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Exploring age-related changes in creativity

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EXPLORING AGE-RELATED CHANGES IN CREATIVITY

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ABSTRACT

Age-Related Changes in Creativity

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The effects of aging on creativity using a laboratory task involving combining assigned parts and categories into novel and practical items was explored. Older adults demonstrated equivalent creativity to that of young adults. Measures of working memory and processing speed were also administered. Older adults did not perform as well as younger adults. Results indicate that reducing the demands on processing capacity enables older adults to perform as well as younger adults on creativity tasks.

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CHAPTER 1

EXPLORING AGE-RELATED CHANGES IN CREATIVITY

Human beings show a remarkable ability to adapt their behavior to a complex world. Although we are clearly aided by our previous experience, this ability often involves generating novel and effective ways of reacting to new situations. Because this ability seems so central to our lives, it is perhaps not surprising that creativity has been the subject of great interest on the part of researchers and the general public. One common assumption about creativity is that it declines with age. Such an assumption may seem well-founded because of various research findings demonstrating declines in sensory, motor, and cognitive abilities (Birren & Fisher, 1995, Light, Zelinski, & Moore, 1982). However, such declines are often modest and many abilities such as implicit memory (Schacter, Kihlstrom, Kaszniak, & Valdiserri, 1993; Light, 1991) and semantic memory (Hultsch, Hertzog, Dixon, & Small, 1998) remain relatively stable until late in life. Thus, there is a need to directly assess whether there are age-related changes in creativity, particularly since relatively few studies have been conducted in the past. Perhaps more importantly, these studies would have clear implications for the everyday functioning of older adults. Given creativity's central role in helping us adapt to the world, a decline would likely hamper older adults' ability to cope with the many changes that accompany aging.

Although adult age differences in creativity have received relatively little attention, the topic of creativity has been well studied. This research has taken a variety of forms, as there is currently no consensus on how creativity should be defined. One definition states that creativity is a solution to a problem of significance to society that is original, unusual, ingenious, and relevant (Schultz & Ewen, 1988). However, this definition does not address everyday creativity. Gardner (1993a) does believe that there is an important distinction between everyday creativity and creative genius, which he terms as creativity with a "Big C" and a "little c." Creativity in our daily lives comprises the "little c," and momentous discoveries that occur only occasionally comprise the "Big C." For example, using an item in a novel and unintended way to accomplish a task (e.g., using a potato to remove a broken light bulb) illustrates the "little c" of creativity and Einstein's Special Theory of Relativity illustrates the "Big C" of creativity. Similarly, Margaret Boden (1994) distinguishes between a creative idea that is important to an individual who has never had this idea before, and a historically creative idea has occurred to this individual and no one else.

Besides the distinction between everyday creativity and creative genius, creativity has also been variously defined in terms of the product produced, the process involved, or some relatively stable characteristic of the individual (e.g., a personality trait, or a "gift"). These definitions have clearly influenced the type of research approach used to study creativity. Each approach has yielded important insights into creativity, and provides the background for investigating potential age differences. I will next review the various approaches that have been used to study creativity, with an emphasis on data that is relevant to the question of whether creativity changes with age. I will also argue that one of these approaches – The Creative Cognition Approach – has the potential to illuminate questions about the nature of aging and creativity.

Major Approaches to Studying Creativity

Case Studies

One of the oldest approaches to studying creativity is the case study. In this approach, researchers investigate individuals whose contributions to their fields are universally recognized as creative and outstanding. Research of this type typically involves personal interviews, examination of laboratory logs, memoirs, and autobiographies of famous scientists, artists, composers, and writers. For example, Gardner (1993b) examined the works of Sigmund Freud, Albert Einstein, Martha Graham, Mahatma Gandhi, and other famous individuals. Gardner argues that aging itself changes the nature of creativity. For instance, later in life an individual may become a critic of the field or mentor young people. While this approach highlights important aspects of creativity in a few highly recognized individuals, a weakness of this approach is that it focuses on exceptional individuals, limiting its generalizability to everyday creative processes. In addition, retrospective reports can often be subjective and may not truly reflect the creative processes of the individual at the time of discovery.

Historical Approach

Researchers using the historical approach rely on biographical and historical data to examine creativity. Using archival data collected from longitudinal studies on creativity from scientific disciplines, historians, philosophers, and the arts, Simonton (1990) examined how creativity changes as a function of the aging process. He looked at the output of creative individuals across the life span and found that in a normal life span, the output rate of the last decade of a career is about half that of the career peak. Nevertheless, the curve does vary by domain, with creative outputs in math and science peaking earlier than history and psychology. Although there are individual differences (Simonton, 1984), on average, creative productivity peaks in the late 30s or 40s. However, the quality of creative works appears to have no relation to age. This finding suggests that with respect to older adults, the ability to be creative remains stable throughout development.

Psychometric Approach

This type of approach was developed along the lines of intelligence testing in that creativity is measured by standardized tests. The psychometric approach developed by Guilford (1967) called attention to divergent thinking abilities as a component of creativity. Divergent thinking requires flexibility, fluency and originality. A divergent thinking task requires the production of a large number of appropriate solutions to a problem. Conversely, *convergent thinking* requires the production of one correct answer, such as a vocabulary question, and is the type of question one would encounter on an intelligence test. Tests of divergent thinking include word fluency, where the task is to write as many words as possible that begin with a specified letter, and the alternate uses task, in which one must name as many uses as possible for a common object. With respect to creativity and aging, longitudinal studies of divergent thinking most often show a decline with age (McCrae, Arenberg, & Costa, 1987). However, it should be noted that this finding does not necessarily reflect a decline in creativity. Typically, divergent thinking tasks are timed and speed is a major element in performance. Laboratory research in other aspects of cognition has routinely found age differences in the speed of cognitive processing (Salthouse, 1992). Thus, age differences in divergent thinking could be attributable to slowing in processing speed rather than a decrease in creativity per se.

Creative Cognition Approach

A more recent approach to examining creativity is called the Creative Cognition Approach (CCA; Finke, Ward, & Smith, 1992) which focuses on the underlying cognitive processes involved in creativity. Studies using this approach have used laboratory tasks in an attempt to isolate these processes. The CCA assumes that the component cognitive processes are not different from the processes involved in non-creative tasks or products. Thus, the cognitive processes used in creativity are not 'special', although the manner in which they are employed might be (Finke, et al., 1992). Research using this approach has found that constraining object parts that participants are given in a creativity task appears to lead individuals to more fully explore the possibilities within a task (Finke, 1990). It also has been found that interpretive constraints (categories) that are too general or too specific constrain creativity. To date, the CCA has not been utilized to study adult age differences in creativity.

One additional strength of CCA is that it involves a well-specified model of creativity, called Geneplore (Finke, et al., 1992). This model is so named because it characterizes two distinct phases of the creative process, generation and exploration. The generation component involves creating novel mental images by retrieving information from memory in the form of words, concepts, or basic component parts, and forming associations among them, creating a mental image. Once these novel mental images are assembled, they are considered *preinventive forms*. Preinventive forms are internal representations that are the building blocks of creative products. A preinventive form may consist of basic shapes or forms that one believes might be useful in providing a structure for a new creation. Preinventive forms are generated automatically and quickly, without full meaning, and are interpreted in light of the task at hand. For example, using a set of building blocks in order to construct something new and different, one may assemble them into an interesting form without any particular purpose in mind. Then, once the item is constructed, the shape and form of the object inspire an idea, and only then does the purpose of the new invention come to mind. In a sense, the idea emerges from the preinventive form. Emergence is an important property of a preinventive form. It is a perceptual interpretive process in which unexpected features and relations appear in the preinventive structure (Finke, 1990). For example, a unique combination of shapes may inspire an idea about an invention, and the idea emerges from this unique form. Another important property of a preinventive form is ambiguity. Ambiguity is present when the same idea can be organized in different ways. In the case of preinventive forms, ambiguity is an asset, in that it allows more freedom for exploration and interpretation, and will help lead away from an uncreative solution (Finke, 1992).

The next phase of the Geneplore model, Exploration, consists of strategies for analyzing and manipulating the preinventive forms in search for a solution to the given problem. Once the preinventive form is generated, it can be mentally scanned to determine if it has any useful properties. Among the techniques used in this phase of the model are processes such as interpretation, searching for limitations, hypothesis testing and contextual shifting.

Interpretation of the preinventive forms can be thought of as applying world knowledge to the task. Searching for limitations has the important property of allowing one to recognize what will not work and to focus resources on what will work.

Hypothesis testing involves searching the implications of the novel forms for an answer to a problem, and contextual shifting involves removing an object or concept from its current context and applying it in a new context. Unlike the generation of novel forms in the first phase of the model, which is supposed to more automatic, exploration is thought to be a more controlled, systematic examination of the preinventive forms.

Summary of Major Approaches to Creativity

Creativity has been well studied from a variety of perspectives, yet there is remarkably little research on possible changes that occur with aging. Research from case studies suggest that as people age, the type of duties they often assume (e.g., mentoring, administrating) may differ from the activities (e.g., publishing) on which they were judged when they were more junior. Thus, it appears inappropriate to judge their creativity on the same criteria. Historical research (e.g., Simonton, 1990) suggests that older members of a profession almost always produce less work later in their careers, but that the creativity of the work remains high. Finally, research using the psychometric approach suggests that creativity likely decreases in older adulthood, as indicated by declining performance on tests of divergent thinking. Perhaps the clearest conclusion that can be drawn at this point is that additional research is needed.

Goals of the Present Study

The following study was undertaken to clarify whether there are age-related changes in creativity. To do so, the CCA was adopted. Although this approach has yet to be utilized in studies of age-related differences, it nevertheless has a number of advantages over alternative approaches to the topic. For example, CCA specifies a number of component processes that are involved in creativity. If in fact there are age differences in a given task, it may be possible to characterize the differences in terms of specific cognitive processes that are impaired. In addition, many of the individual processes involved have already been well researched in their own right. For example, there are rich research literatures on age differences in working memory (Salthouse, 1990), imagery (Hertzog & Rympa, 1991, Dirkx & Craik, 1992), and attention (Dywan & Murphy, 1996). This literature allows specific predictions about the conditions under which older adults should be at a disadvantage relative to young adults. Finally, the laboratory tasks used in this approach allow for 1) greater control over the specific information given to the participant, and 2) yield relatively objective measures of creativity (and thus are not prone to problems associated with self-report). Although it can be argued that these tasks might not entirely reflect the characteristics of real-world creativity (Simonton, 1990), the advantages of this approach suggest that it would provide an important complement to research gathered from more qualitative approaches.

In the following study younger and older adult participants created novel and practical objects using a specified set of basic object parts and categories. The stimulus materials consisted of 15 basic object parts (names provided in Table 1) made up of simple three-dimensional forms (see Finke, 1990) and eight different categories. The category names were: *furniture, personal items, transportation, scientific instruments, appliances, tools and utensils, weapons, toys and games.*

TABLE 1

Names of the Three-dimensional Object Parts for the Creativity Task

Sphere	Half-sphere	Cube	Cone	Cylinder
Wire	Tube	Flat Square	Bracket	Rectangular Block
Hook	Wheels	Cross	Ring	Handle

At the beginning of each trial, participants were randomly assigned three basic object parts (e.g., a sphere, wire, and a ring) and one category (e.g., tools and utensils). Participants immediately wrote down the parts and category name and were given five minutes to create a novel and practical invention. Each participant was given six trials. The products of these trials were later rated by two young and two older adults using two dimensions, practicality and originality. The reason for using two sets of raters was to ensure that the products of older and younger adult participants were not rated differentially along age related criteria. Specifically, the raters were used to avoid age-bias in judgments of creativity.[1]

The Geneplore model and previous research suggest that a number of factors could affect older adults' performance on this task. For instance, Finke (1990) interviewed participants after they had finished interpreting object forms in creative imagery tasks and found that they often reported using random trial and error exploration of the preinventive forms. This suggests that the participants held the objects in mind as they manipulated the objects and discarded certain possibilities. This has important implications for investigating age-related changes in creativity. Any time an item is held in mind and operated upon at the same time, working memory (Baddeley, 1986) is critical to the task, and research has shown that working memory declines with age (Salthouse, 1990, Light & Anderson, 1985, Light & Zelinski, 1982, Wright, 1981).

Another possible mediator of performance on this task is mental imagery. Participants have to generate preinventive forms that are essentially visual in nature. Research on imagery in older adults has found some age-related differences. For instance, Dror and Kosslyn (1994) compared young and older adults on visual imagery tasks, and found that not all aspects of imagery exhibit age-related declines. Breaking down image processing into four stages, image generation (retrieving and forming visual images), maintenance (retaining over time), inspection (interpretation of the pattern) and transformation (ability to rotate or change the image), only transformation and generation were impaired. Specifically, older adults had a more difficult time retrieving and forming images from memory (activation), and rotating those images (transformation) once they were activated. Older adults also had slower reaction times and made more errors with complex stimuli.

Although age differences in working memory and imagery are interesting in their own right, the focus of this study is on creativity per se. Thus, several aspects of the procedure that could negatively influence performance independent of creativity have been modified. First, the time given to participants to complete to complete each trial was lengthened from the typical two minutes (Finke, 1990) to five minutes, and participants were allowed to take as much time as they needed to finish a partially generated product. Thus, age differences in working memory and processing speed (e.g., Salthouse, 1992) should play less of a role in the present task. Second, participants in the study will have a sheet with the object parts in front of them rather than requiring them to retrieve the forms from memory during the task (Finke, 1990). This will reduce the retrieval effort involved in activating images from memory (Dror & Kosslyn, 1994). Finally, the contribution of age differences in working memory capacity will be assessed. Specifically, all participants will complete a verbal Reading Span (working memory) task on computer (Salthouse, 1992). Thus, scores on the working memory task can be correlated with the rated creativity of the participant's inventions.

It should be emphasized that this study is a first step in exploring the relationship between aging and creativity using the CCA. Prior research using different approaches has suggested both that creativity declines with age, and that it stays stable. If prior findings of age differences in creativity (e.g. divergent thinking, McCrae et al, 1987) were primarily the result of the age differences in processing speed, then this would suggest that age differences should be small or non-existent in the present study (because of the task modifications). However, if older adults have difficulty utilizing certain component processes (e.g., contextual shifting) because of working memory limitations (that are not eliminated by the task modifications), then age differences in creativity would be expected. However, this would suggest that the rated creativity of participant's productions should be positively correlated with their performance on the working memory task. Finally, it was also predicted that older adults would take longer to complete the task even if their products were ultimately rated just as creative as young adults. This prediction is based on the robust finding of speed of processing differences found as a function of age (Salthouse, 1990). Thus the time a participant took to complete a trial was recorded.

Endnotes

[1]For reasons detailed in the results section, hypotheses regarding differences in the rating of creativity as a function of age could not be adequately tested.

CHAPTER 2

METHOD

Participants

Forty-two young adults, age 18 - 39 (24 women and 18 men) from the University of Nevada, Las Vegas participated in partial fulfillment of class credit. The mean age for the young adults was 20.42 years (SD = 4.25). Forty-two older adults (28 women and 14 men), age 62 – 96 years, were paid $10 for their participation, and provided with parking passes. The mean age for older adults was 70.69 years (SD = 6.98). Years of education was greater for older (M = 15.57, SD = 2.83) than for young adults (M = 13.57, SD = .76), $t(82)$ 4.41, $p < .001$. The mean score on the Gardner-Monge Vocabulary scale (maximum score = 30) was also significantly higher for older (M = 19.45, SD = 5.85) than younger adults (M = 11.40, SD = 3.62), $t(82) = 7.57$, $p < .01$. Older adults were recruited from the community using public service announcements and were screened in a telephone interview containing a health questionnaire. Persons with a history of neurological disorder, heart disease, kidney disease, lung disease, uncontrolled high blood pressure or diabetes, present or previous long term treatment for psychiatric illness, or having suffered form an accident involving loss of consciousness were excluded. All participants were assessed on a four-point self-rated health measure (1- poor to 4 - excellent). These health ratings did not significantly differ between older and younger adults (M = 3.38 and 3.30 respectively, $t(82) = .572$, $p > .05$). Normal vision (or corrected to normal) and hearing was required of all participants. All participants were given a standard test for vision. Although young adults demonstrated better near vision (M = 26.54 and 21.19, for young and older adults respectively, t (82) = 2.57, $p < .01$), and far vision (M = 35.47 and 21.62, t (82) = 2.97, $p < .01$) than older adults, all participants' vision was more than adequate for the task they were given.

Materials

Each participant was provided with a response packet and a sheet with the fifteen preinventive forms printed on it. Each part was described by the experimenter and given a specific name that was used by the participants to refer to the parts. The response sheet consisted of 4 sections in which 1) the category name and preinventive parts were recorded, 2) the invention was to be named, 3) drawn, and 4) explained (what the invention does and what the parts do) for each trial. On each trial, participants were randomly assigned three of the object parts and a category name. Examples of two novel inventions that were constructed using parts assigned from the 15 preinventive forms (see Finke, 1990) were provided, to give participants an idea of what a creative product would look like.

Working memory was assessed using the verbal Reading Span task (Salthouse, 1992) presented on a IBM compatible computer on a 14" monitor. This task measures the ability to both hold information in mind and process it at the same time. Participants must answer a sentence comprehension question while simultaneously remembering the last word of the sentence. For each trial, a sentence is presented on the computer screen, followed by a question about the sentence. Under the question are three alternatives and an arrow pointing to them. Participants indicate their answer by pressing the down arrow key until the arrow is opposite from the correct alternative, then hit the enter key. A new screen appears with a blank line in which they must type the last word of the sentence they just read and answered a question about. The first three trials involve only a single sentence, and then an additional sentence is added in each subsequent block of three trials, up to a maximum of eight sentences. Performance on each task is measured by the number of items (last words) correctly recalled when the sentence comprehension question is answered correctly (Salthouse, 1992). The span was determined by the highest number of sentences responded to correctly on two out of three trials. The task terminated automatically when the participant responded incorrectly more than once on a given trial on either the sentence comprehension question or the to-be-remembered item. Participants completed several practice trials in order to familiarize them with the task. The task itself was self-paced. After the working memory test, participants completed the Letter Comparison task (Salthouse, 1992), a measure of speed of processing. This task involved comparing two strings (of varying lengths) of letters and indicating whether they were the same or different. Participants had a total of 30 seconds to complete a trial, and a total of two trials were given. The sum of the two trials of correctly answered comparisons measured performance. Finally, both the Gardner-Monge (1977) vocabulary test, and a basic health and demographic questionnaire were administered. Each session took approximately one and one-half hours to complete.

Procedure

Participants were tested either individually or in pairs. After having their vision checked, participants were given their response packets and object forms sheet.

Instructions were read aloud by the experimenter and participants were given two examples of novel inventions. At the beginning of each trial, participants were assigned one category and three object parts, which they wrote down in their response packets. Participants were then instructed to look at the objects on their sheet and to mentally assemble the parts to make a practical and creative object using the three designated parts that correspond to an item belonging to the given category. Participants were instructed to use the parts the designated number of times and that they could not alter the fundamental shape of the object, with the exception of the tube and the wire, which were defined as bendable (Finke, 1990). Once the participant decided upon an idea, they first wrote down the name of the object, drew it, and then described it in words. No changes were allowed after they named the object and began to draw. Participants were told that they had five minutes to complete each trial, but were allowed extra time at the end of each trial if needed to complete the task. The time it took for a participant to complete each trial was recorded, although the timing was done surreptitiously. There were six trials for each participant. After the creativity task, participants were given the working memory test, letter comparison test, and vocabulary test.

CHAPTER 3

RESULTS

A number of trials were not completed or were completed incorrectly, and thus could not be rated for creativity. Reasons included participants' claiming to not be able to form an image using the provided parts, describing a product that did not belong to the provided category, using incorrect parts, or not producing a label or description of the product. The number of excluded trials is presented in Table 2 as a function of age and type of error. Overall, younger adults completed 80% of the trials compared to 66% for the older adults. In addition, three older adults failed to complete any of the six trials.

TABLE 2

Number of Excluded Trials as a Function of Age and Type of Error

	Young	Old	Total
Wrong category	30	42	72
Incomplete	21	24	45
Not attempted	0	21	21
Total	51	87	138

Note. Incomplete includes products that did not have all the required parts, had the wrong parts, or were not finished.

Of the three categories, only "not attempted" reached significance between younger and older adults (χ^2 (1, N = 504) = 21.91, p < .01).

Judging

Two younger and two older adults rated the remaining data. The product of each trial was rated on a one to five scale along two dimensions, Practicality and Originality, using 5-point Likert-type scales: from 1 for not practical (or original) to 5 for very practical (or original). A product was designated "creative" when it received high practicality and originality scores (exact values discussed below). Examination of the ratings revealed consistency between three of the four raters. One young adult rater, however, used an extremely conservative criterion for judging practicality. Because of this, very few trials were rated as creative (n = 31, compared to n = 193, n = 128, and n = 138 for the remaining raters, for both conditions combined). Thus, it was decided that the best course of action was to exclude the ratings of this particular rater. The remaining three rater's scores were averaged on each of the two dimensions. To be rated as creative, a product had to have an average over 4.0 on both the practicality and originality dimensions.[2] To be rated as highly creative, a product had to receive an average rating of 4.0 on the practicality dimension and a 4.5 on the originality dimension.

Measures of Creativity

Before examining the total number of creative products, the average scores for practicality and originality were analyzed as a function of condition (age). One-way ANOVAs revealed that the products of younger and older adults did not differ on average for practicality (M = 3.12 and 3.23, for younger and older adults, respectively, F(1, 364)

= 1.39, MSE = .64, $p > .05$) or originality (M = 3. 57 and 3.50, $F(1, 364) = .74$, MSE, .53 = $p > .05$). As illustrated in Table 3, the number of products rated as creative (χ^2 (1, N = 366) = .015, $p > .05$) and highly creative (χ^2 (1, N = 366) = .006, $p > .05$) did not differ as a function of age. The inter-rater reliability coefficient for the creativity measure was moderate ($\alpha = .47$). For both conditions, products from approximately 20% of the completed trials were rated as creative.

TABLE 3

Number of Creative and Highly Creative Products, by Age Group

	Young	Old
Non-Creative	161	133
Creative	40	32
Highly Creative	13	11
Total	201	165

Note. Highly creative products are included in the creative products.

The fact that the older adults and younger adults did not differ in the amount of creative products produced is all the more interesting when you consider that older adults completed fewer trials than young adults (M = .66 and .80, $F(1, 502) = 13.22$, MSE = .20, $p < .01$. However, older adults (M = 4 minutes, 14 seconds) took significantly longer to complete the trials than younger adults (M = 3 minutes, 45 seconds, $F(1, 82) = 9.89$, MSE, 1.08, $p < .01$. In summary, older adults produced just as many creative products as young adults did, but took longer to do so. Thus, it appears that the task modifications introduced in this experiment were effective in reducing conditions that potentially hamper performance in older adults.

Cognitive Processing Measures

Young and older adults did differ on a number of other cognitive measures. For instance, younger adults scored significantly higher on the working memory task, (M = 3.2 and 2.0 for young and older adults respectively, $F(1, 82) = 14.89$, $MSE = 1.92$, $p < .01$). Younger adults also scored significantly higher on the speed of processing task, (M = 22.7 and 16.36 for young and older adults respectively, $F(1, 82) = 37.61$, $MSE = 22.4$, $p < .01$). However, as can be seen in Table 4, the correlations between the measures of cognitive processing (working memory and processing speed) and creativity were not significant with the exception of vocabulary which was significantly positively correlated with creativity for older adults. One example of a product rated as creative for a young and an older adult respectively, is provided in Figures 1 and 2.

TABLE 4

Correlation between Cognitive Abilities and Creativity

	Young	Old
Working Memory	.009	.06
Processing Speed	.02	.15
Vocabulary	.08	.20*

Note. *$p < .05$.

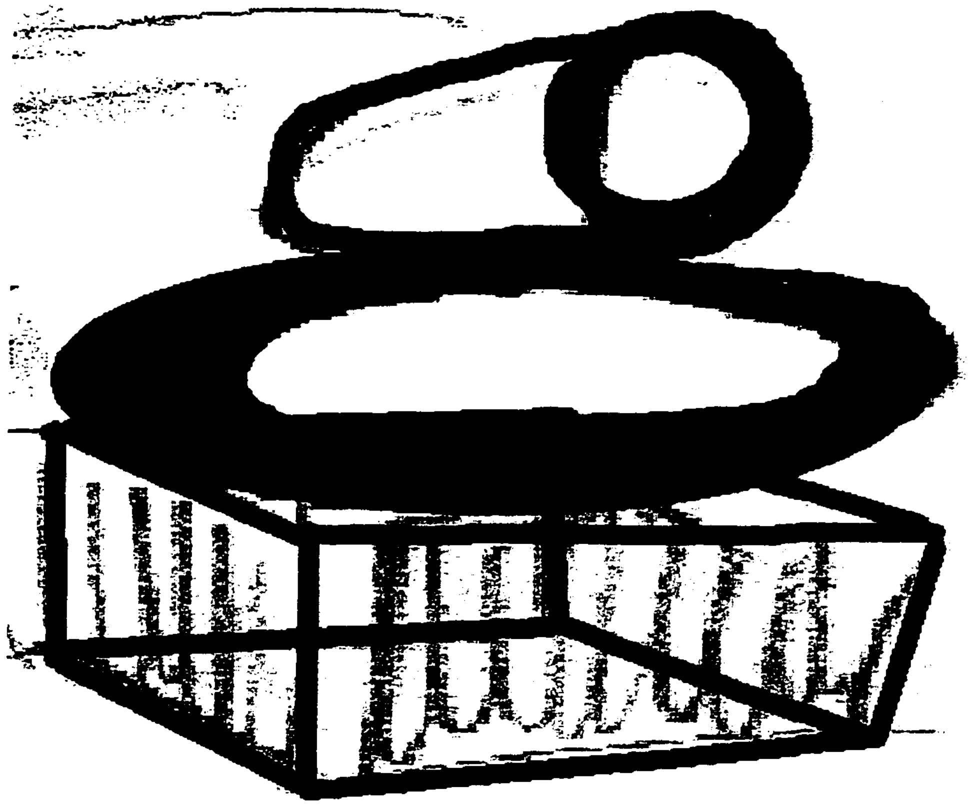

Figure 1. Illustration of a product produced by a young adult rated as creative. The object was named a "rock or grenade throwing device" and was constructed using the ring, half-sphere, and cube, and belongs to the category "weapons." One places a rock or grenade in the half-sphere, and the ring is flexible to launch at opponents.

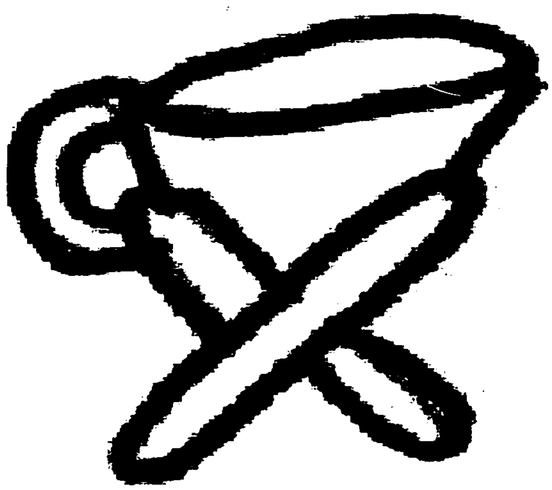

Figure 2. Illustration of a product produced by an older adult rated as creative. The object was named "portable cup holder" and created using the cone, handle, and cross, and belongs to the category "personal items." The cone and handle are used as the cup, and the cross secures the cup to certain cars.

Endnotes

[2] In past research (e.g., Finke, 1990) a product had to receive a nine or higher on the practicality dimension (sum of two raters), and an eight or higher on the originality dimension to be considered creative. Because we averaged the ratings of three raters rather than two, this introduces increased variability. To compensate, it was decided that the criterion for practicality be relaxed slightly (i.e., a 4.0 average was used instead of 4.5).

CHAPTER 4

DISCUSSION

Advancing age can often bring a multitude of worries about loss of mental ability. However, it does not appear to be the case that the aging process affects all aspects of cognition equally (Light, 1991, Hultsch, Hertzog, Dixon, & Small, 1998). The results of this study are consistent with this idea. Older adults were no less likely than younger adults to produce products that were rated as creative. However, older and younger adults' performance was not equivalent in every way. Older adults completed fewer trials than younger adults and took longer to complete the trials.

In general, these findings provide support for the proposal that previous findings of age differences in creativity (e.g., McCrae, et al., 1987) could be a function of task characteristics that reduce performance in older adults. The results of this study indicate that when older adults are given enough time, and the working memory demands are reduced, they are just as creative as younger adults. This finding is also supported by the "environmental support" hypothesis of Craik (1983, 1986) which suggests that young and older adults will perform similarly when given a high degree of support (cues, lower memory load, etc.), but that age differences will increase as environmental support decreases. Thus, age differences on tests of divergent thinking may be due to a decline in speed of processing rather than a decline in creativity. At this point, it is important to stress that future research needs to more closely examine this issue by systematically manipulating the amount of time allowed for the task and the amount of environmental support.

An important finding was that older adults were less likely to complete a trial than younger adults. As can be seen in Table 2, only older adults failed to complete a trial because they did not attempt a solution. In addition, three older adults (and no young adults) failed to complete a single trial. Finally, two older adults left the laboratory after receiving instructions but before completing a single trial. There are at least two general explanations for these results. First, it appears that older adults may have used a more conservative criterion for reporting an idea. In other words, older adults may have been more reluctant to report an idea if they did not think it was creative. Second, older adults appeared to show more anxiety about the task. Statements such as "I am just not creative" or "I just can't do this" demonstrated this. Thus their confidence in their ability to do the task (self-efficacy) appeared lower than for young adults. Prior research has shown that self-efficacy beliefs can negatively impact performance of older adults on a number of cognitive tasks (Caprio-Prevette & Fry, 1996, Lachman, 1991). Note that these two explanations are not necessarily independent. An older adult may become more conservative in the reporting an idea if they have low confidence in their ability to do the task. Future research will need to explore this question in more detail.

Advantage of the Creative Cognition Approach

The advantage of using the CCA (Finke, et al., 1992) in investigating age differences in creativity is clear. Combining current knowledge of cognitive processing helps to clarify the cognitive processes underlying performance in creativity tasks. In the context of this study, this led to a focus on task characteristics that would differentially affect older adults. Because the effect of these characteristics was reduced (by task modification), measures of working memory and speed of processing favored younger adults, yet creativity in older adults remained as high as in younger adults. The results of the present study have helped clarify the influence of working memory and processing speed, so now other aspects of creativity, such as knowledge base, can be manipulated to investigate their influence using the CCA approach. Moreover, because the CCA proposes that creative process are not different from non-creative processes (except possibly in their application, Finke et al., 1992), the results of this study can be applied to other areas of cognition such as problem solving. Finally, the CCA eliminated the problems associated with self-report and case studies.

Future Research

Future studies involving this approach can begin to investigate the effects of age on the two stages of the Geneplore model, Generation and Exploration. The Geneplore model proposes that there may be individual differences in the use of various aspects of the two phases (e.g., activation and contextual shifting), accounting for the wide variability in creative styles (Finke et al., 1992). Research is needed to isolate the individual processes proposed by the model, which can then be used to examine the effect of age on these processes. In addition, future research could manipulate the amount of time given for the creativity task. If older adults are less creative when the time for the creativity task is shortened, it would be further evidence that age differences in divergent thinking are attributable to speed and not creativity.

The results of this study have a number of real-world applications. Understanding that older adults can be as creative as younger adults if task characteristics such as retrieval from memory are modified can be applied to daily life. Rather than expend unnecessary processing resources on retrieval, older adults can write information down and free-up limited processing capacity (Craik, 1983). Also, additional time can be allowed for completing everyday tasks, therefore reducing the need for speeded processing. Another important implication of this study is the need for older adults to work at modifying their self-efficacy beliefs and reduce the anxiety that interferes with performance. Previous research has demonstrated that cognitive restructuring and relaxation training administered to older adults improves memory performance (Floyd & Scogin, 1997, Yesavage, Rose, & Spiegel, 1982). Training older adults to be less anxious may reduce the number of older adults reluctant to seek creative solutions to their problems.

The world presented to us is a complex one, and creativity helps us to overcome new problems that arise in our everyday life. The findings of this study suggest that creativity need not decrease with age. However, it also suggests that older adults who seek creative solutions should modify their environment in ways that reduce the impact of processes that are clearly affected by age (e.g., speed of processing, working memory). Although this is only a first study, the findings also suggest that the Creative Cognition Approach is likely to be useful in understanding both the basic processes involved in creativity and how those processes may be influenced by aging.

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