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Battelle 3 Developmental Inventory 3rd Edition

Empirical Investigation Into Developmental Milestones and the Typical Age of Mastery Acquisition

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Abstract

Empirical evidence is provided to support the emergence and acquisition of developmental milestones. *The Battelle® Developmental Inventory*, *3rd Edition* (BDI-3®) (Newborg, 2020) item difficulty measures and BDI-3 normative data (norms) are used to identify the typical ages that children acquire and master selected milestones.

The typical age of mastery acquisition is presented as an age range and was determined by linking a criterion-based measure that closely approximates the 75% probability of mastery on selected milestones with the BDI-3 norms. This linking of a criterion-based measure with normative data allows for the derivation of an accurate measure of the typical age of milestone acquisition.

Background

Developmental milestones are critical skills and behaviors that are typically acquired by children in a sequential manner. The accurate assessment of developmental milestone acquisition is an essential component of identifying developmental delay and providing services that children with delays need. Given this need for accurate identification, many developmental milestone checklists have been published. These checklists, which are typically based on published clinical opinions, tend to lack robust empirical evidence (i.e., evidence based on normative data). There is also substantial variability across checklists regarding both content coverage (the developmental milestones specified) and the age of acquisition assigned to individual milestones (Zubler et al., 2022; Wilkinson et al., 2019).

Zubler et al. (2022) specified several criteria that were used in the revision of the Centers for Disease Control and Prevention "Learn the Signs. Act Early." (CDC-LTSAE) developmental surveillance checklist. Three of the specified criteria relate to milestone observability, empirical evidence, and milestone interpretation. First, developmental milestones should be easily observable by parents, caregivers, teachers, and specialists in child development. Second, milestones should be supported by normative data with the expectation that 75% or more of children should be able to achieve milestone mastery at the reported age of acquisition. Third, each milestone should be specific enough to be easily understood, and examples should be provided when necessary.

The Battelle Developmental Inventory, 3rd Edition (BDI-3) is a standardized, individually administered assessment designed to measure the acquisition of developmental milestones by children ranging in age from birth through 7 years old. It is primarily used by educators and specialists in child development to identify children who exhibit developmental problems at an early age. The BDI-3 is the third edition of the *Battelle Developmental Inventory* (Newborg et al., 1984). Items for the BDI were selected through a qualitative review of over 4,000 items drawn from various instruments that specialize in measuring child development. Selected items were pilot tested and empirically evaluated by experts specializing in one or more developmental areas. Since the original publication of the BDI, items have been added, updated, and refined over successive editions, culminating in the publication of the BDI-3 (Newborg, 2020).

The BDI-3 measures child development across five domains: Adaptive, Social-Emotional, Communication, Motor, and Cognitive. Each domain is comprised of two to three subdomains. Table 1 displays the composition of each domain. The nationally representative standardization sample was comprised of 2,500 children ages birth through 7 years old who were selected to match the same-age U.S. population percentages across four stratification variables: race, parent's education, geographic region, and gender.

BDI-3 items are intended to measure the skills associated with developmental milestones and are administered using three formats: a structured test item format, direct observation of the child, and a parent/teacher interview format. Each item or milestone skill is scored 0 for no credit, 1 for partial credit (skill emergence), or 2 for full credit (skill mastery).

Table 1. BDI-3 Domains and Subdomains

Domain	Subdomain
Adaptive	Self-Care, Personal Responsibility
Social-Emotional	Adult Interaction, Peer Interaction, Self-Concept and Social Role
Communication	Receptive Communication, Expressive Communication
Motor	Gross Motor, Fine Motor, Perceptual Motor
Cognitive	Attention and Memory, Reasoning and Academic Skills, Perception and Concepts

Method

Item data from the standardization of the BDI-3 were used. Of the 13 BDI-3 subdomains, 9 subdomains measure child development from birth through 7 years old: Self-Care, Adult Interaction, Self-Concept and Social Role, Receptive Communication, Expressive Communication, Gross Motor, Fine Motor, Attention and Memory, and Perception and Concepts. Four subdomains measure development from 2 years old through 7 years old: Personal Responsibility, Peer Interaction, Perceptual Motor, and Reasoning and Academic Skills.

Cluster analysis (CA) and exploratory factor analysis (EFA) were executed for each of the 13 subdomains, and the analyses results were used to assist with the selection of milestones. In this context, CA and EFA were used to understand the pattern of intercorrelations (relationships) between items and to combine/group items together to form a reduced set of clusters or factors (Tabachnick & Fidell, 1983).

The CA groups data points (items) into clusters based on their similarities. This study used the Ward's minimum variance (ward.D2) method, which is a linkage criterion commonly used in hierarchical clustering and focuses on minimizing the increase in within-cluster variance when merging clusters. This approach tends to produce clusters of relatively uniform size and is robust to outliers. The steps of the cluster analysis are as follows:

1. Compute the pairwise squared Euclidean distances between all data points.
2. Calculate the within-cluster variance for each possible pair of clusters that can be merged and select the pair that minimizes the increase in variance the most.
3. Treat merged clusters as a single cluster.
4. Build a dendrogram (hierarchical treelike structure) that shows the sequence of cluster mergers.

The cluster analysis used the Cluster Analysis Basics and Extensions R software package (Version 2.1.4) (Maechler et al., 2022).

The Factor command in IBM SPSS Statistics (Version 29.0) (IBM Corp., 2022) was used to execute the EFA. The principal axis factoring (PAF) extraction method with an oblique rotation method (PROMAX) was used for the EFA. The oblique rotation method was used to allow for correlated factors. A minimum eigenvalue of 1.0 for inclusion was used, and scree plots

were evaluated to assist in the determination of the number of factors. For each of the 9 subdomains that measure development from birth through 7 years old, four factors emerged that grouped items into these age-appropriate item sets: infant, toddler, preschool, and early school-age (Grades K–2). For the 4 subdomains that measure development from 2 years old through 7 years old, three factors emerged for the Personal Responsibility and Peer Interaction Subdomains and four factors emerged for the Perceptual Motor and Reasoning and Academic Skills Subdomains. Items for these 4 subdomains were grouped into toddler, preschool, and early school-age (Grades K–2) item sets. For all 13 subdomains, the EFA and CA produced similar results, with both analyses tending to group the same items into the same age-appropriate item sets. Three criteria were used for selecting developmental milestones. First, the milestones had to be easily observable by both child development specialists and caregivers. Second, the milestones had to have strong factor loadings. And third, the milestones had to be distributed and balanced across the factors/clusters that grouped items into age-appropriate item sets.

Calibrated item difficulties and normative scores (norms) from the standardization of the BDI-3 were used to identify the typical ages associated with the mastery of selected developmental milestones. The first step in the development of the BDI-3 norms was the calibration of the BDI-3 standardization item data with the Masters Partial Credit Model (PCM; Masters, 1982). The PCM is a polytomous Rasch measurement model for items that have a set of ordered response categories for which credit is given for partially correct responses. Ordered response categories imply an increased ability on the trait being measured. For each item, step thresholds are estimated between adjacent response categories for which the probability of the two adjacent categories is equally likely. Given an examinee's ability, the step thresholds are used to estimate the probability of category response (Wright & Mok, 2000). The PCM accommodates items with different response categories, a different number of response categories, and different response formats (Mead, 2008).

WINSTEPS® (Linacre, 2022) was used to operationalize the PCM. For items that are scored on a 3-point metric (0, 1, or 2), as the BDI-3 items are, WINSTEPS reports a global item difficulty measure as well as the Rasch-Thurstone thresholds for adjacent categories. Two Rasch-Thurstone threshold measures are reported: one for the point where a child has a 50% probability of transitioning from a score of 0 to a score of either 1 or 2 and another for the point where a child has a 50% probability of transitioning from a score of either 0 or 1 to a score of 2. In the latter case, the threshold measure represents the point where a child has a 50% probability of receiving a score of 2.

The calibration of the standardization data with the PCM placed item difficulties and examinee ability scores on to the same scale. The examinee ability scores were used in the development of the BDI-3 norms. The initial stage of norms development involved the plotting of examinee ability scores associated with the 2nd, 16th, 25th, 50th, 75th, 84th, and 98th percentiles across the normative age groups. Polynomial regression trend curves were then fit and smoothed through these points. Trend curves using the normative age group means and standard deviations were also developed and checked for reasonability with the above percentile trend curves.

Given the properties associated with a polytomous Rasch measurement model such as the PCM, a mastery ability score approximating the 75% probability of receiving a score of 2 was computed for each subdomain item (milestone). Central to this computation was the notion that the transition from a score of either 0 or 1 to a score of 2 could be viewed as a dichotomy. This allowed for computational shorthand, whereby the ability score needed for a close approximation of the 75% probability of milestone mastery could be computed simply by adding a value roughly equal to the scale value of 1.1 logits to the Rasch-Thurstone threshold measure associated with the point where a child had a 50% probability of receiving a score of 2. The end result was that for each subdomain milestone, a mastery ability score was computed that closely approximated a 75% probability of receiving a score of 2 (skill mastery). Once the mastery ability score was computed for a given milestone, the BDI-3 subdomain norms table was used to look up and identify the typical age of mastery acquisition for that milestone. The typical age of mastery acquisition is presented as an age range. The youngest age that is identified in the age range reflects the age where the mastery ability score for a given milestone first fell within a percentile rank range of between 50 and 75. Since this was the first (youngest) age encountered in the score look up, the mastery ability score typically fell at or just below the 75th percentile. The youngest age in the age range represents the emergence of milestone acquisition where a sizable minority (approximately 25% to 30%) of the children in the BDI-3 standardization received an ability score greater than or equal to the mastery score and would be expected to receive full credit on a given milestone. The oldest age that is identified in the age range reflects the last age at which the computed mastery ability score for a given milestone fell within a percentile rank range of between 25 and 50. Since this was the last (oldest) age encountered in the score lookup, the mastery ability score typically fell at or just above the 25th percentile. This age represents the mastery of milestone acquisition at which a sizable majority (approximately 70% to 75%) of the children in the BDI-3 standardization received an ability score greater than or equal to the mastery ability score and would be expected to receive full credit on a given milestone.

Results

Developmental milestones were selected that are easily observable and interpretable and that are significant indicators of the developmental subdomain being measured. For each milestone, an ability score that closely approximated the 75% probability of receiving a score of 2 (mastery) was computed, and the BDI-3 norms tables were used to determine the typical age of mastery acquisition.

Results for each subdomain are presented in Appendices A and B. Note that the tables in Appendix A are presented as figures in Appendix B. Tables A1 to A13 in Appendix A present comprehensive subdomain milestones and their typical ages of mastery acquisition. Plots B1 to B13 in Appendix B present data visualizations that depict the relationship between these same milestones and their associated ages of mastery acquisition. The subdomain milestones in Appendix B appear in an abbreviated form to accommodate plot-fit considerations.

Tables A1 and A2 present selected milestones from the Adaptive Domain. Milestone data from the Self-Care Subdomain is displayed in Table A1. The Self-Care Subdomain measures the skills necessary for a child to transition from complete dependence on a parent to greater self-sufficiency. Skills are measured across five broad areas: eating, dressing, toileting, grooming, and sleeping. Table A2 presents milestones from the Personal Responsibility Subdomain. Personal Responsibility measures a child's ability to assume responsibility in these areas: recognizing and avoiding common dangers, using appropriate behavior in public settings, caring for personal belongings, and accessing electronic devices in a responsible manner (Newborg, 2020).

Tables A3, A4, and A5 present milestones from the Social-Emotional Domain. Milestone data from the Adult Interaction Subdomain is displayed in Table A3. Adult Interaction measures infant attachment, the skills associated with how children respond to and initiate social contact with adults, and the ease with which children see and use adults as resources to solve problems. Table A4 presents milestones from the Peer Interaction Subdomain. Peer Interaction measures how a child interacts with children of a similar age. This includes milestones that measure how a child initiates social contact with peers and how a child relates to other children within a small group. Table A5 presents milestones from the Self-Concept and Social Role Subdomain, which measures a child's development in terms of self-awareness, coping skills, and how a child relates to the world around them (Newborg, 2020).

Tables A6 and A7 present milestones from the Communication Domain. Milestone data for the Receptive Communication Subdomain is presented in Table A6. Receptive Communication measures a child's development with respect to understanding words, questions, commands, and nonverbal cues. Table A7 presents milestones from the Expressive Communication Subdomain, which measures development in terms of how a child uses sounds and words to communicate with others. This includes items to measure speech articulation (Newborg, 2020).

Tables A8, A9, and A10 present milestones from the Motor Domain. Table A8 displays milestone data from the Gross Motor Subdomain. Gross Motor measures the development of skills around whole body movement such as walking and running. Table A9 presents milestones from the Fine Motor Subdomain, which measures a child's use and control of the

smaller muscles in the arms, hands, and fingers to complete tasks that require increasing levels of small muscle coordination. Milestone data for the Perceptual Motor Subdomain is presented in Table A10. Perceptual Motor measures the ability to integrate perceptual skills (skills associated with how sensory information is organized into meaningful patterns) with fine motor skills. Perceptual Motor measures skills such as using blocks to build a tower, a bridge, or replicate a design as well as skills associated with how well children copy numbers, letters, and figures (e.g., a diamond shape; Newborg, 2020; Ornstein & Carstensen, 1991).

Tables A11, A12, and A13 present milestones from the Cognitive Domain. Milestone data for the Attention and Memory Subdomain is displayed in Table A11. Attention and Memory measures a child's ability to attend to stimuli for varying lengths of time as well as the child's development of short-term and long-term memory. Milestone data for the Reasoning and Academic Skills Subdomain is presented in Table A12. Reasoning and Academic Skills measures a child's critical thinking skills in terms of problem identification, analysis, and problem resolution. For preschool and early school-aged children, the milestones also measure age-appropriate academic skills. Table A13 presents milestones from the Perception and Concepts Subdomain, which measures a child's perceptual acuity and their ability to recognize attributes of objects and understand how they relate to each other (Newborg, 2020).

Discussion

The typical age of mastery acquisition for selected developmental milestones was determined by linking a criterion-based measure that closely approximates the 75% probability of mastery on selected milestones with the BDI-3 norms. This linking of a criterion-based measure with normative data allows for the derivation of an accurate measure of the typical age of mastery acquisition.

Tables A1 through A13 in Appendix A report the age ranges associated with the mastery of selected milestones. For each age range, the oldest reported age is the age at which 70%–75% of children are expected to achieve mastery, and it aligns roughly with the 75% cut (75% of children expected to achieve mastery) used by Zubler et al. (2022) in the revision of the CDC-LTSAE developmental surveillance checklist. The youngest reported age is the age at which roughly 25% to 30% of children are expected to achieve mastery. By presenting the typical age of mastery acquisition in the form of an age range, this paper attempts to capture some of the variability associated with child development. This variability can be observed in the Appendix B subdomain plots. For most subdomains, there is a broadening of the age ranges associated with milestone mastery as milestones advance in complexity along the developmental continuum.

Limitations

There are limitations with respect to the age ranges that are reported for the typical age of mastery acquisition. At the youngest reported age in the milestone age range, a sizable minority of children (25% to 30%) are expected to master the milestone. However, practitioners should bear in mind that most children (70% to 75%) at that age are not expected to master the developmental milestone. The youngest reported age in the age range represents the point at which children are emerging on the developmental milestone. Likewise, at the oldest age reported in the milestone age range, most children (70% to 75%) are expected to master the milestone. However, a sizable minority of children (25% to 30%) are not expected to master the developmental milestone. Practitioners should exercise a cautious interpretive approach when children fall outside the typical mastery age range for a given developmental milestone.

Suggestions for Future Research

This This paper uses a mastery ability score that was computed as the point where children have approximately a 75% probability of receiving a score of 2 (full credit) on a selected milestone. Perhaps a 75% probability is not stringent enough and the use of a higher probability might be warranted. Likewise, the oldest age reported in each age range represents the age at which 70% to 75% of children would be expected to achieve mastery of any given milestone. Conceivably, this cut value may not be stringent enough, and practitioners may be better served by identifying the age at which perhaps 80% or 90% or more of children would be expected to achieve mastery of a milestone.

Researchers might consider testing different probabilities for achieving milestone mastery or might investigate different cut values to evaluate the impact of these choices on the typical age of mastery acquisition.

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Appendices

Appendix A

Table A1. Adaptive Domain, Self-Care Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
(EATING) The child opens his or her mouth and holds it open as the spoon approaches.	4 to 6 months
(EATING) The child eats semisolid food (e.g., mashed bananas, mashed potatoes, or oatmeal) when it is placed in his or her mouth.	7 to 9 months
(EATING) The child feeds himself or herself bite-sized pieces of food (e.g., cereal, crackers, cookies, vegetables, or bread).	10 months to 1 year, 2 months
(DRESSING) The child participates in dressing by holding out his or her arms or legs.	1 year, 2 months to 1 year, 7 months
(EATING) The child communicates the need or desire for food using words, pictures, or gestures.	1 year, 5 months to 1 year, 11 months
(EATING) The child distinguishes between food items and nonfood items and avoids chewing or swallowing nonfood items.	1 year, 8 months to 2 years, 5 months
(GROOMING) The child washes and dries his or her hands without help.	2 years, 9 months to 3 years, 8 months
(TOILETING) The child has bowel movements in the toilet regularly with no more than 1 accident per week.	3 years, 0 months to 4 years, 2 months
(SLEEPING) The child sleeps through the night without wetting the bed.	3 years, 6 months to 4 years, 8 months
(TOILETING) The child takes care of his or her own toileting needs, including removing simple clothing, wiping, and putting clothes back on.	3 years, 9 months to 4 years, 11 months
(DRESSING) The child dresses and undresses without help.	3 years, 9 months to 5 years, 2 months
(DRESSING) The child engages and zips a zipper without help.	4 years, 9 months to 6 years, 5 months
(GROOMING) The child takes a bath or shower without help.	6 years, 3 months to 7 years, 11 months
(EATING) The child uses a knife and fork to cut food into smaller pieces.	≥ 7 years, 6 months
(EATING) The child prepares a simple meal without verbal reminders or physical help.	≥ 7 years, 6 months

Table A2. Adaptive Domain, Personal Responsibility Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child understands that hot is dangerous (e.g., the child understands the dangers of touching hot items such as stoves, candles, or fireplaces).	2 years, 0 months to 3 years, 2 months
The child shows care when handling something delicate or fragile (e.g., a baby, puppy, or cup with liquid in it).	2 years, 3 months to 3 years, 8 months
The child uses appropriate behavior in public settings with only occasional reminders from an adult (e.g., a classroom, library, restaurant, or store).	2 years, 9 months to 4 years, 5 months
The child demonstrates caution and avoids common dangers (e.g., by staying away from the street or from dangerous objects like broken glass).	3 years, 3 months to 4 years, 11 months
The child accesses a computer, tablet, or other electronic device independently (e.g., turns it on, navigates to a game or program, or, if needed, enters a password).	4 years, 0 months to 5 years, 8 months
The child follows established rules when playing simple games.	4 years, 9 months to 6 years, 8 months
The child asks permission to use others' possessions.	5 years, 9 months to 7 years, 5 months
The child goes to bed without assistance (i.e., the child performs bedtime routines and goes to bed without help).	6 years, 0 months to 7 years, 5 months
The child takes care of personal belongings independently (i.e., without being reminded).	6 years, 9 months to 7 years, 11 months
The child crosses the street safely.	6 years, 9 months to 7 years, 11 months
The child knows his or her address (this includes knowing the house or apartment number, street name, town or city, and state).	≥ 7 years, 11 months

Table A3. Social-Emotional Domain, Adult Interaction Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child responds to a familiar adult voice (e.g., by shifting his or her eyes toward the familiar person or smiling in response).	0 to 3 months
The child shows awareness of other people (e.g., by turning his or her head toward a person's voice or following a person with their eyes).	1 to 4 months
The child shows a desire for social attention in situations when he or she is not hungry, tired, or needing a diaper change.	5 to 10 months
The child explores adult facial features when being held.	6 to 10 months
The child expresses enjoyment of or preference for certain items, activities, or situations.	8 months to 1 year, 2 months
The child discriminates between familiar and unfamiliar people.	11 months to 1 year, 9 months
The child shows appropriate affection toward people, pets, or possessions like stuffed animals.	1 year, 2 months to 2 years, 11 months
The child responds positively to adult recognition and encouragement.	1 year, 4 months to 3 years, 5 months
The child responds positively when familiar adults or adults in authority initiate social contact, such as greeting a child or asking the child a question.	1 year, 11 months to 4 years, 5 months
The child joins in or imitates an adult's performance of simple tasks.	3 years, 3 months to 5 years, 5 months
The child follows adult directions with little or no resistance.	5 years, 3 months to 7 years, 11 months
The child follows the rules given by an adult for playing simple group games with peers.	5 years, 3 months to 7 years, 11 months
The child accepts constructive criticism or feedback from an adult.	> 7 years, 11 months

Table A4. Social-Emotional Domain, Peer Interaction Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child enjoys playing with other children.	≤ 2 years, 8 months
The child mimics or responds to peers' emotions (e.g., by smiling or laughing when another child appears happy).	2 years, 0 months to 3 years, 11 months
The child initiates social contact with peers in play (e.g., initiates social contact with a child his or her same age while playing).	3 years, 3 months to 5 years, 5 months
The child shows sympathy or concern for peers (e.g., when a child his or her age gets hurt or feels sad).	3 years, 3 months to 5 years, 8 months
The child plays cooperatively with children his or her own age rather than playing alone.	3 years, 9 months to 6 years, 2 months
The child shows interest in being included in groups of children his or her own age.	3 years, 9 months to 6 years, 2 months
The child shares property such as toys or other possessions with children his or her own age.	4 years, 9 months to 6 years, 11 months
The child willingly takes turns and shares when interacting with children his or her age.	5 years, 3 months to 7 years, 5 months
The child plays cooperatively in rule-regulated games with peers (e.g., sports and board games).	5 years, 3 months to 7 years, 5 months
The child offers to help children his or her own age (e.g., by getting materials or answering questions).	6 years, 3 months to 7 years, 11 months
The child understands when a child his or her age makes a request or demand that is not reasonable or might get him or her into trouble.	≥ 7 years, 9 months

Table A5. Social-Emotional Domain, Self-Concept and Social Role Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child smiles or vocalizes (e.g., coos, babbles, or squeals) in response to adult attention.	0 to 3 months
The child shows awareness of his or her feet.	6 to 8 months
When appropriate, the child is able to show positive emotions (e.g., smiling, laughing, or hugging).	1 year, 0 months to 1 year, 5 months
When appropriate, the child is able to show negative emotions (e.g., crying or frowning).	1 year, 3 months to 1 year, 11 months
The child recognizes and identifies himself or herself in a mirror.	1 year, 8 months to 3 years, 2 months
The child shows pride in his or her work or accomplishments.	2 years, 0 months to 3 years, 8 months
The child recovers from distress in a reasonable amount of time (5 minutes or less) when comforted.	2 years, 3 months to 4 years, 2 months
The child engages in adult role-playing and imitation.	3 years, 0 months to 4 years, 8 months
The child initiates social interactions with others (e.g., by greeting others or telling a story).	3 years, 0 months to 4 years, 11 months
The child states his or her first and last names.	3 years, 6 months to 5 years, 2 months
The child follows classroom rules and agreements with only occasional reminders or redirections.	4 years, 6 months to 6 years, 2 months
The child recognizes another's need for help and offers assistance without being asked.	4 years, 9 months to 6 years, 5 months
The child describes his or her feelings (e.g., uses words such as *happy*, *sad*, *angry*, or *scared*).	5 years, 6 months to 7 years, 8 months
The child waits patiently for a reward, desired item, or event.	6 years, 3 months to 7 years, 11 months
The child stays on task and works through difficulties and frustrations (i.e., persists when confronting difficulties and frustrations).	> 7 years, 11 months

Table A6. Communication Domain, Receptive Communication Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child startles to loud unexpected sounds.	0 to 3 months
The child quiets or smiles when spoken to by a familiar voice.	4 to 7 months
The child turns his or her head toward a source of sound outside his or her field of vision.	4 to 7 months
The child responds to his or her name (e.g., by moving his or her eyes or head or changing body position).	7 to 10 months
The child responds to different tones of a person's voice (e.g., by smiling in response to a pleasant tone or crying in response to a harsh tone).	8 months to 1 year, 0 months
The child identifies family members or pets when named (e.g., by pointing to or looking at them).	1 year, 2 months to 1 year, 8 months
The child associates spoken words with familiar objects (e.g., points to a ball if told "Point to a ball.").	1 year, 6 months to 2 years, 2 months
The child points to body parts (e.g., hands, feet, nose, eyes) when named.	1 year, 6 months to 2 years, 2 months
The child understands simple action verbs (e.g., eat and sleep).	2 years, 0 months to 2 years, 11 months
The child responds to *where* and *when* questions (e.g., "Where are your shoes?" or "When is it time to go to gym class?").	3 years, 0 months to 4 years, 8 months
The child identifies pictures of objects by their use (e.g., by pointing to a ball when asked what they would use to play catch and pointing to a book when asked what they would read).	3 years, 3 months to 4 years, 8 months
The child responds to the adverbs *softly* and *loudly* (e.g., "Clap your hands softly" and "Clap your hands loudly").	3 years, 6 months to 5 years, 2 months
The child follows 2-step verbal commands (e.g., "Pick up the ball, then give me the ball.").	4 years, 0 months to 5 years, 11 months
The child follows 3-step verbal commands (e.g., "Push in your chair, walk to the door, and wait in line.").	4 years, 6 months to 6 years, 8 months
The child reads nonverbal cues from others.	5 years, 3 months to 7 years, 2 months
The child responds to the adverbs *nearest* and *farthest*.	≥ 7 years, 6 months

Table A7. Communication Domain, Expressive Communication Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child makes noncrying vocalizations (e.g., cooing or gurgling sounds).	1 to 4 months
The child vocalizes to express his or her feelings (e.g., pleasure, displeasure, eagerness, or satisfaction).	6 to 10 months
The child produces one or more single-syllable consonant-vowel sound combinations such as “pa,” “ba,” “ka” or “ma.”	9 months to 1 year, 2 months
The child babbles with inflection (e.g., follows the rhythm of adult speech, such as adjusts tone to communicate emotions).	10 months to 1 year, 3 months
The child imitates or repeats speech sounds.	1 year, 4 months to 1 year, 11 months
The child uses 10 or more words in a functional way (e.g., words used for specific things such as a cookie, ball, or spoon).	1 year, 7 months to 2 years, 2 months
The child correctly answers *what* questions.	2 years, 0 months to 2 years, 11 months
The child communicates using simple sentences with three or more words.	2 years, 6 months to 3 years, 5 months
The child asks questions that begin with *what*.	2 years, 9 months to 3 years, 11 months
The child actively participates in conversations with adults and other children (e.g., takes turns listening and speaking).	3 years, 0 months to 4 years, 5 months
The child responds appropriately to *yes* or *no* questions.	3 years, 3 months to 4 years, 8 months
The child asks questions that begin with *why* and *how*.	3 years, 6 months to 4 years, 11 months
The child identifies the use of everyday objects (e.g., a jacket, cup, or crayon).	3 years, 9 months to 5 years, 5 months
The child communicates his or her experiences clearly enough for others to understand.	4 years, 6 months to 6 years, 2 months
The child talks about things that might be.	≥ 7 years, 6 months
The child provides synonyms and antonyms without visual cues.	> 7 years, 11 months

Table A8. Motor Domain, Gross Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child holds his or her head erect for 1 minute when placed in a seated position.	3 to 4 months
The child turns his or her head freely from side to side while supported in a sitting position (e.g., while sitting in an infant seat or highchair).	3 to 4 months
The child holds his or her head in a straight line with the body when pulled from a supine position (on back) to a seated position.	4 to 5 months
The child sits on a firm surface without assistance for at least 1 minute.	6 to 8 months
The child moves 3 or more feet by crawling on his or her hands and knees.	8 to 10 months
The child pulls himself or herself up to a standing position while holding on to a stationary object (e.g., piece of furniture) without adult assistance.	9 to 11 months
The child stands in an upright position without support for 30 or more seconds.	11 months to 1 year, 3 months
The child moves from a sitting position to a standing position without support or assistance.	1 year, 0 months to1 year, 4 months
The child walks without support for 10 feet while maintaining balance.	1 year, 1 month to1 year, 5 months
The child walks up four or more stairs with support (e.g., handrail, hand on wall).	1 year, 5 months to 1 year, 11 months
The child runs 10 feet while maintaining balance.	1 year, 7 months to 2 years, 2 months
The child throws a ball 5 feet forward with direction (e.g., toward a parent/partner).	2 years, 0 months to 2 years, 11 months
The child walks up 3 or more stairs, alternating feet, without assistance from a person.	2 years, 9 months to 3 years, 11 months
The child walks down 3 or more stairs, alternating feet, without assistance from a person.	3 years, 3 months to 4 years, 5 months
The child jumps forward three or more times with his or her feet together.	3 years, 6 months to 4 years, 11 months
The child stands on each foot alternately for 4 or more seconds with his or her eyes closed.	5 years, 3 months to 6 years, 5 months
The child walks forward 6 feet, heel-to-toe, without losing balance.	5 years, 9 months to 7 years, 8 months
The child catches a tennis ball, tossed from 10 feet away, with two hands.	6 years, 0 months to 7 years, 11 months
The child throws a tennis ball overhand with the dominant hand to a target (e.g., partner/parent) from 10 feet away.	≥ 7 years, 6 months

Table A9. Motor Domain, Fine Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child holds his or her hands in an open, loose-fisted position when not grasping an object.	3 to 5 months
The child holds an object with his or her fingers against the heel of the palm for 3 or more seconds.	4 to 7 months
The child holds and shakes a toy when it's handed to them.	5 to 8 months
The child picks up a small object using several fingers and the thumb	9 months to 1 year, 0 months
The child picks up a small object with the ends of the thumb and index finger in an overhand approach (neat pincer grasp).	1 year, 3 months to 1 year, 10 months
The child scribbles on paper using a crayon or marker	1 year, 6 months to 2 years, 5 months
The child draws circular or straight lines on paper.	2 years, 3 months to 3 years, 5 months
The child holds a pencil or crayon between the thumb and finger(s), near the fingertips	3 years, 0 months to 3 years, 11 months
The child cuts paper with scissors.	3 years, 3 months to 4 years, 5 months
The child folds a sheet of paper.	4 years, 0 months to 5 years, 2 months.
The child cuts with scissors following a line.	4 years, 3 months to 5 years, 5 months
The child touches the fingertips of each hand successively with the thumb of the same hand.	5 years, 6 months to 7 years, 5 months
The child traces designs with pointed corners.	5 years, 9 months to 7 years, 8 months
The child ties a single overhand knot.	6 years, 6 months to 7 years, 11 months

Table A10. Motor Domain, Perceptual Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child stacks four blocks vertically to make a tower.	2 years, 0 months to 2 years, 11 months
The child copies a vertical (straight up and down) line.	3 years, 0 months to 3 years, 11 months
The child builds a three-block bridge with 2 blocks on the bottom spaced slightly apart and 1 block centered on top.	3 years, 6 months to 4 years, 5 months
The child copies a circle.	4 years, 3 months to 5 years, 2 months
The child writes his or her first name using any mix of uppercase and lowercase letters.	4 years, 6 months to 5 years, 8 months
The child is shown a picture of a six-block design and uses blocks to replicate the six-block design.	5 years, 0 months to 6 years, 2 months
The child copies the numbers 1 through 5.	5 years, 3 months to 6 years, 8 months
The child copies letters with curves (e.g., *O*, *S*, and *P*).	5 years, 6 months to 6 years, 11 months
The child copies letters with diagonal lines (e.g., *A*, *V*, and *X*).	6 years, 0 months to 7 years, 11 months
The child copies a diamond.	6 years, 9 months to 7 years, 11 months
The child copies two tilted triangles.	≥ 7 years, 6 months

Table A11. Cognitive Domain, Attention and Memory Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child visually attends to a light source moving in a 180-degree arc.	0 to 3 months
The child visually attends to a familiar person who is 4 to 6 feet away for 5 or more seconds.	2 to 4 months
The child follows an auditory stimulus (e.g., the child turns his or her head or eyes to both sides to follow a sound like clapping or a bell ringing).	5 to 8 months
The child attends to an ongoing activity (e.g., playing with an object or watching a person or animal doing something) for 15 or more seconds.	6 to 10 months
The child recognizes that a person still exists when out of view (e.g., game of peekaboo).	11 months to 1 year, 7 months
The child uncovers a hidden toy (e.g., a toy that is hidden under a cloth or an object such as a cup).	1 year, 0 months to 1 year, 8 months
The child looks at, points to, touches, or names pictures in a book.	1 year, 10 months to 3 years, 2 months
The child selects the hand hiding a toy following a 10-second delay.	3 years, 0 months to 4 years, 5 months
The child recalls familiar objects that are no longer in view (e.g., The child is shown three objects, the objects are hidden from view, and one object is removed. When shown the remaining two objects, the child correctly identifies the object that was removed.).	4 years, 0 months to 5 years, 5 months
The child recites the alphabet.	4 years, 9 months to 6 years, 2 months
The child focuses his or her attention on one task while being aware of, but not distracted by, surrounding activities.	5 years, 3 months to 6 years, 11 months
The child repeats four-digit sequences in order (i.e., repeats 4 numbers in the same order in which they heard them).	5 years, 6 months to 7 years, 5 months
The child repeats two-digit sequences backward (i.e., repeats 2 numbers in the reverse order from which they heard them).	6 years, 3 months to 7 years, 11 months
The child repeats sequences of four and five pictures from memory with a 15-second delay.	≥ 6 years, 9 months

Table A12. Cognitive Domain, Reasoning and Academic Skills Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child frequently and independently shows interest and enjoyment in age-appropriate books or printed materials.	2 years, 3 months to 3 years, 5 months
The child matches three objects that have the same color.	2 years, 6 months to 3 years, 8 months
The child names the colors of three objects that are either red, yellow, or blue.	2 years, 9 months to 3 years, 11 months
The child identifies sources of common actions (e.g., when asked, "What flies?" or "What barks? " or "What sleeps? ").	3 years, 6 months to 4 years, 8 months
The child recognizes picture absurdities (e.g., the child is presented two pictures and correctly identifies what is wrong or silly in each picture for example, if a picture shows a person walking on a ceiling).	4 years, 3 months to 5 years, 8 months
The child completes two simple patterns using red and yellow chips (e.g., The child is given 3 red and 3 yellow chips, the examiner places three chips down in the order red, yellow, red, and the child is instructed to place the next chip down to complete the pattern sequence.).	4 years, 3 months to 5 years, 8 months
The child completes analogies (e.g., "A dog can run; a bird can ___ (fly).").	4 years, 6 months to 5 years, 11 months
The child answers simple logic questions (e.g., "Why do we wear clothes?" or "Why do people have cars? ").	4 years, 9 months to 5 years, 11 months
The child writes letters that stand for sounds (e.g., upon hearing a letter sound such as /t/, the child writes the correct letter—*T* or *t*).	5 years, 3 months to 6 years, 5 months
The child counts from 1 to 40 by memory in correct order.	5 years, 3 months to 6 years, 5 months
The child adds numbers from 0 through 9 (e.g., the child correctly solves four addition problems).)	6 years, 3 months to 7 years, 2 months
The child produces a word that rhymes with a given word. (i.e., the child produces a rhyming word for each of four words presented to the child).	6 years, 9 months to 7 years, 11 months
The child solves simple addition word problems (e.g., the child is presented with two problems and correctly solves them.	6 years, 9 months to 7 years, 11 months
The child understands commonly used fractions ($\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$) as they relate to pictures (e.g., the child correctly points to the pictures that show one third, one half, and one fourth.	≥ 7 years, 0 months
The child solves simple subtraction word problems (e.g., the child is presented with two problems and correctly solves them).	≥ 7 years, 0 months
The child reads irregularly spelled words (i.e., words that cannot be sounded out easily).	≥ 7 years, 0 months

Table A13. Cognitive Domain, Perception and Concepts Subdomain: Typical Age Range of Milestone Mastery Acquisition

Milestones	Typical Age of Mastery Acquisition
The child visually explores his or her surroundings by turning the eyes or head.	0 to 4 months
The child feels and explores things around them by touching or visually inspecting them.	7 to 11 months
The child places a circle and a square in a form board.	1 year, 5 months to 2 years, 2 months
The child identifies familiar objects when told what they are used for (e.g., the child is shown a cup, shoe, and spoon and asked "Which object you drink out of?").	2 years, 6 months to 3 years, 5 months
The child identifies big and little shapes.	2 years, 6 months to 3 years, 5 months
The child identifies colors of familiar objects (e.g., a carrot and an apple) without those objects in view.	3 years, 0 months to 4 years, 2 months
The child sorts forms by shape.	3 years, 3 months to 4 years, 5 months
The child identifies soft, rough, and smooth textures/surfaces.	4 years, 0 months to 5 years, 8 months
The child compares the sizes of familiar objects not in view (e.g., identifies that a dog is smaller than a cow and that a tree is bigger than a flower).	4 years, 3 months to 6 years, 2 months
The child identifies visual differences among similar numerals and letters (e.g., tells the difference between a 6 and a 9 and between an *R* and a *P*).	4 years, 3 months to 6 years, 2 months
The child groups objects by shape and color.	4 years, 9 months to 6 years, 8 months
The child identifies the picture that is different (e.g., when shown a group of objects or pictures, the child can identify which one doesn't belong to the group).	5 years, 0 months to 6 years, 11 months
The child categorizes familiar objects by function (e.g., spoon and fork go together and shoe and shirt go together).	5 years, 9 months to 7 years, 2 months
The child conserves two-dimensional space (i.e., can identify similarity and dissimilarity in areas when shown block patterns arranged in different juxtapositions).	≥ 7 years, 0 months

Appendix B

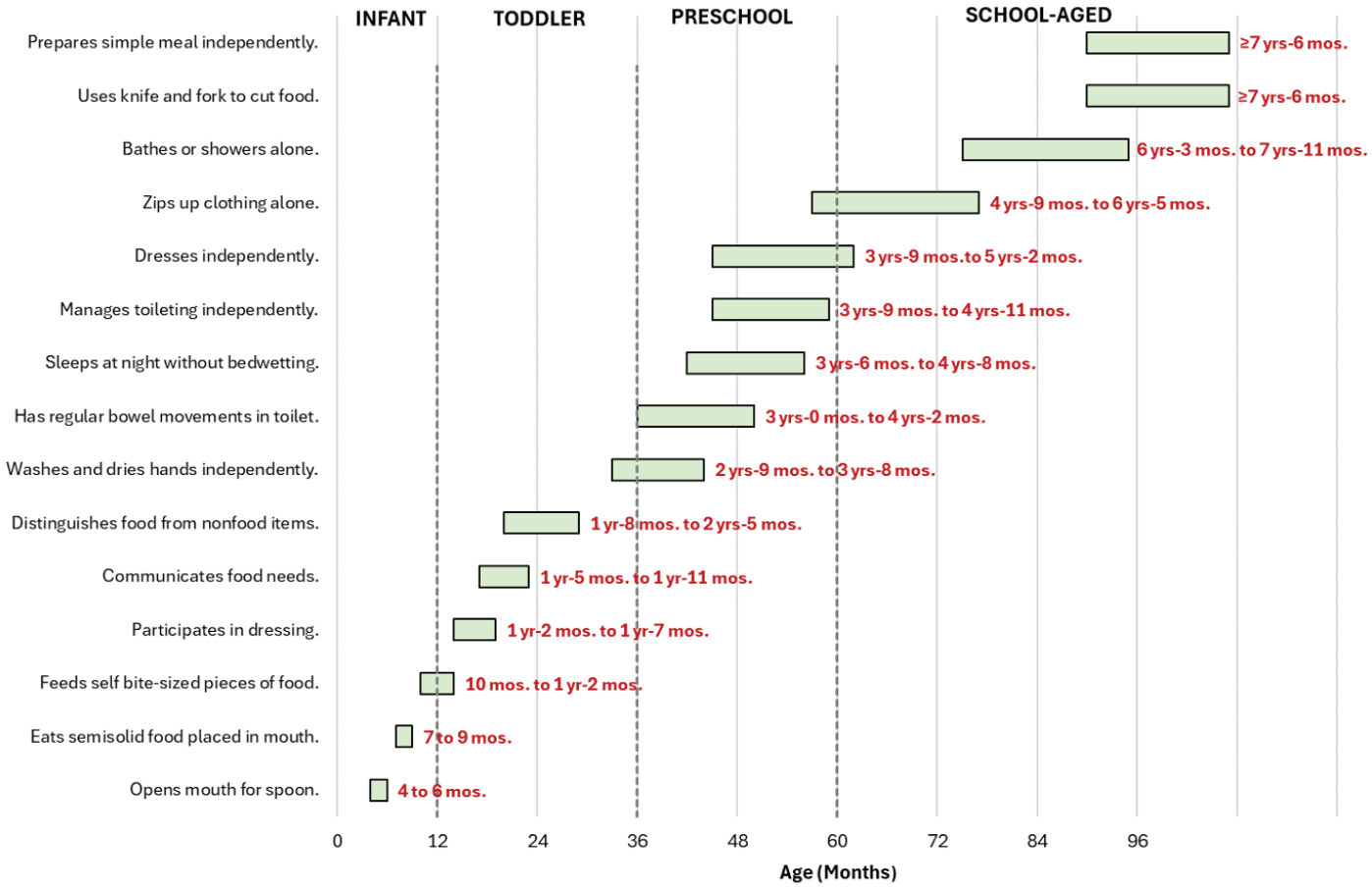

Figure B1. Adaptive Domain, Self-Care Subdomain: Typical Age Range of Milestone Mastery Acquisition

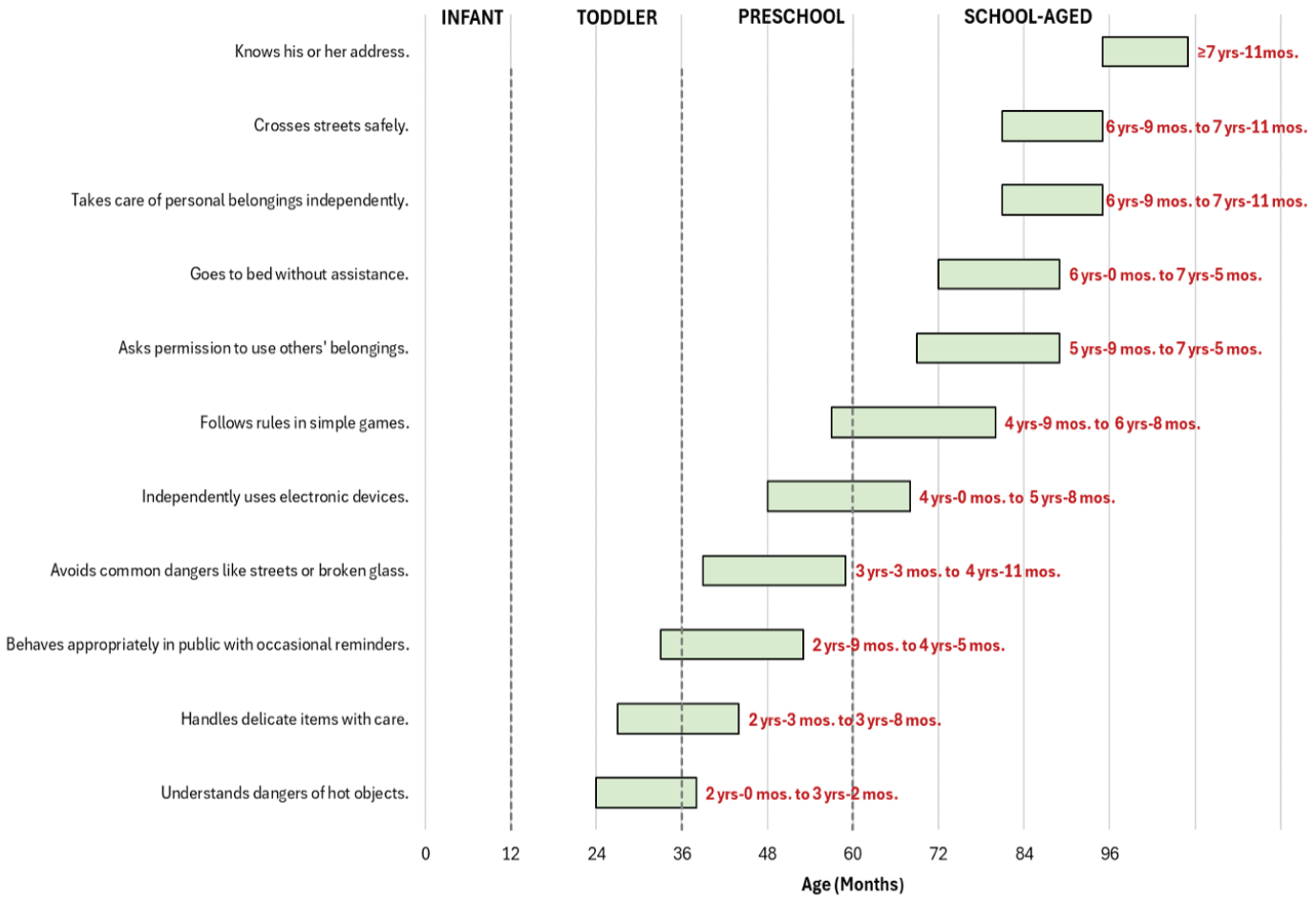

Figure B2. Adaptive Domain, Personal Responsibility Subdomain: Typical Age Range of Milestone Mastery Acquisition

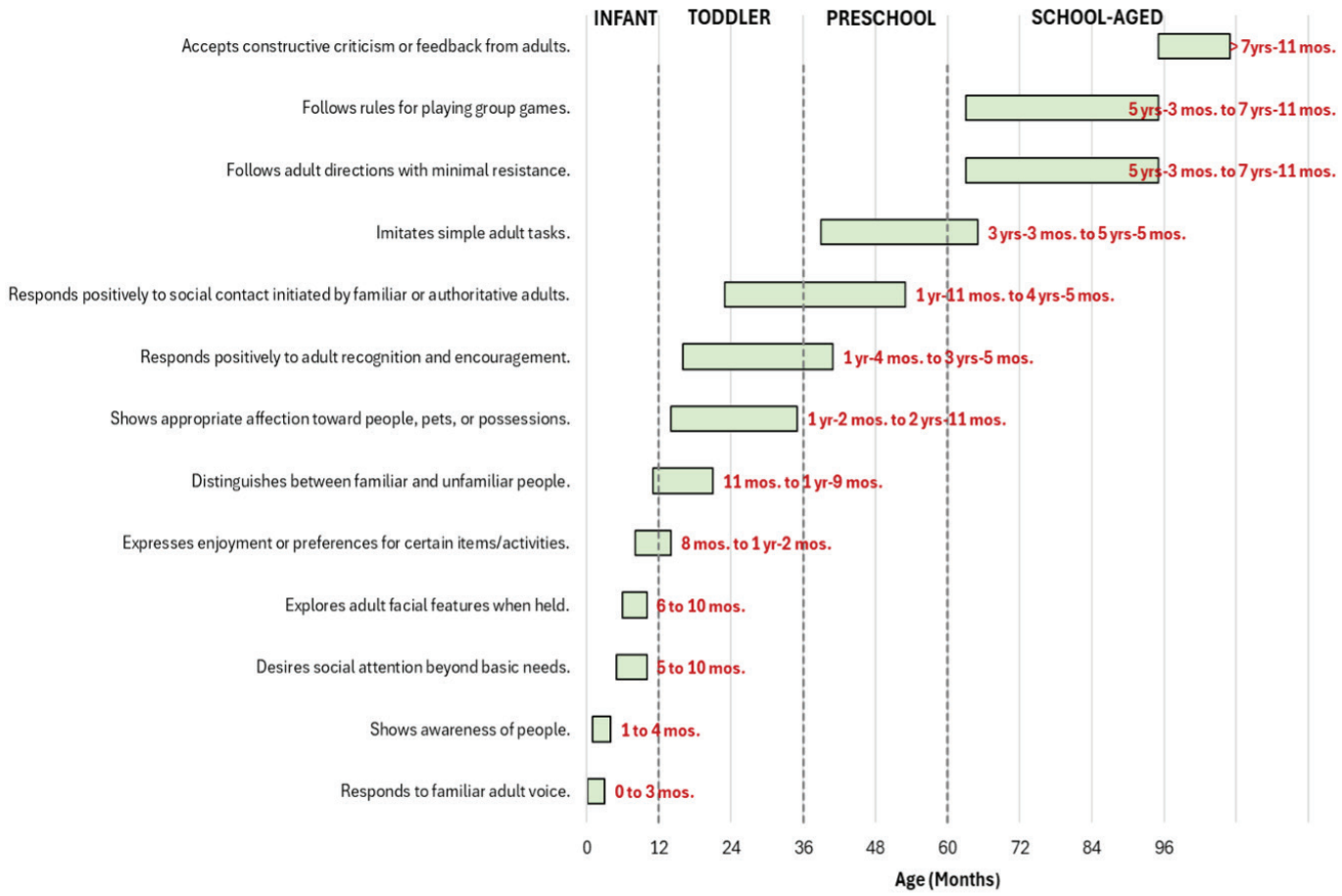

Figure B3. Social-Emotional Domain, Adult Interaction Subdomain: Typical Age Range of Milestone Mastery Acquisition

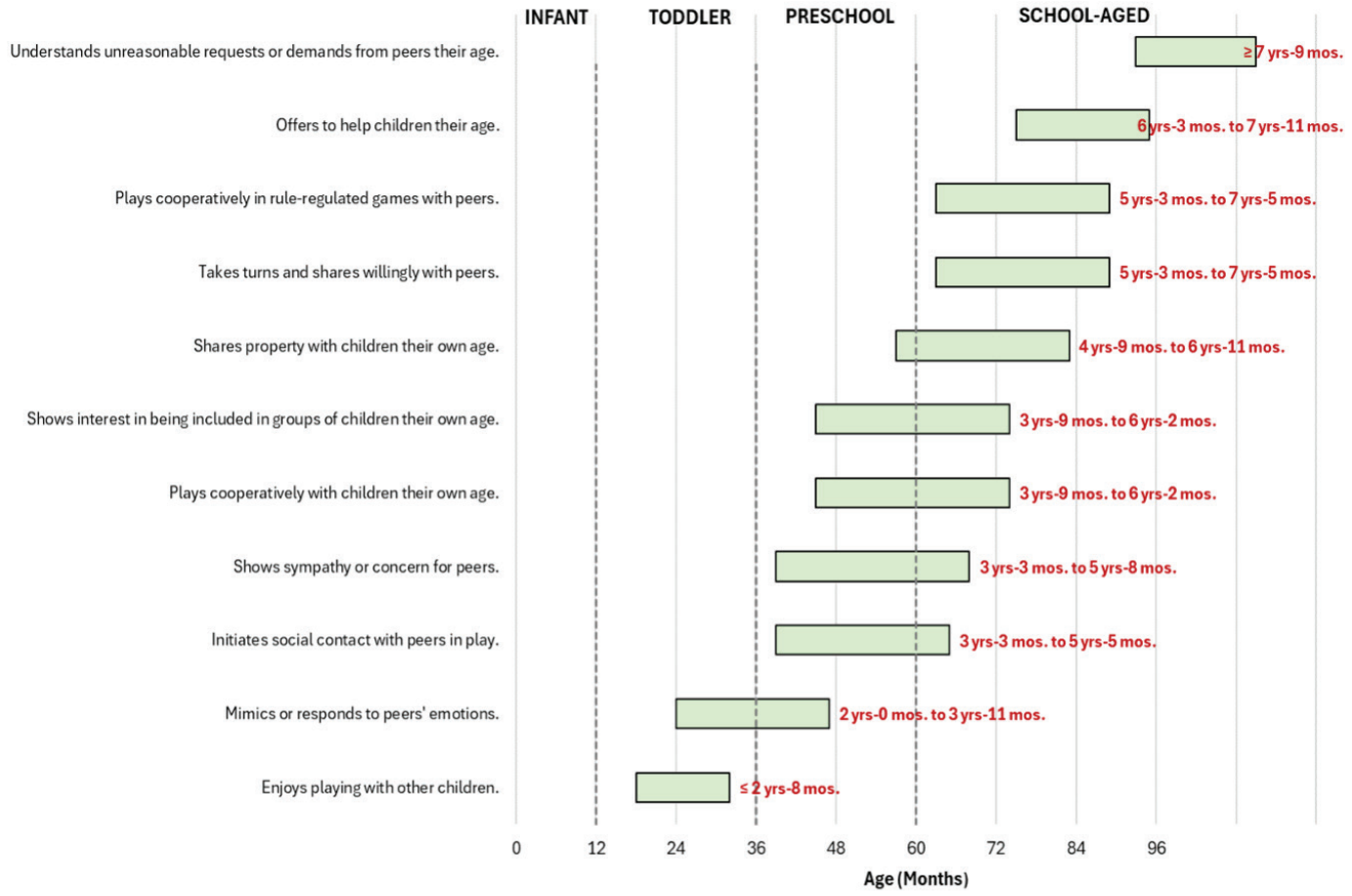

Figure B4. Social-Emotional Domain, Peer Interaction Subdomain: Typical Age Range of Milestone Mastery Acquisition

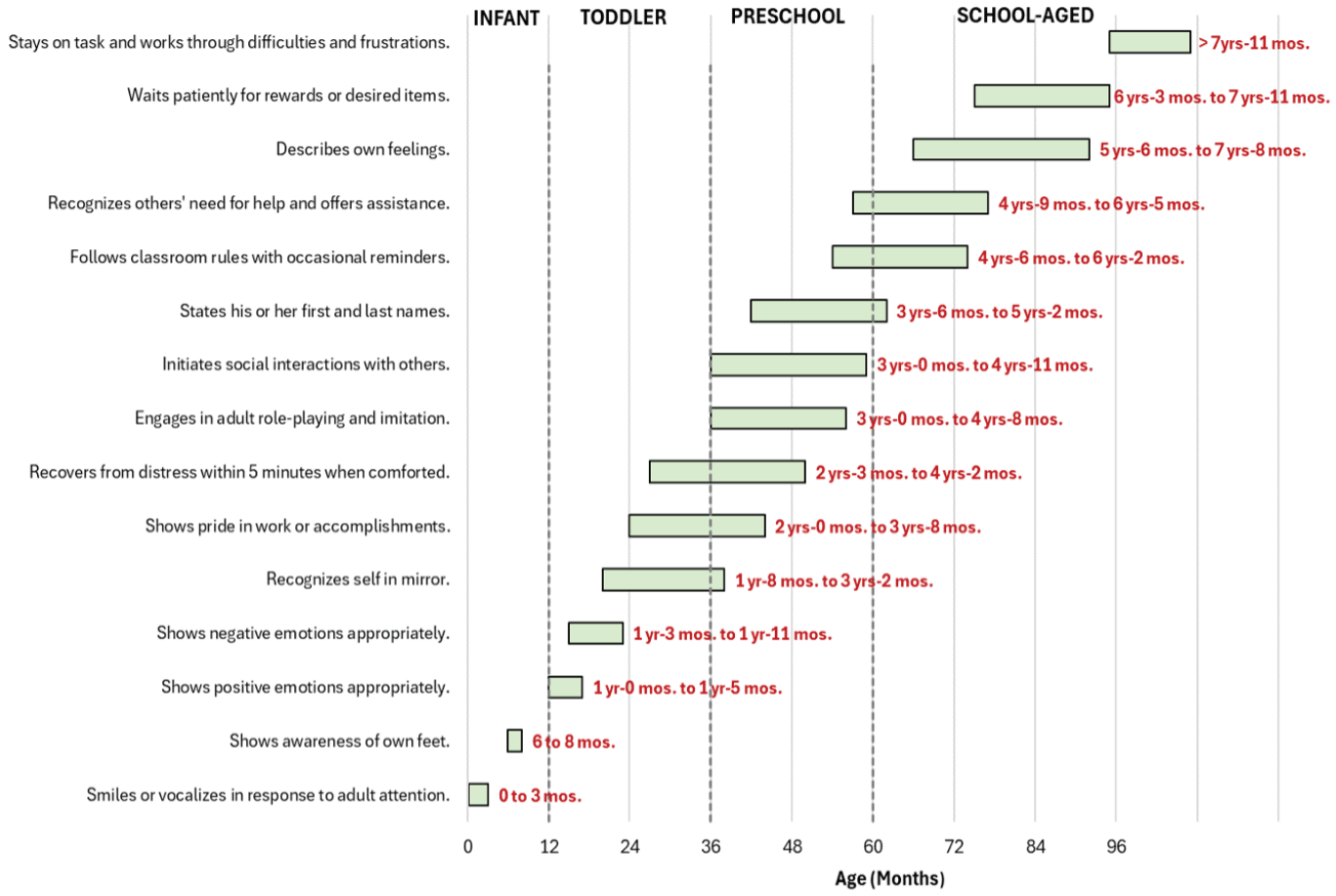

Figure B5. Social-Emotional Domain, Self-Concept and Social Role Subdomain: Typical Age Range of Milestone Mastery Acquisition

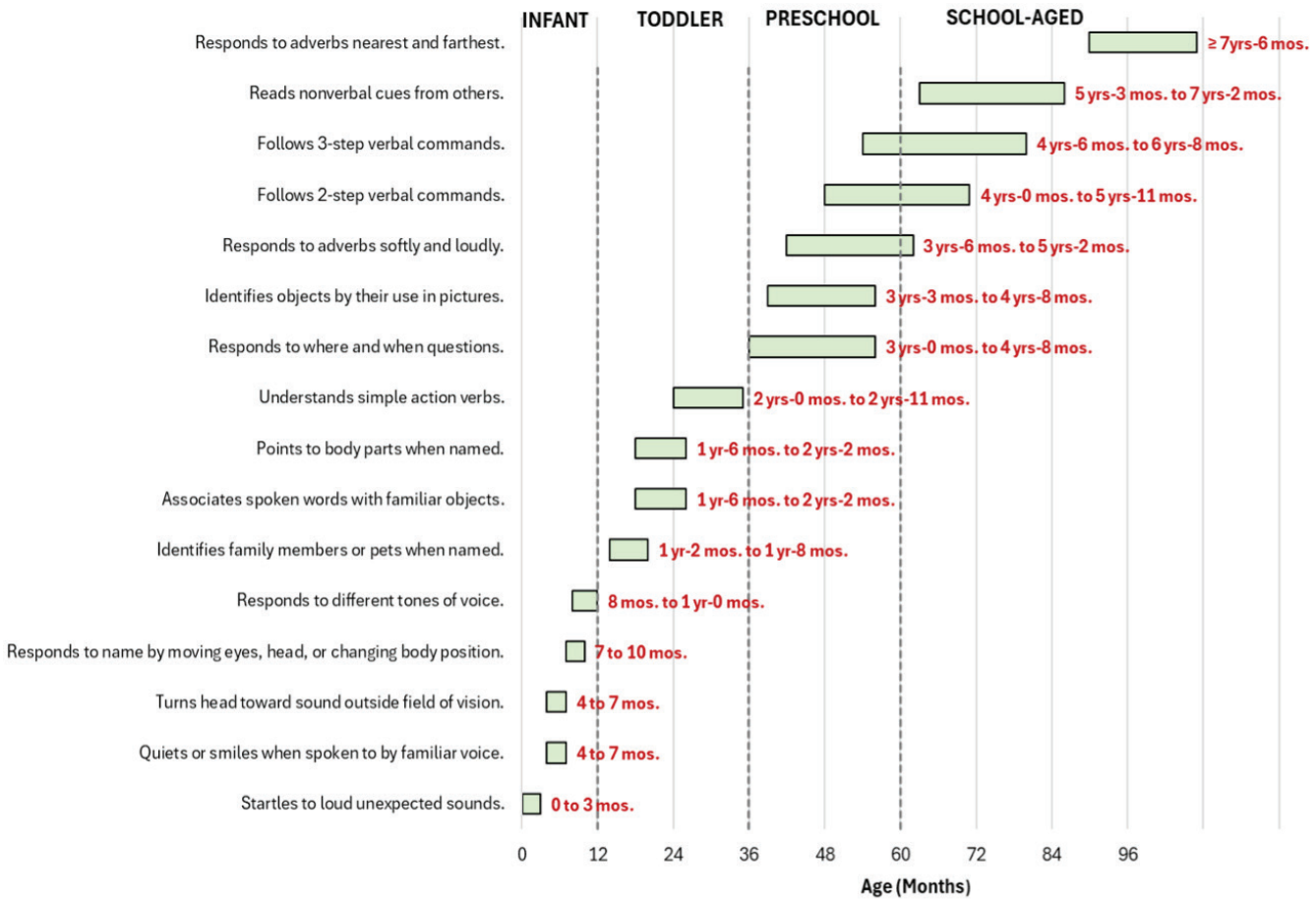

Figure B6. Communication Domain, Receptive Communication Subdomain: Typical Age Range of Milestone Mastery Acquisition

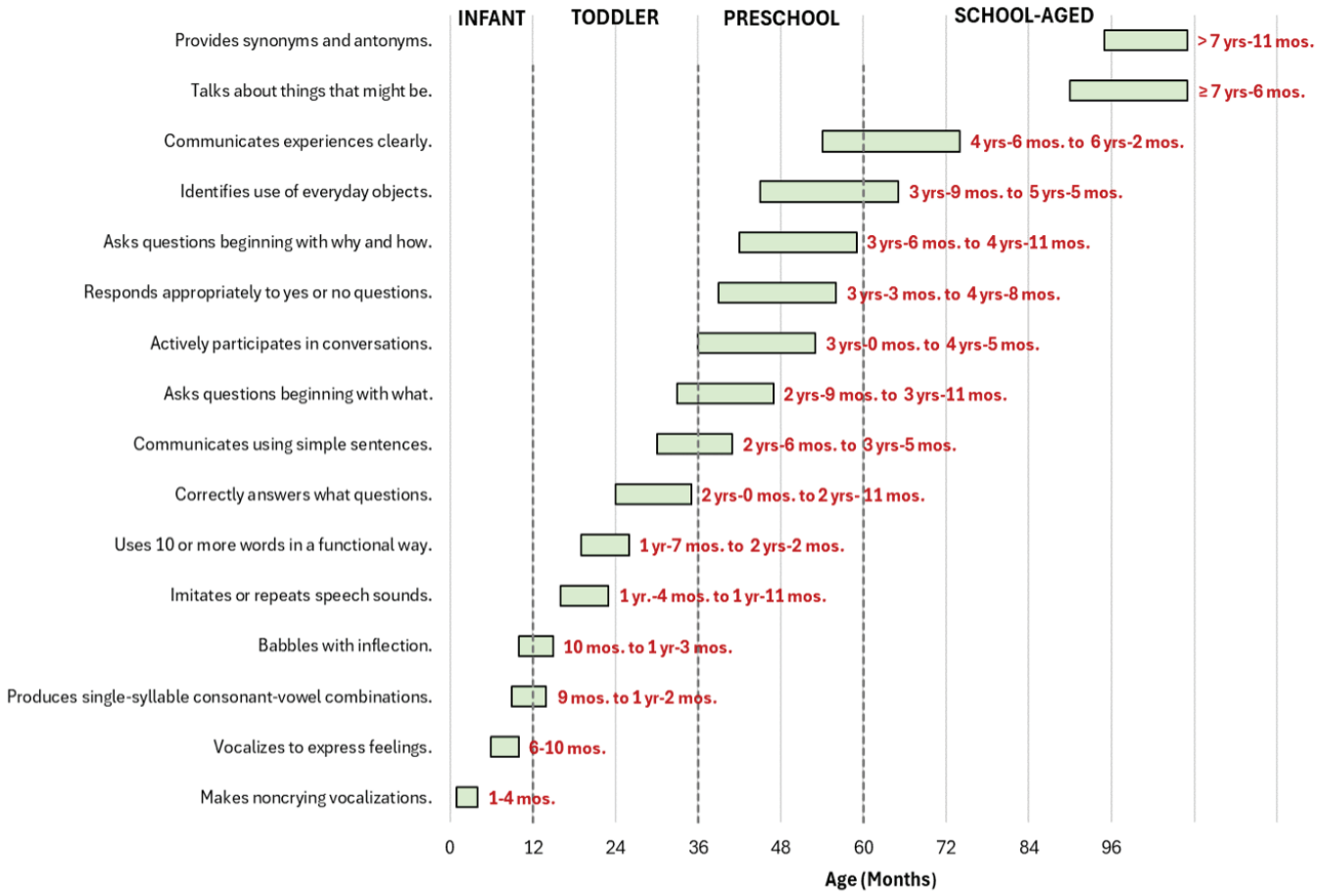

Figure B7. Communication Domain, Expressive Communication Subdomain: Typical Age Range of Milestone Mastery Acquisition

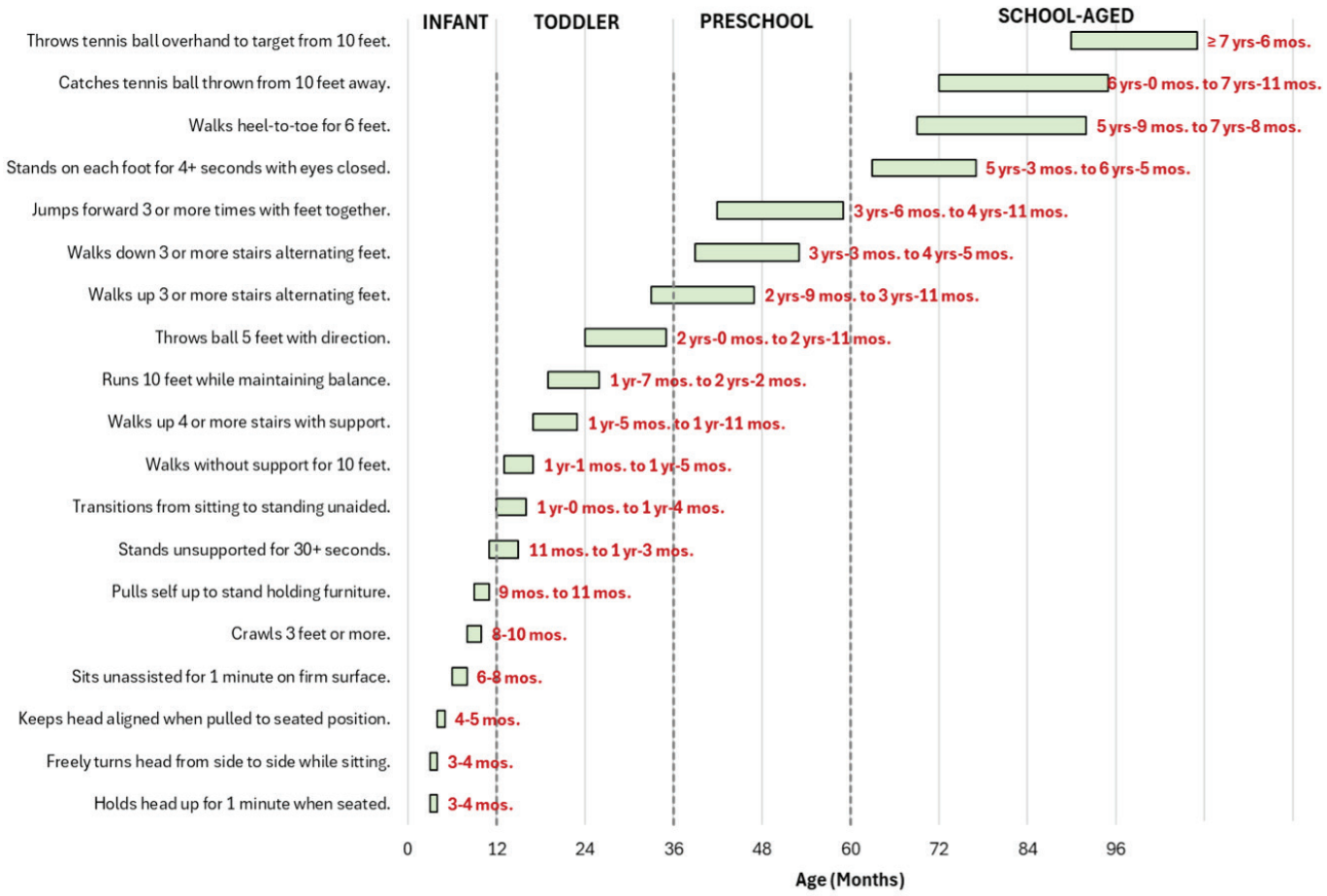

Figure B8. Motor Domain, Gross Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

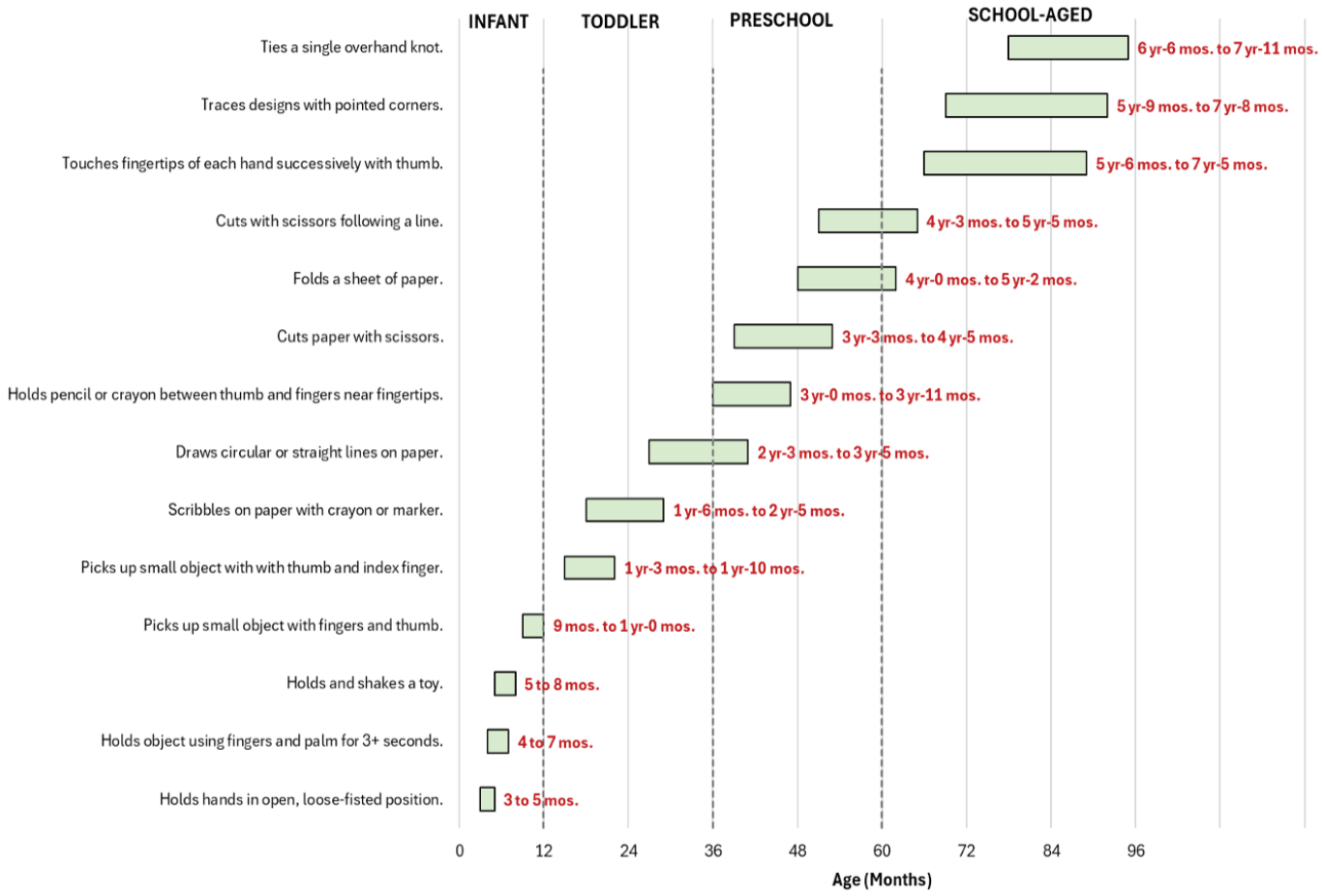

Figure B9. Motor Domain, Fine Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

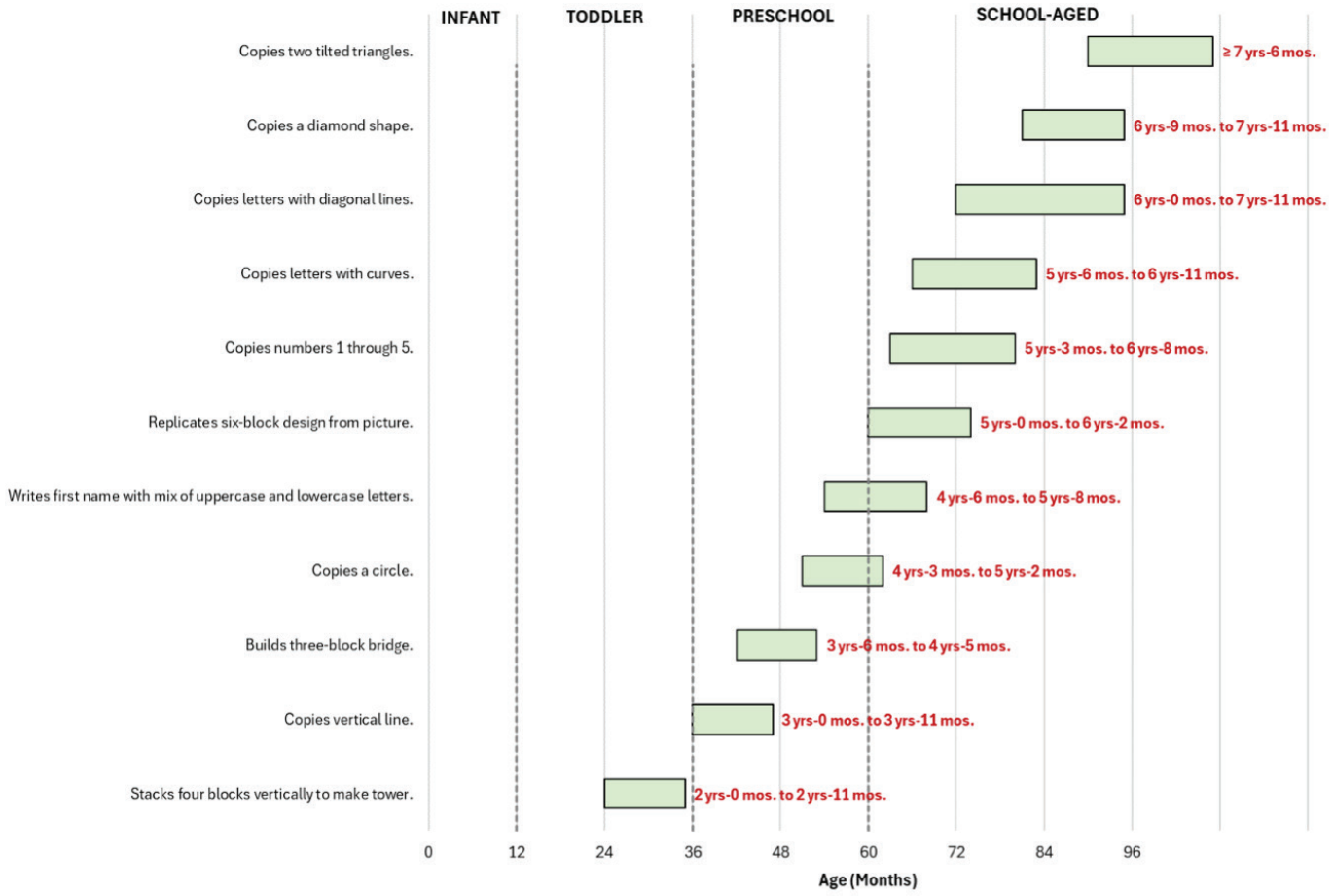

Figure B10. Motor Domain, Perceptual Motor Subdomain: Typical Age Range of Milestone Mastery Acquisition

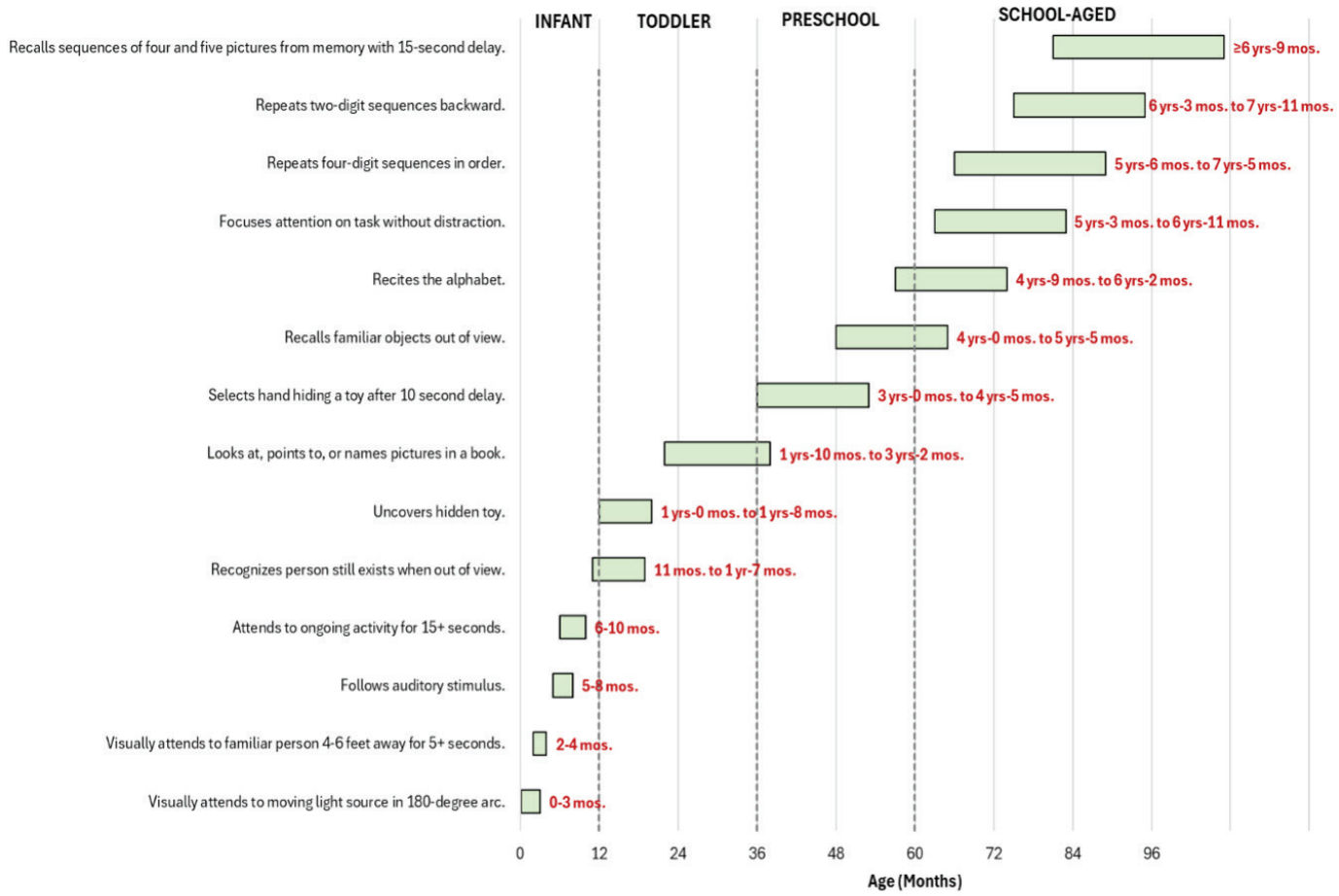

Figure B11. Cognitive Domain, Attention and Memory Subdomain: Typical Age Range of Milestone Mastery Acquisition

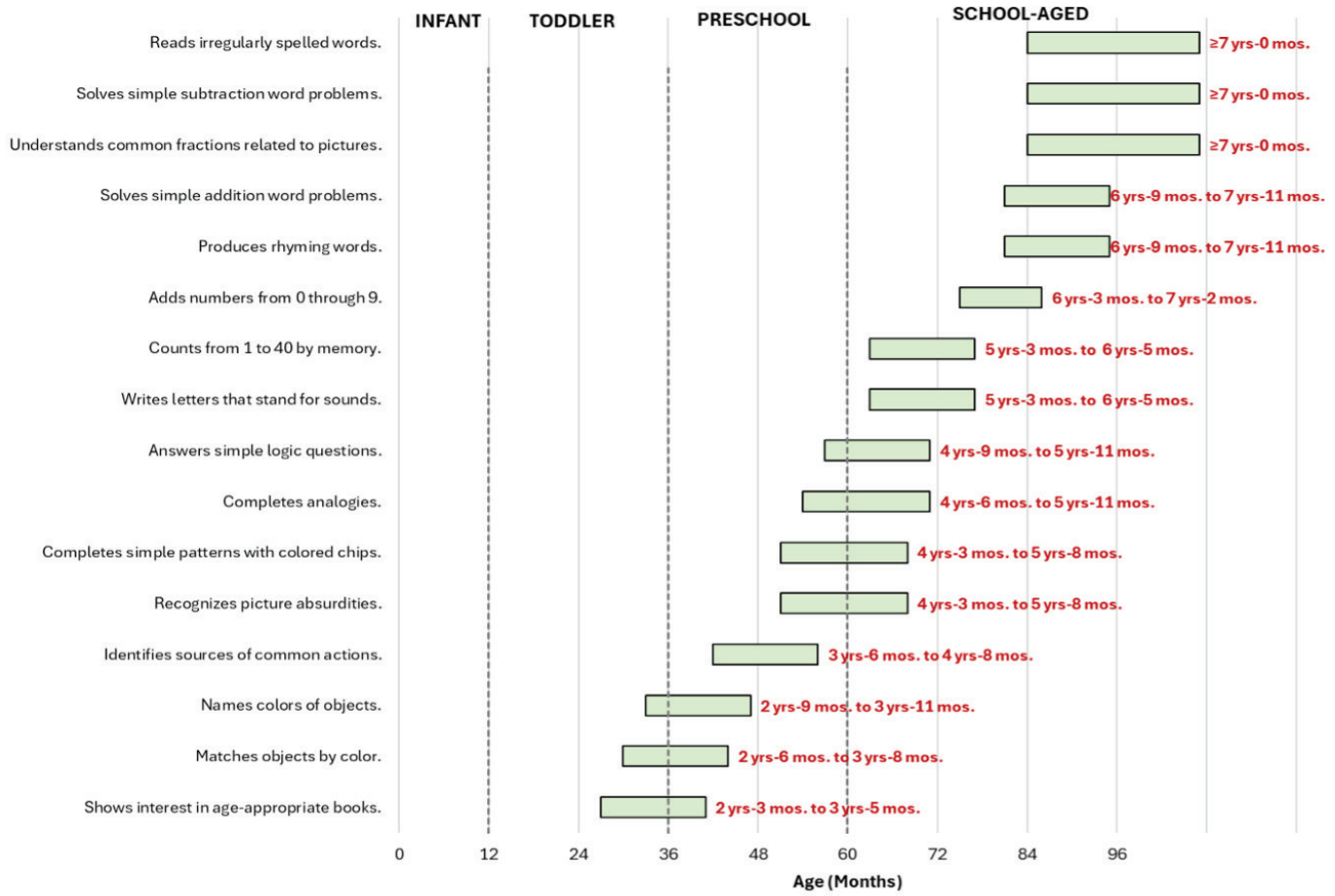

Figure B12. Cognitive Domain, Reasoning and Academic Skills Subdomain: Typical Age Range of Milestone Mastery Acquisition

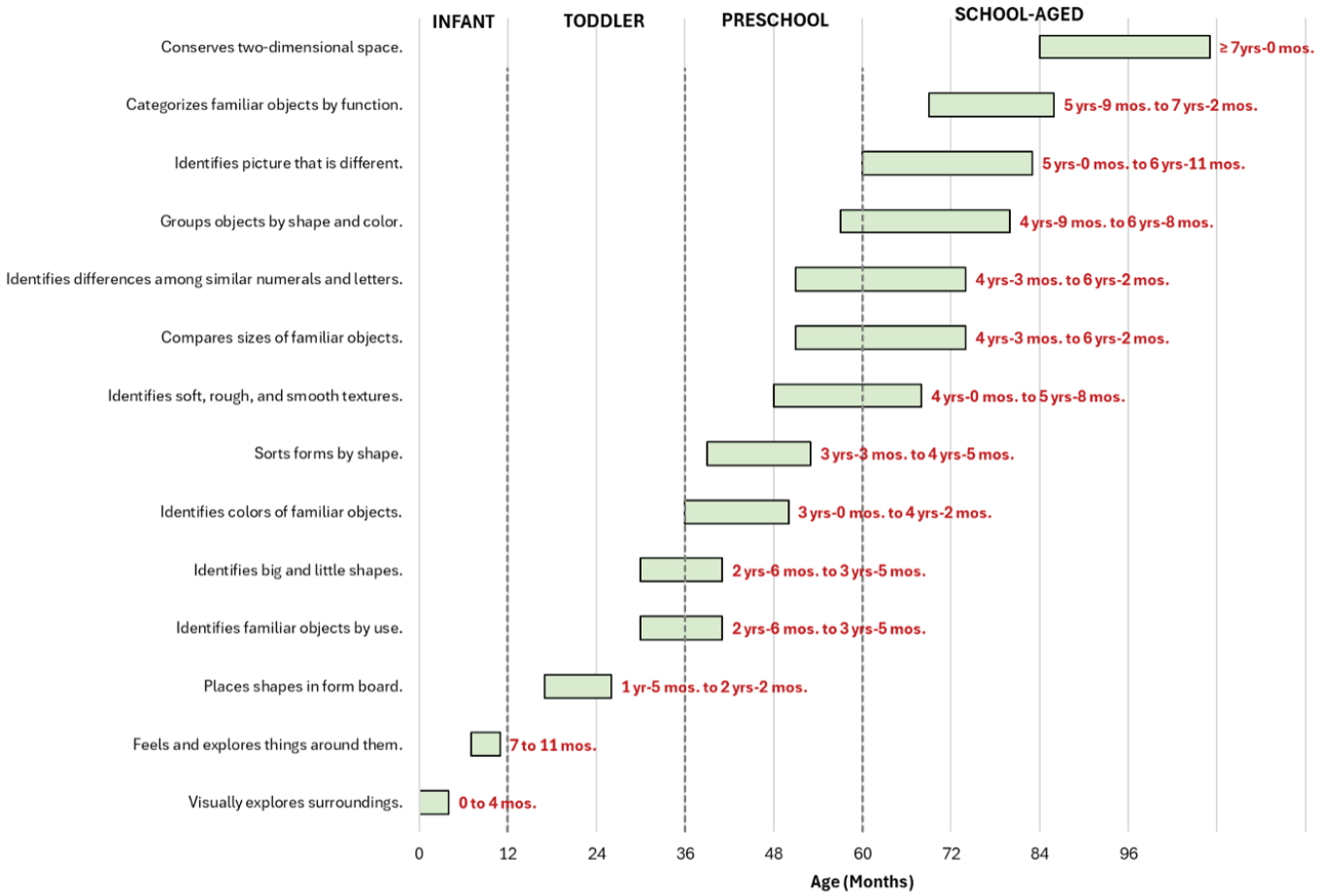

Figure B13. Cognitive Domain, Perception and Concepts Subdomain: Typical Age Range of Milestone Mastery Acquisition