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Acquiring Piaget's Conservation Concept of Numbers, Lengths, and Liquids as Ordinary Play

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Abstract

Piaget's influential research on the conservation concept has a wide-reaching impact even in modern-day settings. This study examines Piaget's concept from a perspective that is different from those in existing studies. It focuses on improving the relationship between toddlers and tasks for the acquisition of the conservation concepts of number, length, and liquids. Given that new investigative tasks may be needed to clarify the stage and factors of acquisition, this study examines the possibility of acquisition of the conservation concept by 3-year-olds, with an improved task that is integrated into ordinary conversation and play. The treatment variable was the Piaget task as part of ordinary conversation and play, and the A-B design was adopted because withdrawal is naturally difficult. Results demonstrated the possibility of 3-year-olds' acquisition of Piaget's concept by familiarizing the toddler with the task. Such intervention through the incorporation of Piaget tasks into ordinary conversation or play had clear positive effects, contrary to the results of previous studies that dismiss a 3-year-old's ability to understand the conservation concept.

Keywords: conservation concept, Piaget task, toddler-stage acquisition

1. Introduction

Piaget's research on the conservation concept has been influential at many levels, and investigatory Piaget tasks have clarified the acquisition stage for the conservation concept of numbers, liquids, and lengths as follows (Piaget, 1952; Ginsburg & Opper, 1969; Piaget & Inhelder, 1974; Goswami, 1998; Siegler, DeLoache, & Eisenberg, 2003):

・*Numbers*: Two lines (A1, A2) were shown to children, each accompanied by the same number of marbles. The children were asked to confirm if same number of marbles existed. Then, line A2 was made longer or shorter, and the children were asked if it was the same as A1. After the children answered, researchers confirmed whether it was the same. At this time, the group of 6- to 7-year-olds recognized that the number of marbles was the same.

・*Liquids*: Children were shown two cylindrical containers (A1, A2) of the same size, containing the same quantity of liquid. They were asked to confirm whether, in fact, both contained the same quantity of liquid. Then, the contents of A2 were transferred to a container of a different size from A1. The children were then asked if the quantity of liquid it contained was the same as that in A1. After the children answered, researchers confirmed whether it was the same. The group of 6- to 7-year-olds recognized that the quantities of the liquid were the same; thus, this group had acquired the conservation concept.

・*Length*: Two sticks (A1, A2) of the same length were placed side by side, with their ends coinciding, and the children checked whether the sticks had the same length. Then, A2 was shifted, and the children were again asked if it had the same length as A1. After the children answered, the researchers again confirmed whether it was the same. The group of 6- to 7-year-olds recognized that the two sticks were the same.

In recent years, the advance of science and technology, such as that occurring in neuroscience, has seen discoveries being done from new perspectives (Houdé et al., 2011; Poirel et al., 2012). However, general trends in research, depending on conversations with toddlers (studies done using Piaget tasks), have been solidifying over the past several decades. Currently, the general opinion from subsequent studies is that for Piaget tasks, and the acquisition stage is 6 years and older (Goswami, 1998; Field, 1987; McEvoy & O'Moore, 1991; Ping & Goldin-Meadow, 2008; Asokan, Surendran, Asokan, & Nuvvula, 2014).

Nevertheless, some critics have also stated that these tasks underestimate children's competence (Orlando & Armando, 1996). In fact, many studies concerning pragmatics relate to this point (Goswami, 1998; Donaldson, 1978; Rose & Blank, 1974; Siegal, 1991; McGarrigle & Donaldson, 1974; Dehaene, 1997). Furthermore, some reports have stated that acquisition can happen sooner, at between 4 and 6 years, if task methods are properly designed or practiced (Siegler, 2016; Gelman, 1969; McGarrigle & Donaldson, 1974; Light, Buckingham, & Robbins, 1979; Hargreaves, Molloy, & Pratt, 1982). However, designing tasks often changes questions' contexts, and some researchers have held that such changed questions do not actually examine Piaget's conservation concept (Miller, 1982; Nakagaki, 1990; Goswami, 1998). Additionally, some studies have shown that the acquisition can happen sooner if final requestioning is not employed (Rose & Blank, 1974; Samuel & Bryant, 1984; Dehaene, 1997). However, other studies have shown that requestioning has little impact (Goswami, 1998).

The studies cited above demonstrate several points of uncertainty regarding Piaget tasks. However, while there is room for disagreement over the conservation concept that can be distinguished with Piaget tasks, for the moment, this study considers it to be the "true conservation concept" because the ability to provide a correct answer via dialogue is certainly important in formal education. Accordingly, if new investigatory tasks are discovered, there will still be research value in ascertaining the stage of acquisition or factors in acquisition.

Potential points of improvement for Piaget tasks are examined below. Others have shown that the greatest potential lies in making the survey content (or context) more familiar; however, when criticism of this is considered, changes appear to be less desirable. Considering the above sentence, the idea of making Piaget study itself into something familiar emerged. In other words, a new notion of integrating the tasks themselves into children's ordinary conversation or play arose. Normal play is defined as any activity that "is (a) pleasurable and enjoyable, (b) has no extrinsic goals, (c) is spontaneous, (d) involves active engagement, (e) is generally engrossing, (f) often has a private reality, (g) is nonliteral, and (h) can contain a certain element of make-believe" (Hirsh-Pasek & Golinkoff, 2008, p. 2). Many reports have found that play in early childhood is important for learning mathematics (Seo & Ginsburg, 2004; Ramani & Siegler, 2008; Gelman, 2006; Hirsh-Pasek, Golinkoff, & Eyer, 2003; Ginsburg, 2006). Moreover, part of ordinary conversation naturally refers to and frequently incorporates mathematical content, and some researchers have reported that such incorporation positively affects young children's mathematical abilities (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006).

To satisfy the mathematical condition above, conducting the study continuously is important; thus, the subject can first become familiar with the task. Furthermore, it is important to incorporate awareness regarding mathematical ideas other than the conservational concept through conversations on mathematical terms, concepts, sense, questions, perceptions, viewpoints, and thought into ordinary conversations and play as a preliminary step to study conservation tasks. Furthermore, establishing conversation with each young child is equally desirable as having someone whom the child accepts as a play partner conduct the testing.

For Piaget tasks, study subjects can be under 6 years; in fact, some studies have shown that acquisition is possible by 4- to 5-year-olds if tasks are improved. Thus, a 3-year-old was chosen as this study's subject in the hope of producing new results because children begin having basic conversations at the age of 3 years.

This study examines the possibility of acquisition of the conservation concept of numbers, liquids, and lengths by 3-year-olds by improving the given task, that is, integrating the task into the toddler's ordinary conversation and play.

2. Methods

・*Research design*: Single-case research methods were employed (Barlow, Nock, & Hersen, 2009) because these methods are suitable for drawing conclusions about new hypotheses. Additionally, there is the physical difficulty of studying several subjects at once. The treatment variable was the Piaget tasks as a part of ordinary conversation and play, and the A-B design was adopted because withdrawal is naturally difficult.

・*Target*: One 3-year-old toddler (female) (from 3 years, 2 months old to 3 years, 11 months old).

・*Characteristics of the target child*: She was not forced to learn mathematics. To integrate mathematical awareness into ordinary conversation and play, a study was conducted on conversations related to mathematical content (e.g., quantities, geometry, and logic) from the time the child turned 3 years. This study inquired into 70 mathematical items for each month, and it was conducted during play or ordinary conversations (including quizzes). For example, two pencils were shown, and the child was asked, "Which one is longer?" to check the understanding of the length, or a square piece of cheese was held, and she was asked, “What is this shape?” to check the understanding of the name of a square (cf., Watanabe, 2015).

・*Relationship with the tester*: The target child lived in a three-person household with the tester and spouse (her younger brother was born when she was 3 years and 11 months old). The target child spent most of her time with the tester, having conversations or playing. For example, the tester took her to kindergarten, and the child spent almost all of her time outside kindergarten on weekdays and holidays, including outdoor and indoor playtime, with the tester.

・*Methods*: The study was conducted with Piaget tasks, conducted as part of ordinary conversation and play; they were given as quizzes while the child was playing with blocks or during snack time. Taking breaks or quitting in the middle of a task was acceptable. Correct answers or responses were not pursued.

・*Stages by age in months*: 3 years, 0 months is considered to be any arbitrary day in the 1-month period from the first day (day 0) of being 3 years old through the day before day 0 of being 3 years and 1 month old. The study was conducted with arbitrary timing.

・*Content*: This study’s content was identical with that of Piaget tasks. As a general rule, the final question was asked only once, and no reason for the response was queried.

(1) Numbers

Approximately five spheres were placed in two separate lines (A1, A2), and the child was asked to check whether the two lines were the same. Then, A2 was made longer or shorter (changed at least twice). After each change, the child was asked whether it was the same as A1 by asking, “Which is more?” or “Which number is bigger?” (Figure 1).

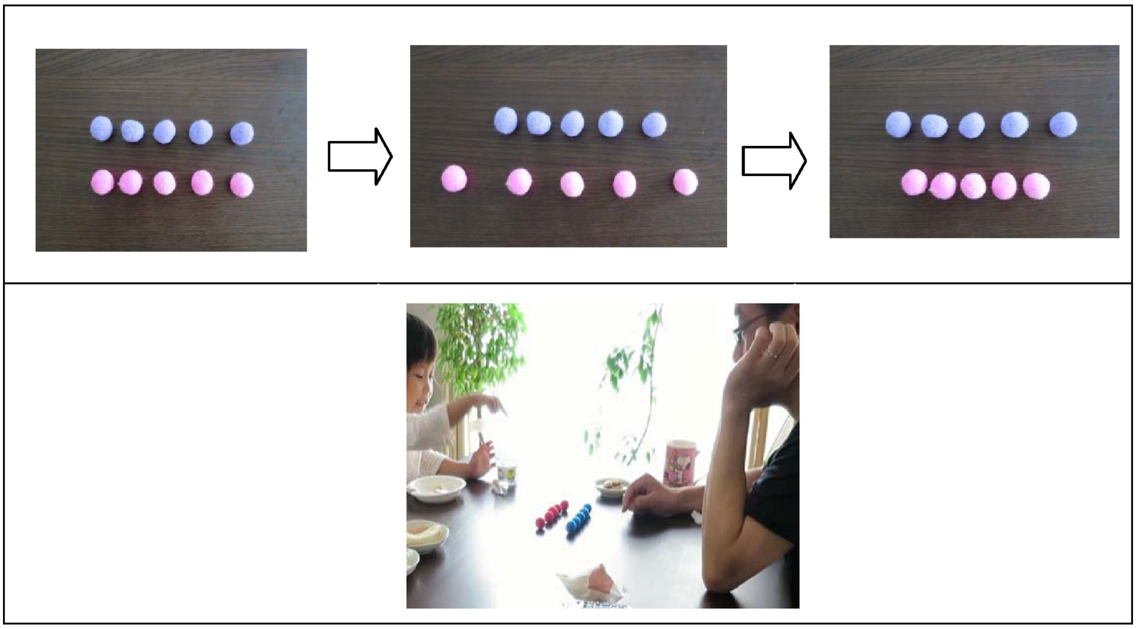

Figure 1. Piaget’s task of number conservation

(2) Liquids

Two congruent cylindrical containers (A1, A2) were placed side by side, water was poured into them, and the child checked whether the containers had the same quantity of liquid. Water from container A1 was transferred to a taller container with a smaller bottom than A1; the child was asked whether the water in the new container had the same quantity as in A2, using questions like “Which has more?” or “Which one contains more water?” (Figure 2).

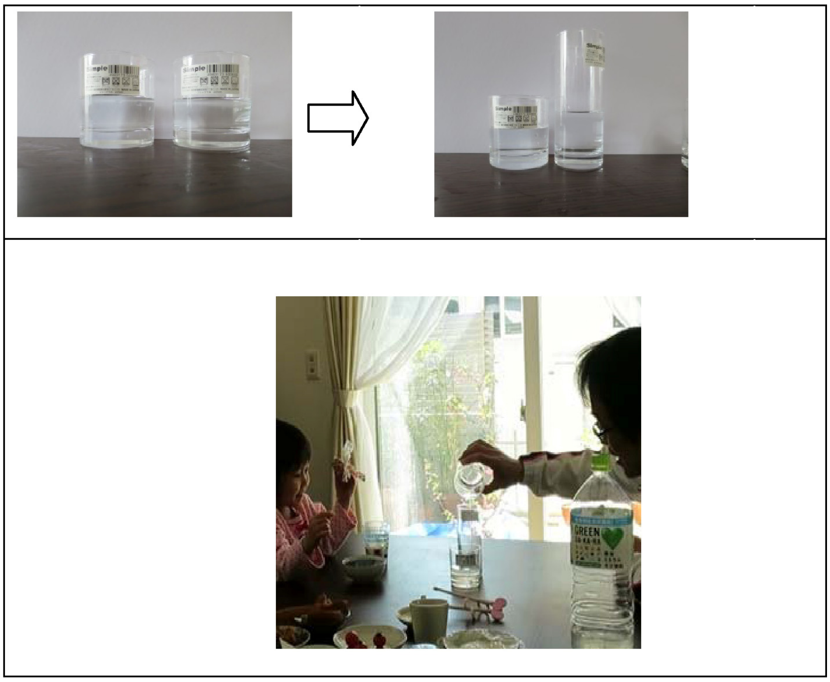

Figure 2. Piaget's task of liquid conservation

(3) Length

Two pens of the same length (A1, A2) were aligned, and the child confirmed whether they had the same length. Then, the position of A2 was off set up or down, and the child was asked whether it was the same as A1: "Which is bigger?" (Figure 3).

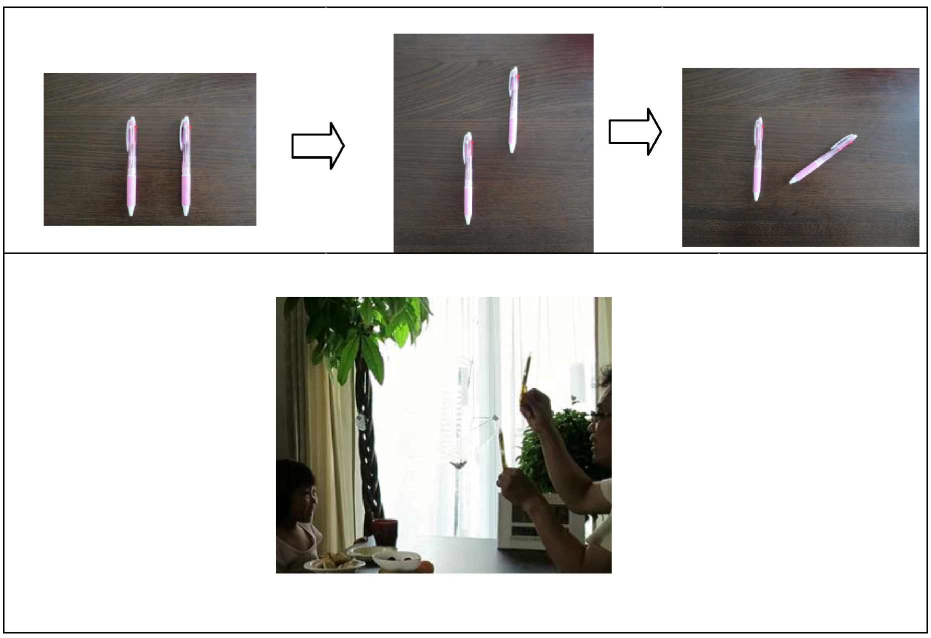

Figure 3. Piaget's task of length conservation

3. Results

Table 1 and Figures 4, 5, and 6 show the study's results. Here, Zero indicates mistaken response, and 1 indicates correct response (the child pointed to the correct option). Typically, the establishment of an original baseline occurs prior to intervention. In this study, however, the task itself was the intervention; thus, if a stable 0 baseline was established after the study, there is no problem in also establishing that the stable 0 baseline continued through the intervention stage. In this study, intervention began when the child was 38 months old, and the baseline was stable at 0 for more than 4 months after the intervention; thus, the study results made it possible to establish a stable 0 baseline prior to the study (before 38 months).

The study's results clarified that the intervention had a positive effect for numbers and liquids at 43 months and for lengths at 42 months (so clear that a statistical test was unnecessary). In other words, lengths attained a value of 1 at 3 years and 6 months; numbers and liquids attained this value at 3 years and 7 months. As this value continued to be stable at 1 for the subsequent 4- to 5-month period, at the very least it can be said that at 3 years and 11 months, the child had acquired the conservation concept of numbers, liquids, and lengths. Additionally, mathematical awareness studies beyond the conservation concept were also conducted from 3 years and 0 months. However, because scores for these remained at 0 for 4 to 5 months after the start of intervention, apparently, no direct relationship to understand the conservation concept could be observed in a study of mathematical awareness that excludes the conservation concept. However, because a study that covered more than 70 items was incorporated into ordinary conversation and play over a 2-month period, the study and its content became part of these activities. One can easily imagine that this would be useful for understanding conservation tasks.

Table 1. Total results by age for Piaget's concept of conservation tasks

Type Age (Months)	Number	Liquids	Length
38	0	0	0
39	0	0	0
40	0	0	0
41	0	0	0
42	0	0	1
43	1	1	1
44	1	1	1
45	1	1	1
46	1	1	1
47	1	1	1

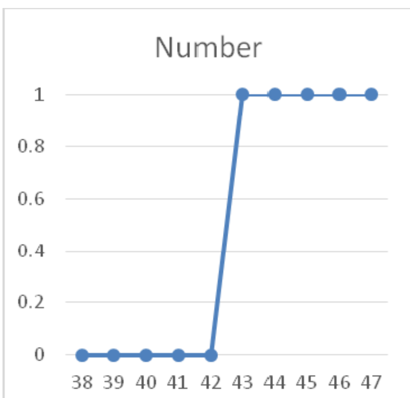

Figure 4. Number results for 3-year-olds on Piaget's conservation tasks

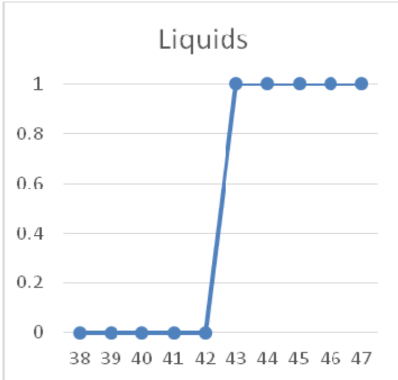

Figure 5. Liquid results for 3-year-olds on Piaget's conservation tasks

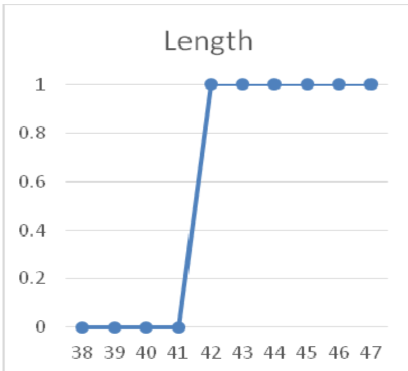

Figure 6. Length results for 3-year-olds on Piaget's conservation tasks

4. Discussion

Prior research has reported that for children aged less than 6 years, Piaget tasks were impossible to understand (Goswami, 1998; Field, 1987; McEvoy & O'Moore, 1991; Ping & Goldin-Meadow, 2008; Asokan et al., 2014). Other reports have stated that acquisition can begin sooner (between 4- and 6-year-olds) if task methods are properly designed or training is conducted (Seigler, 2016; Gelman, 1969; McGarrigle & Donaldson, 1974; Light, Buckingham, & Robbins, 1979; Hargreaves, Molloy, & Pratt, 1982).

With regard to these points, this study has shown that it is possible for a 3-year-old to acquire the conservation concept using Piaget tasks without improving the task content or conducting training merely by incorporating the tasks into a toddler's ordinary conversation or play.

The single-case study was relatively easy to work on, but even with this design, various physical limitations were added (e.g., extensiveness of study content, continuity of the study, establishing play and conversations with the subject, and selecting the tester). This is believed to be the reason that such a study had not been conducted until now.

Many proposals to change the study content have been made; however, it appears that no one had the idea of changing how the study itself was perceived without changing its content.

Clearly, however, increasing the study's scale or the number of opportunities for such a study would be difficult. Therefore, this study became a step in the creation of a research hypothesis, but it lacks generality. Hopefully, many subsequent studies (even repeated undertakings of single-case studies) will be conducted.

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