Brief Note

Cognitive Processes in Formative Activity Containing Symbolic Use: Students With Mild to Moderate Intellectual Disabilities

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The purpose of the present study was to investigate cognitive processes underlying formative activity that contains symbolic use, in students with intellectual disabilities. Participants were 21 students with intellectual disabilities (average MA=8:6; CA=14:9), and 56 children without intellectual disabilities (27 six-year-olds and 29 nine-year-olds). The research task was to draw an original “interesting picture”, using a pencil and stickers. The results indicated that the students with intellectual disabilities tended to produce few formative activity containing symbolic use compositions, and that their composition mainly showed typical representations. This may be attributed in large part to the difficulty that students with intellectual disabilities when searching for prior knowledge regarding components, and to their cognitive processes, which tend to be characterized by a limited ability to synthesize mentally or transform individual components.

Key Words: formative activity containing symbolic use, sticker representation strategy, students with mild to moderate intellectual disabilities

Introduction

Formative activity containing symbolic use refers to, for example, the behavior of a child who gathers some rocks and branches, arranges them into something resembling a person’s face, and then calls that his or her father’s face. This kind of symbolic use of materials for representation is emphasized in educational art and design programs and in many works of art (e.g., Ueno, 1998; Wakayama, 2008a).

In a study by Wakayama (2008b), children without intellectual disabilities were given the task of using a meaningless shape to symbolize something in a picture that they drew. The children were given verbal prompts such as, “This shape looks like a leaf of a flower.” Five-year-olds without intellectual disabilities tended to draw pictures that went beyond typical symbolic forms and had attached imaginative and emotional meanings. This type of drawing experience

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accelerates the development of symbols by children and plays an important role in nurturing sensitivity, self-expression, and creativity. However, little fundamental research has been done on symbolic drawings, and no explanations have been published of internal processes involved or causes of individual differences in the finished creations.

One useful concept for understanding cognitive processes involved in formative activity containing symbolic use is the geneplore model of creative activities (Finke, Ward, & Smith, 1992). According to the Finke et al. (1992) model, people search for prior knowledge about various components and synthesize or transform them in order to generate visual patterns (generative phase), and then interpret those visual patterns conceptually or deduce their functions (exploratory phase). The patterns become more sophisticated and emergent as the generative and exploratory phases repeat cyclically.

Using the concept of creative imagery to approach formative activity containing symbolic use, as in the example above, we could infer that, as a result of searching for prior knowledge of the rocks and branches (components), the child visualizes a human face and then arranges the rocks and branches to coincide with this image (mental synthesis or transformation). Finally, the child interprets the face as his or her father's, in order to make it more interesting.

Formative activities are essential for everyone including people with intellectual disabilities, throughout their lives, not only in the classroom, but in work and leisure settings as well. Research intended to elucidate cognitive mechanisms behind formative activity containing symbolic use will contribute to understanding and supporting these activities. In principle, formative activity containing symbolic use is also deeply tied to divergent thinking and creativity, subjects that have been neglected in research with children with intellectual disabilities.

Therefore, the purpose of the present study is to investigate, from the perspective of the geneplore model (Finke et al., 1992), cognitive processes involved in formative activity containing symbolic use in students with intellectual disabilities. Children with and without intellectual disabilities were compared, in order to enable identification of differences in their creations and production behavior.

Method

Participants
The participants with intellectual disabilities were 21 students enrolled in a school offering special needs education whose mental ages (MA) measured by the Tanaka-Binet test ranged from 7 years 2 months to 10 years 10 months (average, 8 years 6 months). Their average chronological age (CA) was 14 years 9 months (CA range, 11 : 10–17 : 02). The students' teachers confirmed that none of the students had notable visual, auditory, or kinesthetic impairments that might affect their performance on the research task.
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The participants without intellectual disabilities were 29 kindergarteners (CA range, 5:09–6:08, average 6:03) and 29 third-graders (CA range, 8:10–9:10, average 9:02). The 9-year-olds without intellectual disabilities were included because their average MA corresponded to the average MA of the students with intellectual disabilities. The six-year-olds without intellectual disabilities were included because their average MA corresponded to the approximately three-year MA lag often observed in the performance of cognitive tasks by children with intellectual disabilities (e.g., Spitz, 1987; Watanabe & Umetani, 2001).

Task and Materials

The research task was to make an original “interesting picture,” using a pencil and stickers. This task is a formative activity containing symbolic use called “symbolic drawing”. It was chosen on the premise that drawing is familiar to children and is relatively unaffected by their past experiences, compared to other formative activities.

The materials provided were a pencil (2B), a sheet of B4 drawing paper (257 mm×264 mm), and an A4 (210 mm×297 mm) sheet of stickers that had 12 stickers of different colors and shapes (shapes: circle, square, and triangle; colors: red, blue, yellow, and green) on the sheet (see Fig. 1). Each sticker was 5 cm wide. These stickers were selected because they were attractive and easy to use, so that the children could concentrate on the experimental task.

![Fig. 1 A Sheet of Stickers](image-url)
M. Watanabe

Procedures

The study was conducted in a classroom in the school, with one child participating at a time. The researcher first spoke to the children for a few minutes about drawing (e.g., “Do you like drawing?”, “What do you usually draw?”), in order to enhance their motivation. Next, the researcher gave the child a sheet of drawing paper, a pencil, and a sheet of stickers and said, “You can use these stickers to draw an interesting picture. It can be anything you want. Tell me when you’re finished.”

When the child indicated that he or she was finished with the task, the researcher asked questions so as to identify everything on the sheet of paper. If a child had completed the task using only stickers, the researcher asked the child to draw something to show what the stickers were supposed to be.

The children’s activities during the task were recorded with a video camera. In addition, the researcher, who sat next to the child, made observational notes. Including instruction time, the task took 10–15 minutes per child.

Results

In the present report, the term “composition” refers to any combination of stickers and drawings that the children produced on the sheet of paper that they had been given. According to this definition, it was possible to have more than one “composition” on the sheet of paper.

Drawings with no stickers were excluded from the analysis. Two of the six-year-olds without intellectual disabilities made all of their compositions without using stickers, and their drawings were therefore excluded from the analysis.

Characteristics of the Compositions

Number of compositions produced. Many of the children created multiple compositions (see Fig. 2). The students with intellectual disabilities produced 3.14 compositions per child on the average (SD=1.58); the six-year-olds without intellectual disabilities, 2.74 (SD=2.41), and the nine-year-olds without intellectual disabilities, 4.41 (SD=1.79). A single-factor analysis of variance revealed significant differences between the 3 groups (F(2, 74)=5.18, p<.01). Multiple comparisons using Tukey’s HSD test showed that the nine-year-olds without intellectual disabilities produced more compositions than either the students with intellectual disabilities or the six-year-olds without intellectual disabilities (MSe=4.09, p<.05).

Representation type. Representations were classified into two types, as shown in Table 1. In typical representations, objects in the compositions are depicted using the colors and shapes that they usually have. Typical representations are realistic. In novel representations, objects in the compositions are depicted in a way that is unique and outside of ordinary boundaries. This includes composi-
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tions that focus on design, using colors and shapes (see examples 4 and 6 in Table 1), and compositions that tell an interesting story (see example 5 in Table 1). All 268 compositions were classified into one of these two representation types, according to the above criteria. The classification was conducted independently by two individuals (83.6% concordance rate), and any disagreements were decided through discussion. Compositions that showed characteristics of both types were classified as novel representations.

Table 2 shows the number of compositions of each type of representation produced by each of the three groups of children. A $\chi^2$ test (group (3) $\times$ representation type (2)) revealed a significant difference ($\chi^2 (2) = 13.3, p < .01$). Residual analysis showed that the students with intellectual disabilities and the six-year-olds without intellectual disabilities had a tendency to make more typical representations and fewer novel representations ($p < .10$), and that the nine-year-olds without intellectual disabilities had significantly more novel representations and fewer typical ones ($p < .01$).

**Production Behavior**

**Production procedure.** Producing a composition involved putting one or more stickers on the paper and drawing with the pencil. Based on the order in which these steps were performed, the children's production procedures were classified into two broad types: the sticker-first type, in which the child first put stickers on the paper, and then drew with the pencil, and the drawing-first type, in which the child first drew with the pencil, and then added stickers.

![Example of Multiple Compositions Created by a Child with Intellectual Disabilities](image)

**FIG. 2** Example of Multiple Compositions Created by a Child with Intellectual Disabilities

*Note.* The 4 compositions are a signal, a car, people, and a bird. The main composition is the bird, made of 4 stickers and some pencil lines.
<table>
<thead>
<tr>
<th>Representation Types</th>
<th>Classification Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Representations</td>
<td>The content in the picture is depicted using its usual colors and shapes.</td>
<td><img src="image1" alt="Composition 1" /> <img src="image2" alt="Composition 2" /> <img src="image3" alt="Composition 3" /></td>
</tr>
<tr>
<td>Novel Representations</td>
<td>Subjects are depicted in a way that is unique and outside of ordinary boundaries. This includes compositions that focus on design using color and shape and compositions that tell a story.</td>
<td><img src="image4" alt="Composition 4" /> <img src="image5" alt="Composition 5" /> <img src="image6" alt="Composition 6" /></td>
</tr>
</tbody>
</table>

*Note.* Composition 1: Balloon (six-year-old without intellectual disabilities).
Composition 2: House (six-year-old without intellectual disabilities).
Composition 3: Car (participant with intellectual disabilities).
Composition 4: Magic Slide (nine-year-old without intellectual disabilities).
Composition 5: Big centipede attack! (nine-year-old without intellectual disabilities).
Composition 6: Future car (nine-year-old without intellectual disabilities).
The participants supplied titles for their compositions.
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**TABLE 2** Type of Representation

<table>
<thead>
<tr>
<th>Type of Representation</th>
<th>Typical</th>
<th>Novel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children with intellectual disabilities</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Six-year-olds</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Nine-year-olds</td>
<td>11</td>
<td>18</td>
</tr>
</tbody>
</table>

*Note.* The six-year-olds and nine-year-olds did not have intellectual disabilities.

**TABLE 3** Production Procedure

<table>
<thead>
<tr>
<th>Type of Production</th>
<th>Drawing-first</th>
<th>Sticker-first</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children with intellectual disabilities</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Six-year-olds</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Nine-year-olds</td>
<td>4</td>
<td>25</td>
</tr>
</tbody>
</table>

*Note.* The six-year-olds and nine-year-olds did not have intellectual disabilities.

Table 3 shows the number of each type of production procedure used by each of the three groups of children. A $\chi^2$ test (group (3)$\times$production procedure type (2)) indicated a significant difference ($\chi^2(2)=10.8, p<.01$). Residual analysis found no significant difference in the extent of use of the two types of production procedure for the students with intellectual disabilities. The 6-year-olds without intellectual disabilities used more drawing-first procedures and fewer sticker-first procedures ($p<.01$), whereas the nine-year-olds without intellectual disabilities did not use more sticker-first procedures and fewer drawing-first procedures ($p<.01$).

**Number of stickers used in the main composition.** For purposes of the present paper, the analysis was limited to the main composition. The average number of stickers used in the main composition by the students with intellectual disabilities was 3.57 ($SD=2.69$). The average for the six-year-olds without intellectual disabilities was 2.74 ($SD=2.41$), and it was 5.31 ($SD=2.8$) for the nine-year-olds without intellectual disabilities. Single factor analysis of variance revealed a significant difference between the means ($F(2,74)=6.7, p<.01$). Multiple comparison (Tukey's HSD test) showed that the 9-year-olds without intellectual disabilities used more stickers than the students with intellectual disabilities and 6-year-olds without intellectual disabilities ($MSe=7.16, p<.05$).

**Sticker representation strategies.** Sticker representation strategies were categorized on the basis of the way that the stickers were combined. In the simple strategy, the stickers were used without being overlapped or shifted (see Composition 2, house, and Composition 3, car, in Table 1). In the overlapping strategy, the stickers were put at least partly on top of each other (see the steps of the slide in Composition 4 in Table 1). In the shifting strategy, the stickers were intentionally shifted (see Composition 5, a crumbled roof of a house, in Table 1). Examples in which only one sticker was used (see Composition 1 in Table 1) were

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TABLE 4  Representation Strategy: Use or Non-use of Each Sticker

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
<th>Overlapping</th>
<th>Shifting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U</td>
<td>N</td>
<td>U</td>
</tr>
<tr>
<td>Children with intellectual disabilities</td>
<td>17</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Six-year-olds</td>
<td>20</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Nine-year-olds</td>
<td>29</td>
<td>0</td>
<td>18</td>
</tr>
</tbody>
</table>

Note.  U=Use, N=Non-use.

The six-year-olds and nine-year-olds did not have intellectual disabilities.

rized as non-use of a simple strategy.

A summary of the use or non-use of each sticker representation strategy by the three groups of children is shown in Table 4. Fisher's direct probability test (two-tailed test) revealed that there was a significant frequency bias for the simple strategy ($p<.001$). Residual analysis found no significant difference in the use or non-use of the simple strategy by the students with intellectual disabilities. There was significantly more use and less non-use by the six-year-olds without intellectual disabilities ($p<.05$) and by the nine-year-olds without intellectual disabilities ($p<.01$).

A $\chi^2$ test (group (3)×use or non-use (2)) showed that there was a significant frequency bias ($\chi^2(2)=18.5$, $p<.01$) for the overlapping strategy. Residual analysis showed that the students with intellectual disabilities and the six-year-olds without intellectual disabilities had less use and more non-use ($p<.05$) of the overlapping strategy, whereas the nine-year-olds without intellectual disabilities had more use and less non-use ($p<.01$) of that strategy.

Fisher's direct probability test (two-tailed test) showed that there was a significant frequency bias for use or non-use of the shifting strategy ($p<.001$). Residual analysis showed that the students with intellectual disabilities had a tendency to have less use and more non-use ($p<.10$) of the shifting strategy, and that the six-year-olds without intellectual disabilities had significantly less use and more non-use ($p<.05$). The nine-year-olds without intellectual disabilities had more use and less non-use ($p<.01$) of the shifting strategy.

Discussion

The purpose of the present study was to investigate cognitive processes underlying formative activity containing symbolic use in students with intellectual disabilities using the conceptual approach of the geneplor model (Finke et al., 1992). The characteristics of the symbolic compositions and the production behavior of the students with intellectual disabilities were compared to those of the children without intellectual disabilities.

The students with intellectual disabilities produced fewer compositions
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compared to the nine-year-olds without intellectual disabilities. They produced a larger number of typical representations that used color and shape in ordinary ways, and fewer novel representations that showed a unique way of representation. These differences were not seen in the six-year-olds without intellectual disabilities, suggesting that the characteristics of formative activity containing symbolic use compositions made by the students with intellectual disabilities were roughly the same as those made by the six-year-olds without intellectual disabilities, which suggests that there is a two- to three-year MA lag. In their production behavior, the students with intellectual disabilities tended to use fewer stickers for the main composition and tended not to use complex overlapping and shifting strategies or other complex strategies when combining the stickers.

These results can be interpreted by in the context of the internal processes hypothesized by the geneplore model (Finke et al., 1992). The fewer number of compositions produced by the students with intellectual disabilities is likely due to the difficulty for them of searching for prior knowledge about the components.

It is also possible that the children without intellectual disabilities had less prior knowledge. However, presumably there is little difference between children with and without intellectual disabilities in the amount of knowledge associated with the common colors and shapes used in the present study. Rather, previous research has indicated that memory retrieval in students with intellectual disabilities tends to be slower and less efficient than that in children without intellectual disabilities (e.g., Phillips & Nettelebeck, 1985). These tendencies may work to restrict the combination of components with prior knowledge, resulting in fewer compositions.

The reason that most of the compositions of the students with intellectual disabilities were typical representations may be because using complex sticker representation strategies was difficult for them. Many of the nine-year-olds without intellectual disabilities used complex sticker representation strategies like overlapping and shifting and created original representations. For the most part, the students with intellectual disabilities did not demonstrate that kind of representation strategy. Rather, they used a smaller number of stickers, reflecting the simple sticker representation strategies that they were using. This suggests that mental synthesis and transformation of components are restricted in the geneplore model.

Experimental research on mental synthesis and transformation in adults without intellectual disabilities has indicated a connection with working memory (Pearson, Logie, & Gihooly, 1999). Compared to children without intellectual disabilities, students with intellectual disabilities have poorer performance in tasks involving working memory. Recently, it has been argued that working memory may be different in structure or more limited in amount in children with intellectual disabilities (e.g., Numminen, Service, Ahonen, Korhonen, Tolvanen, Patja, & Ruoppila, 2000; Henry & MacLean, 2003; Henry & MacLean, 2002). This

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would limit on mental synthesis and transformation.

The present study found that the formative activity containing symbolic use compositions produced by the students with intellectual disabilities tended to be few in number and to display typical representations. This may be attributed in large part to these children's difficulty searching for prior knowledge regarding components, and to cognitive processes characterized by a limited ability to synthesize mentally or transform individual components.

In closing, we consider what kind of support may assist students with intellectual disabilities to overcome these qualities limiting formative activity containing symbolic use. To increase the number of compositions produced, the tying together of components and prior knowledge has to be stimulated. For example, it may be possible to increase the number of compositions by specifying a category, such as "animals" or "food", thus limiting the range of prior knowledge that has to be searched. From a qualitative perspective, it may be effective to specify the representation strategies to be used, such as overlapping or shifting. Taking these steps would allow students with intellectual disabilities to experience the fun of combining different shapes and colors together.

The story-telling qualities demonstrated in the novel representations by the nine-year-olds without intellectual disabilities may be traced to the interpretation phase in the geneplore model. It may be effective to offer children hints to help them reinterpret the visual patterns that they generate. For example, after a child creates a car like the one in Composition 3 in Table 1, prompts such as "Where is this car going to go now?", or "Who is riding in the car?", may encourage further elaboration of the composition. Methods like these will be examined by the present author in future studies.

Endnotes

1) The main themes in the compositions were divided into nine categories: people (self, friends), buildings (houses, apartments), animals (fish, cats), plants (flowers, trees), machines (cars, traffic signals), scenery (sun, clouds), food (rice balls, bread), imaginary people (Anpanman, monsters), and other (e.g., balls, balloons). The most common categories in the compositions of the students with intellectual disabilities were people (12 children, 57.1%), followed by other (6 children, 28.6%). The most common categories in the compositions of the six-year-olds without intellectual disabilities were buildings and other (10 children in each category, 37%). In the compositions of the nine-year-olds without intellectual disabilities, the most common category was machines (18 children, 62.1%), followed by scenery (13 children, 44.8%).

2) Out of all the compositions on the sheet of paper, the main composition was identified either as the one that was obviously the focal point or the one that used the most stickers.
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References


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