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Age-appropriate adaptation of creativity tasks for infants aged 12–24 months

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ABSTRACT

Creativity is an important skill that relates to innovation, problem-solving and artistic achievement. However, relatively little is known about the early development of creative potential in very young children, in part due to a paucity of tasks suitable for use during infancy. Current measures of creativity in early childhood include the Unusual Box Test, Torrance's Thinking Creatively in Action and Movement (TCAM) task and the Toca Kitchen Monsters task. These tasks are designed for children aged above 12, 36 and 18 months respectively, but very few measures of creativity can be used for infants aged below 2. Accordingly, here we report age-appropriate adaptations of TCAM and Toca Kitchen Monsters tasks for infants as young as 12 to 24 months. Considerations taken into account include (1) infants' cognitive capacities (i.e., attention span, language comprehension skills, motor skills, and approach to play), and (2) practicality of the stimuli, including suitability for use amid the COVID-19 pandemic. The modified creativity battery for infants includes three tasks: Music Play, Object Play and Exploratory Play tasks. The task protocols elaborated in this paper are intended to facilitate studies on the early development of creativity in infants aged between 12 and 24 months. Primary highlights include:

- Age-appropriate adaptation of creativity tasks for use with infants aged between 12 and 24 months.
- Consideration of infants' cognitive capacities and stimulus practicality.
- Innovative use of movement as expression of infants' creative behaviour.

Specifications table

Subject area:	Psychology
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Method details

Tasks 1 & 2: TCAM Music Play & Object Play tasks

The Music Play and Object Play are tasks adapted from the Torrance's Thinking Creatively in Action and Movement (TCAM) protocol. TCAM was specifically designed to eliminate the need to complete the tasks verbally and via drawing, which imposes higher demands for childrens' linguistic and motor skills. However, some limitations still exist in the execution and coding scheme. First, the nature of the activities is very task-oriented and some verbal instruction is still required. Specifically, for Activities I and II, children have to comprehend the instructions given to elicit the movements as requested. However, this may not work well for children younger than 2, who have a limited attention span and verbal comprehension skills. To minimise the number of verbal instructions, visual stimuli may be presented to facilitate childrens' understanding of the task requirement. The second limitation of TCAM is the materials used. For Activities III and IV, children are tasked to manipulate a paper cup and wastebasket, and creativity is scored thereafter. These materials are common items for children, but the task may become too difficult and restricted for preverbal infants to invent new uses. Other items that are common in young childrens' everyday environment may be preferable. Another shortcoming of the TCAM is how childrens' behaviours are coded. According to the TCAM manual, only the end product is analysed. However, as proposed by Rhodes [5], the "four Ps of creativity" highlight the importance of the process of how creative ideas and end products are generated. Moreover, given that children are constantly interacting with the environment to communicate their ideas, the processes by which children complete the activities may be informative about their creative abilities. Thus, the process of completing the task should be taken into consideration when scoring for creativity.

To address these shortcomings, we condensed the activities in TCAM to (a) free movement and (b) manipulation of objects, that will henceforth be referred to as Music Play and Object Play respectively (see Table 1 for a summary of the modifications).

Music Play: Design and administration

The purpose of the Music Play task is to elicit free movement in infants aged 2 years and below. One factor found to facilitate movement in preverbal infants is music. Previous literature suggests that music induces infants (as young as 3 months old) to move intuitively [6] and that infants have a predisposition for rhythmic movement to music [7]. Hence, music was incorporated into this task to elicit free movement in preverbal infants more naturally. Animated stimuli were also created to attract preverbal infants' attention, provide cues for them to move and reduce the need for verbal instructions.

The full protocol comprises 4 phases (see Appendix A for detailed task instructions):

#1: Warm-up Phase (Dance Mats + Audio played on phone)

#2: Familiarisation Phase (Audio played on television)

#3: Concrete Trials (3 animal scenes: Dinosaur → Bird → Shark)

#4: Abstract Trials (3 themes: Ocean → Zoo → Space/Alien)

Animations and videos were created using PowerPoint, Canva and included royalty-free music/videos (Appendix B). These animations were programmed on the Gorilla platform and shown on a 50-inch Aiwa television screen. As the stimuli may be too big when displayed on the large television screen, they were scaled down to an 80 by 80 units layout on the Gorilla platform. The television was also positioned at approximately 128 cm from the infant (see Appendix A). The audio/music used were carefully selected to ensure that the warm-up and familiarisation phases presented a similar range of rhythmic pulse rates for both concrete and abstract trials (see Appendix B). Music was played at a loudness of approximately 60–70 dB. Infants were allowed to move freely in the room during this task.

During the warm-up phase, a dance mat was presented to the child (see Appendix A) and fun pieces of music were played in the background. The purpose of this was to allow the child to understand that he/she is required to move for this task and to increase his/her familiarity with the new environment in the lab. The warm-up phase lasted for a maximum of 10 min, and mothers were allowed to interact freely with their child during this phase.

During the subsequent familiarisation phase, a song was played in the background via the television's audio output. The purpose of this phase was to allow the infant to be comfortable with the novel stimuli (i.e., television) and to encourage them to move in time to the stimulus on the screen. Accordingly, the experimenter performed a set of actions (e.g., waving hands) and encouraged the infant to move along with him or her. During this familiarisation phase, the mother was also allowed to interact freely with the infant. After the infant was observed to be comfortable with the new environment, the experimenter moved on to the concrete trial phase.

Table 1
Summary of Task Modifications Made for TCAM.

Category	TCAM [1,2]		Adapted Tasks (i.e., Music Play & Object Play)
Targeted Age Group	3 to 8 years old		12–24 months
Alteration of Stimuli	Description of Activities	Classification and Evaluation of Activities	Modification of Activities
	I. "How Many Ways?" - Observe the child moving in different ways from location A to B. II. "Can You Move Like?" - Child is tasked to move like an animal or tree.	Classification: Activities I and II can be further categorised as **free movement**. Evaluation: The administration of these activities still involved many verbal instructions.	**Music Play**: Aims to elicit free movement in infants. Modification: Music Play incorporates music and animated visual stimuli to reduce requirement for verbal instruction. This also facilitates more natural movements in infants.
	III. "What Other Ways?" - Observe how the child place a paper cup into the wastebasket. IV. "What Might It Be?" - Observe how the child invent new uses of a paper cup.	Classification: Activities III and IV can be further categorised as **object manipulation**. Evaluation: These activities require the manipulation of a paper cup and wastebasket, which may be difficult for infants to engage in a variety of object manipulation.	**Object Play**: Allows creative object manipulation by infants. Modification: Stimuli for Object Play are specially selected to be abstract in nature and permit a variety of manipulations.
Actions Coded	Actions are coded following activities/ task requirements. However, only the end products are coded.		Computation of the actions for Music Play and Object Play is the same as TCAM (i.e., actions infants elicited pertain to the task requirement). Modification: Actions elicited during the tasks will be coded as well because the process of idea generation is important in facilitating creativity [5]. Also, given that the stimuli used in Music Play and Object Play were different from TCAM, the actions in the coding template will ultimately be different.

Concrete trials were created to elicit basic movements (e.g., walking) from the infants. Subsequently, abstract trials aimed to elicit more unusual and novel actions via the use of more fanciful animated stimuli. Concrete trials were always presented before abstract trials in a fixed order.

A total of 3 videos were created for the concrete trials. Each video lasted for 30 s and featured one animal (i.e., dinosaur, bird and shark). Animal animations, fun background music, animal sounds and movement sound effects were embedded in the video. Before the start of concrete trial, the mother was instructed not to physically interact with and/or generate any novel examples for her child. Nonetheless, she was allowed to imitate her child's or experimenter's actions. When the video started, infants were first given 10 s to think of actions to perform on their own before experimenters would show them a basic action for that stimulus. The purpose of this was to allow infants to initiate actions freely. If the infant did not perform any actions after 10 s, the experimenter would perform a basic action for that stimulus (e.g., stomping for the dinosaur stimulus), and encourage the infant to move.

Finally, the child was shown the 3 videos created for the abstract trials. Each video lasted for 1 min, and featured one theme (i.e., ocean, zoo and space/alien) with distinct fanciful animated characters. The length of each video in the abstract trial was longer than for concrete trial, as we expected infants to require more time to process the abstract movements of characters and to express more creative modes of movement. While the songs and fictitious animations were playing, the experimenter would encourage the infant to select one of the characters from each theme that he/she would like to dance/move along with. During this process, the mother was instructed to give only verbal encouragement to the child. No physical interactions and/or demonstrations of novel examples to the child were allowed for these trials.

Infants' actions were recorded on video during this task and subsequently manually coded. The coding scheme (shown in Appendix C) sought to capture specific actions performed by infants in response to each animation sequence. For example, when viewing the zoo-themed video, infants were expected to spin around following the penguin stimulus. Accordingly, a list of expected actions was collated for each concrete and abstract trial (Appendix C). It should be noted that this list is not exhaustive and new actions can be added as performed by infants.

Object Play: Design and administration

The Object Play task was adapted from the object manipulation task in the TCAM battery. This task assesses whether infants can generate alternate uses for common items. Hence, the materials were carefully selected to ensure that these are familiar for children aged below 2 years. A total of 4 toys were selected for this task: (1) Balls/cubes, (2) Telephone, (3) Camera and (4) Lego pieces (see Appendix D).

Table 2
Categories of Actions Coded for Object Play Task.

Category	Description/Example
A: Physical Contact with Objects and No Actions	Example: Holding on to an object
B: Exploratory Sensorimotor Play	Physically manipulating and inspecting objects (e.g., rotating objects)
C: Relational-non-functional Play	Relating two or more objects without adhering to the function (e.g., stacking of cards on top of the camera)
D: Functional-conventional Play	Using the object according to its "cultural" function (e.g., telephone)
E: Constructive/Creative Functional Play	Engaging in creative activities while learning the various uses of objects and materials (e.g., making music/sounds by intentionally banging the magnetic balls) or engaging in pretend play (e.g., building a house using the magnetic blocks and pretending to be a monster by wrecking it)

Table 3
Summary of Modifications from Toca Kitchen Monsters.

Category	Toca Kitchen Monsters [3,4]	Exploratory Play
Targeted Age Group	18–146 months	12–24 months
Medium for Administration	Technology – first generation iPad mini	Physical environment Reason for change: Exploratory behaviours are influenced by touchscreen experiences. As infants may be too young with limited exposure to touchscreen gadgets, this makes administration via a tablet not feasible.
Stimuli	#1. Various categories to cluster the items a) Food items b) Kitchen appliances c) Scenes within the game #2. Different items within a category a) Food items: Broccoli, carrot, lemon, meat, monster food, mushroom, sausage, tomato b) Kitchen appliances: saucepot, pan, microwave, knife, blender, salt, pepper c) Scenes within the game: start/restart, fridge, monster #3. Items positioned at fixed tabs	 i) Vehicles ii) Music instruments iii) 2D-toys iv) Neutral zone – mother only i) Vehicles: toy car, steering wheel toy ii) Music instruments: microphone, toy piano, toy guitar iii) 2D-toys: busy board, pop-up toy Toys located within the tents
Actions Coded	Actions during the process were automatically collected in the tablet	Manual coding of the actions elicited by infants: 1. Total number of zones explored 2. Amount of time spent in each zone 3. Number of items explored during each instance of exploration of a particular zone

For this task, the infant was handed one toy at a time and allowed to manipulate it for 90 s. After 90 s elapsed, the toy (e.g., telephone) was replaced with a new one (e.g., camera). To prompt infants to play, the experimenter would say "[Infant's name], can you play with this toy" and hand the toy to the infant. The primary objective of this task was to examine infant's generation of alternative uses for the toys (other than the toys' functional use).

Infants' behaviours were recorded on video and only intentional manipulations of objects were coded. Following the object play coding scheme proposed by Neale and co-workers [8], actions were categorised into (i) physical contact with objects only (no action), (ii) physical contact with objects using repetitive actions and (iii) physical contact with objects using non-repetitive actions. Categories (ii) and (iii) were further broken down into (1) exploratory sensorimotor play, (2) relational-non-functional play, (3) functional-conventional play and (4) constructive/creative functional play [9,10]. These combined coding schemes yielded 5 categories that comprised the final coding scheme for Object Play (see Table 2). Appendix E further provides a non-exhaustive list of example actions within each category.

Quantification of creativity in Music Play and Object Play

Infants' creative potential can be assessed by the fluency and originality of their ideas [2]. Fluency refers to the number of unique ideas generated in a given period, which can be tabulated by summing up the number of actions the infant generates during the trial/task. For originality, the statistical infrequency within a sample is used as an index of the rarity (and thus originality) of the action. Specifically, each action is assigned an originality index tiered by a frequency distribution (derived from the full set of responses across all participants); an action that is rarer in a sample would have a higher originality index. Overall scores for originality are computed by summing the individual action scores, and a bonus of 4 points is awarded if combinations of actions were unusual [2].

Value-Add of Music Play and Object Play

At present, one task that can be used to assess creativity in early childhood is the Unusual Box Test (UBT). Capitalising on childrens' nature to explore objects, the UBT uses an unusually shaped colourful wooden box and 5 novel items. Through the manipulation of objects, childrens' creative potential is assessed based on the fluency and originality of ideas [11]. This task successfully assessed creativity in infants as young as 1 year of age [12] and was the first-ever embodied assessment of creativity for children younger than 2 [13]. However, there is still a lack of tasks suitable for infants in the present literature, to provide a more comprehensive assessment of early creative potential. Accordingly, we designed the Music Play and Object Play task to (1) address the shortcomings of traditional assessments and (2) introduce novel ways to evaluate a child's creative potential through incorporating music into the tasks and carefully selecting toys with functionality and abstractness to allow a range of interactions.

Task 3: Exploratory Play

The original Toca Kitchen Monsters touchscreen game provides an innovative digital platform to examine children' exploratory behaviours. However, as explained by Pelz and co-workers [4], one variable that needs to be taken into consideration for this task is children' prior exposure to touchscreen gadgets. Results obtained using this task indicate that exploratory behaviours (quantified by discovery rate) increase with touchscreen experience [4]. Since infants aged below 2 years may lack touchscreen experience, this task may not yield reliable data with this younger age group. Hence, here we propose an adapted version of the task that does not require the use of tablets (see Table 3 for a summary of the modifications).

Key design elements of the Toca Kitchen Monsters task are retained, including having (1) various categories to cluster items, (2) different items within a category and (3) items positioned at fixed spatial locations. With these considerations in mind, the materials used for our adapted Exploratory Play task comprises 3 physical tents, each with different design themes and a separate set of toys (see Appendix F for the detailed protocol). The toys chosen did not emit any sound in order to prevent this from distracting infants and affecting his/her exploratory behaviours.

Before the administration of the task, the mother was positioned equidistant from each tent and instructed to remain in that position throughout the task. This prevented a physical bias toward any particular tent due to the mother's proximity. To prompt the infant to play, the experimenter would say "[Infant's name], can you play with these toys" while making a wide hand gesture to include all the tents laid out in front of him/her. The task ended after the child had explored the area for 8 min. To examine infants' creative exploratory behaviour, a total of 4 zones were considered, with 1 neutral zone for the mother and 3 zones for each tent. To quantify creative exploration, the total number of zones explored during the whole task, the amount of time spent in each zone and the number of items explored during each of these instances were coded.

Summary

Creativity plays a crucial role in early learning and cognitive development. However, the majority of the tasks examining creativity are only suitable for use with older children. Here, we aimed to create age-adapted versions of existing creativity tasks that were suitable for use with younger children aged between 12 and 24 months. Key considerations taken into account were infants' limited attention span, restricted language comprehension skills, less developed motor skills and their approach to play. The age-adapted creativity battery accordingly included music, as well as suitable alterations to the task instructions, stimuli and coding scheme. Also, including an assessment of infants' fine and gross motor skills during analysis may be critical, as the task protocols elaborated here primarily involve motor creativity. With this, the creativity battery will permit earlier and more sensitive measurements of young childrens' creative potential.

Important future research is required to validate the psychometric properties of the creativity constructs measured using these age-adapted tasks, as well as to test their generalisability in other contexts, particularly in non-Western countries. Specifically, future longitudinal studies could follow children from the ages of 12–24 months (when these early measures are administered) up until the ages of 5–6 years when more standard tests of creativity such as the Torrance Test of Creative Thinking (TTCT) [14] and Creative Foraging Game (CFG) [15] can be administered, to assess the developmental stability of the measured constructs. It would also be of interest to compare scores on these Creativity tasks against concurrent measures of infant cognitive flexibility and verbal fluency. Finally, to assess cross-cultural validity, these Creativity tasks should in future be administered to cohorts from both Western and non-Western countries. Previously, Vong and co-workers [16] administered the Taiwanese version of TCAM in a Chinese population (from Macao) of 493 children aged between 4 and 8 years old. Their results revealed a U-shaped developmental trend with age as the most prominent predictor of creativity. However, the limited use of the TCAM (and other adaptations) outside of a Western context is an important constraint to address in future studies.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Ling Zheng Teo: Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing. **Victoria Leong:** Conceptualization, Methodology, Supervision, Funding acquisition, Writing – review & editing.

Data availability

No data was used for the research described in the article.

Ethics statements

Work involved human subjects: we confirm that the relevant informed consent was obtained from those subjects

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Supplementary materials

Supplementary material (Appendices A to F) associated with this article can be found, in the online version, at doi:10.1016/j.mex.2024.102655.

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