational stages occur between the ages of 2 and 7, when children begin to represent their world with words, shadows, and images. Children begin to use language during this stage; their memory and imagination are also developing. At this stage, children develop trust in themselves and express

their understanding of the relationship between the past and the future. Symbolic thoughts transcend simple associations between sensory data and physical reaction.^{2,7} Between the ages of 2-4 years, there is a symbolic phase. At this stage, the child develops the ability to represent objects that cannot be seen mentally. This ability broadens children's mental worlds, as evidenced by their ability to describe people, homes, cars, and clouds randomly. Additionally, there is an intuitive thinking phase (4-7 years) during which children begin to use primitive reasoning and seek answers to various questions. According to Piaget, this stage is characterized by free, imaginative, and unique associations that occasionally make no sense.^{6,8} *Third*, concrete operational stages lasts between seven and twelve years. At this stage, the child can perform operative actions, and logical reasoning takes the place of intuitive reasoning, as long as the reasoning applies to specific and concrete examples. *Fourth*, formal stages of operation begin around the age of 12 years. The child moves from concrete to abstract and more logical thinking at this stage.^{2,7}

Piaget emphasizes that as children develop cognitively, they progress sequentially through four major stages. Because heredity and environment interact, it is possible for a child to exhibit characteristics of more than one developmental stage at the oldest ages. Each stage represents a significant change in cognitive processes relative to the previous stage. The stages are sequential and adhere to a consistent order. This means that the child cannot skip or miss a normal developmental stage. Several domains develop and become critical skills in cognitive development during these first two three stages, including psychomotor skills, language, memory, focus and attention, logic reasoning, problem-solving, and critical thinking. Therefore, understanding these domains are important to give sufficient experience in each stage in order to prevent developmental lag.⁸

Cognitive development for children above one year old

Multiple factors contribute significantly to the cognitive development of children older than one year. Included are logical reasoning and decision-making, problem-solving, attention and concentration, psychomotor skills, memory, and language. For cognitive development to be successful, all of these domains must be improved. Memory consists of encoding, storing, and retrieving information.⁹

Problem-solving is the process of establishing a goal, executing actions to achieve that goal, and overcoming obstacles to achieve that goal. It is a complex cognitive ability that depending on a few abilities, such as attention, perception, memory, concepts, and, in most cases, symbolic processes such as language.^{1,3} The activities in which children participate become more complex as they get older, and their ability to solve problems improves. Children encode more details about a problem and allocate their attention more efficiently while encoding. As they grow older, children use information about their routine behavior and the characteristics of their surroundings to solve problems.^{3,10}

Furthermore, children learn a variety of powerful thinking techniques, such as rule-based reasoning, analogies, and hierarchical classification. The ability to gather premises in order to reach a conclusion is referred to as reasoning.^{11,12} Between the ages of 12 and 24 months, observing a child's ability to lift boxes to find a toy, unwrap a toy, turn pages in a book, find hidden toys, and match objects into pairs or pictures can reveal his or her problem-solving ability and reasoning. Throughout childhood, the ability to reason, to draw conclusions or inferences from facts or premises, develops.^{1,3,9}

Attention management, inhibition control, decision making, planning, and working memory are all examples of Executive Functions. Attention involves the recognition and selection of particular sensory input in order to process it more thoroughly in working memory, as well as the ability to focus in one direction.¹² Over the course of early childhood, children improve their attention control and become less easily distracted. Learning requires selective attention; to learn, a person must

focus on the relevant aspects of his or her environment and ignore the irrelevant ones.³

Learning how to control one's attention and shift to another's attention is also crucial. Despite the fact that infants exhibit some attentional control during the first year of life, it is not until early elementary school that children demonstrate significant improvements in their ability to focus on relevant environmental features during a learning task.^{10,13} Focus is the capacity to concentrate one's attention and interests on a single activity. Observing a child's focus involves looking at him or her for extended periods of time and attempting to comprehend a situation, despite having a short attention span.¹¹

Psychomotor skills refer to a toddler's increasing control over their body movements and ability to manipulate objects with greater precision. This element is composed of two skills: gross motor and fine motor.¹¹ The wide-based, slightly stooped, and staccato gait of a 12-month-old child changes into an upright, narrow-based gait. Similarly, running develops shortly after walking, beginning as a stiff-legged approximation and evolving into a well-coordinated movement by 18 months of age that includes rapid changes in speed and direction. Over the course of a year, their fine motor skills and problem-solving abilities improved, which fuelled their desire to repeatedly practice. The development of intrinsic muscle control permits the index finger to be isolated, enabling infants to poke their fingers into small holes in order to explore. By the time they are 12 months old, the majority of infants enjoy repeatedly placing objects in containers and emptying them. In addition, they are able to pick up and bring to their mouths small food items using an advanced pincer grasp.^{10,14}

Children over the age of one are in word-combination periods, during which they acquire language skills at an astounding rate. Typically, a child can use three words by the age of 13 months, and 20 words by the age of 18 months. The majority of these words are the names of familiar caregivers, as well as favorite foods and activities, and the child may begin to combine two words.¹⁰ His receptive language abilities will be slightly more advanced than his expressive language

abilities, and he will be able to comprehend more complex instructions than he can express. At this age, the toddler also imitates past events using symbols or actions. The development of the older toddler's symbolic reasoning continues to advance. The child's cognitive development is increasingly verbal, and they exhibit remarkable communication and problem-solving skills.¹³ Problem-solving and fine motor skills acquired after the first year of life are dependent on the gross and fine motor skills acquired during the first year. As children form similar associations between these skills, the development of one skill promotes or facilitates the development of another.⁹

Cognitive development in the first year of life

A child's development during their first year of life can be assessed in terms of motor development and cognitive development, respectively. Initially, gross motor development proceeds through a series of prone milestones (beginning with the head up and ending with rolling), followed by sitting and finally standing. The development of fine motor skills is also evident in the first year of life, as evidenced by a stronger grasp.^{10,15}

Since children under one year old is still developing, mainly for non-verbal, a few domains can be used to assess cognitive development, including problem-solving, social/emotional, and language.^{3,10} There are no standardized intelligence tests for measuring infant intelligence as there are for measuring intelligence in school-age children. The primary pediatrician can make the most accurate assessment of infant intelligence by observing problem-solving and language development milestones. Language ability is the single most accurate predictor of intellectual potential; problem-solving abilities are the second most accurate predictor. It is possible to estimate verbal intelligence via language development and nonverbal intelligence via problem-solving domain skill development.^{3,15}

Language abilities, which include both receptive and expressive abilities, are the most difficult to observe because infants rarely spontaneously vocalize in the clinician's office. In contrast to receptive skills, which reflect the ability

to comprehend language, expressive skills reflect the capacity to express one's own thoughts, ideas, and desires. There are numerous ways in which language can be expressed, including speech, gestures, sign language, writing, typing, and so-called "body language." Therefore, language and speech are not synonymous terms. Pre-speech periods and naming periods are the two periods found in infants younger than one year old. In terms of receptive language skills, a student may progress from alerts, orients, and responds to follows command. As for expressive language skills, infants begin to exhibit coos, smiles, and vocalizations within the first three months, and then develop reduplicate consonants, echolalia, and the ability to say "dada" and "no" prior to uttering their first words.^{3,10,15}

As part of problem-solving skills, infants' complex cognitive abilities, such as concentration and memory, can be evaluated. The ability to manipulate objects to solve problems (e.g., selecting the correct opening for a circular shape on a three-piece form board) and observing how infants interact with a variety of test objects permits the evaluation of their nonverbal intelligence. Focus and memory can be predicted by observing a child's gaze, concentration, recognition, and exploration of a person or toy.^{3,9,10}

Cognitive measurements by healthcare professionals in clinical settings

Identifying children with developmental delays as early as possible is essential. However, only a certified medical professional, typically a pediatrician in healthcare settings, can make an accurate diagnosis. Pediatricians may refer to other sub-specialties or disciplines, when necessary, but they are the most knowledgeable and trusted professional with whom most families interact during the first five years of a child's life. Parents view pediatricians as the authority on their child's holistic growth and development, so they visit pediatricians not only to diagnose physical illnesses, but also for advice on cognitive and mental development.⁵

The importance of development screening instruments has improved over the years, and

pediatricians now have access to instruments that are both accurate and simple to use in an office setting. The American Academy of Pediatrics (AAP) recommends that all healthy children undergo developmental surveillance and are also screened for developmental delays at ages 9, 18, and 30 months to allow for early intervention.^{4,5}

There is a variety of screening tools available to determine developmental delays in children. It can be classified according to the objectives of administering the test, such as the Denver-II Developmental Screening Test and the Parents' Evaluation of Developmental Status (PEDS) for general developmental screening; the Capute scales and Bayley Scales of Infant Development (BSID) for cognitive domain-specific assessment and the Modified Checklist for Autism in Toddler (M-Chat) Revised are used to assess specific developmental delays.⁴ The Bayley Scales of Infant Development III is the gold standard for assessing cognitive development in children under the age of two. The BSID-III assesses infant and toddler development across cognitive, language, motor, social-emotional, and adaptive domains from 1 to 42 months of age.¹⁶

Pediatricians may turn to the Capute Scales when time is limited, and they need an easier-to-use screening tool than the BSID. The Capute Scales are also highly valid in their ability to assess infants and toddlers in a variety of key developmental areas.¹⁷ There are two Capute Scales: The Cognitive Adaptive Test (CAT) and the Clinical Linguistic and Auditory Milestone Scale (CLAMS). This examination is also referred to as the CAT-CLAMS examination. CAT components differentiate between global developmental delay (cognitive, intellectual, and mental retardation) and communication difficulties, whereas CLAMS components differentiate between mental retardation, language difficulties, and a variety of autism spectrum disorders. The CAT-CLAMS is a promising test that was developed specifically for pediatricians to use in the office. It assesses a child's cognitive and language abilities independently, utilizing parental reports and direct testing of the child's abilities.^{4,5} The study discovered that the CAT-CLAMS test is more convenient and faster to administer in

developmental screening, specifically language and visual-motor. It successfully assesses a variety of developmental disabilities in infants and children.^{17,18}

Each screening instrument has distinct advantages and disadvantages. The method of testing may be determined by population risk factors, the amount of time available for the procedure, the availability of other developmental screening resources in the community, and the pediatrician's personal preference. For example, the Denver-II screening test is widely used but has a low sensitivity and specificity depending on how questionable results are interpreted. Additionally, each test must be administered according to specific instructions; otherwise, the results will be invalid.⁴ Recent reviews of commonly used screening instruments can assist pediatricians in making screening instrument selection decisions.^{5,15,19} There are several tools for assessing developmental delays, but each requires the expertise of a pediatrician and is too complicated for use in parental settings; therefore, there is a need for a community-based assessment instrument.

Key cognitive indicators for practical use in community settings

While pediatricians and healthcare practitioners already have a number of accurate screening tools to measure cognitive development and diagnose cognitive delays, but a community-based tool for parents that is accurate yet easy to understand without overwhelming the parents is quite scarce. An important new method for identifying infants and young children with developmental problems is to systematically elicit parental concern about development. Parental concerns regarding language, motor skill, cognitive, and emotional-behavioral development are highly indicative of actual issues.⁴ As a result, parents also need to have an understanding of the indicators of cognitive development in order to seek out the appropriate professionals in a timely manner.²⁰

Recent evidence indicates that parenting interventions that include components to directly enhance early child learning or strengthen parent–

child relationships are more effective for enhancing early cognitive, language, motor, and socioemotional development than other types of interventions, including nutrition and health.^{21,22} Parenting intervention programs include those that promote parents'/caregivers' knowledge, attitudes, practices, and skills regarding early child development.²³

Recent studies have demonstrated the importance of parental belief for optimal cognitive development in children Miller's (1988) systematic review was the first to demonstrate that parental beliefs about their children's cognitive development influence parental behavior, and that parental behavior influences child development. Parents' beliefs are found to influence their judgment and knowledge of their children's cognitive abilities, and as a result, they may modify their parenting techniques.²⁴ On the cognitive and motor development of children, parents with greater knowledge under a responsive caregiving program exhibit greater differences than those without such knowledge.²⁵ In addition, the study revealed that an increase in parental/provider knowledge of child language development will result in a high-quality childcare language environment, which will contribute to better cognitive outcomes for children.²¹

Given the importance of positive parental belief on the child's holistic development, it is essential to enhance parental self-efficacy or confidence through education on child development and/or child-rearing at different stages. Confidence, often referred to as self-efficacy, describes a parent's self-belief in their ability to perform the parenting role. Increased knowledge, abilities, and self-assurance are positively associated with child development processes and milestones. Parents will be more aware of their child's developmental milestones in a variety of cognitive domains and can consult professionals as needed if simple cognitive indicators are provided.²²

Multiple domains can be used to screen cognitive function in community settings, according to studies, but such research is largely undertaken outside Indonesia. In a study conducted in Malaysia, the cognitive abilities of children younger than two years old are evaluated based on

their sensor development, exploration and manipulation, object relatedness, concept formation, memory, and cognitive processing.²⁶ A systematic review that collected data from the Philippines, Germany, France, Switzerland, and Canada on cognitive domains including language, spatial, memory, and executive function found evidence that these domains can predict cognitive function in children under the age of five.²⁷ One national study in the United States identifies high-priority aspects of cognition that can be measured efficiently and effectively in children between the ages of birth and three. This cognitive development measurement includes six domains: executive function skills, memory, language, processing speed, spatial and numerical processing, and social cognition.²⁸ Indicators of cognitive development must encompass a variety of domains in a manner that is both comprehensive and tailored to local needs. Multiple nations have developed their own indicators, which cover multiple previously introduced domains. A simplified approach to cognitive measurements may be more useful than a standard cognitive assessment used in clinical setting, making it easier to be used by parents.²⁸

Several cognitive development assessment domains overlap, as suggested by Piaget's theory and the aforementioned studies. Summed up, these studies mention and highlight eight domains based on their reliability and usability: executive function (regarding focus & attention), memory, language, psychomotor, logic and reasoning, and decision-making and problem-solving. It can be concluded that there are a number of cognitive development indicators that can be used to inform and educate

parents in order to facilitate effective communication regarding optimal cognitive development. Therefore, we propose a comprehensive yet streamlined cognitive development indicator for children older than one year, which includes eight key indicators: attention, concentration (focus), memory, language, psychomotor, logic, reasoning, and decision-making. As cognitive skills in children under one year old are not yet fully developed and are primarily nonverbal, five key indicators, including language, psychomotor skills, attention, focus, and memory, can be used to raise community awareness of optimal cognitive development.

Conclusions

It is a fascinating process for both the child and their parents to watch their child's cognitive development take place. Developmental surveillance and screening for developmental delays are recommended for all healthy children to avoid late intervention. In the community, it is also important to educate and inform parents about children's cognitive developments milestone. There are several skills that are essential for achieving optimal cognitive growth. We proposed 8 key indicators of cognitive development in infants and children as simplified approach to effectively communicate to parents. The indicators which can be used for children older than one year old consist of: attention, focus, memory, language, psychomotor, logic, reasoning and decision making. In the first year, considering that infants are still undergoing rapid cognitive development process, five indicators namely memory, attention & focus, psychomotor skills, and language can be used to screen their cognitive development.

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Conflict of Interest

R.W.B. and M.S.K. are employees of Danone SN Indonesia. All other authors have no conflict of interest.

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