A PROBLEM SOLVING APPROACH TO UNDERSTANDING THOUGHT PROCESSES IN A CREATIVE TASK: A PROTOCOL ANALYSIS COMPARISON OF ARTISTS AND NON-ARTISTS

by

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A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2007

UMI Number: 3283609

ProQuest Information and Learning Company
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This manuscript has been read and accepted for the
Graduate Faculty in Psychology in satisfaction of the
dissertation requirement for the degree of Doctor of Philosophy.

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_8/24/07____ Aaron Kozbelt, Ph.D.___________
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Abstract

A PROBLEM SOLVING APPROACH TO UNDERSTANDING THOUGHT PROCESSES IN A CREATIVE TASK: A PROTOCOL ANALYSIS COMPARISON OF ARTISTS AND NON-ARTISTS

by

Frieda Fayena Tawil

Adviser: Professor Aaron Kozbelt

In this dissertation the thought processes that occur while artists and non-artists solve the complex, ill-defined problem of creating an original artistic drawing were examined. Twenty-three college art students and 23 non-artists were videotaped as they created original drawings, in any artistic style, from an array of 30 objects. Participants also gave concurrent think aloud protocols. Protocols were transcribed and parsed into clauses. A coding system was developed to fit all verbalized statements into the several categories. Each parsed statement could potentially be assigned two codes, a function code and an emotional code. We examined and compared artists and non-artists in the proportion of types of statements they made throughout the session. We also examined differences in the thoughts of participants between the pre-drawing and the drawing phase of the task. To see how thoughts unfolded as the drawing progressed, we examined the proportion of each type of statement in each five-minute interval after drawing began. Overall, our results gave us a picture of what individuals think about while involved in a creative drawing task, as well as any differences in thought patterns between artists and non-artists. Most importantly, artists and non-artists behave in goal-directed ways where they

set up goals and plans to complete a task, as well as evaluate and monitor their progress throughout the task. Some important differences were also found between artists and non-artists. Most importantly, while artists focused on the more global goals of the drawing, non-artists focused on the more local plans of the drawing. Also, artists made more positive evaluations and fewer negative evaluations while drawing, compared to non-artists. Artists also made more verbalizations about the potential use of the objects, suggesting that they keep an open mind before settling on any one idea for the drawing. Furthermore, while the two groups made the same proportion of metacognitive statements, the proportions of these statements, especially statements where individuals stand back and monitor their work in progress, unfolded differently for the two groups with artists making reliably more metacognitive statements and monitoring their progress much more often as the drawing unfolded over time.

Acknowledgements

I would like to thank everyone who helped with this project. I especially want to thank my adviser, Professor Aaron Kozbelt, for his support and guidance through this project, as well as offering his time to parse narratives and help develop the coding system. I want to thank Lem Sitaras for her help and input in developing a coding system as well as transcribing and parsing protocols. I also want to thank the committee and outside readers, which include Professor Elisabeth Brauner, Professor Laraine McDonough, Professor Buzzy Chanowitz, Professor David Owen, as well as Professor Aaron Kozbelt, for their time and helpful remarks. I also want to thank Professor Elisabeth Brauner for her input on parsing the protocols and developing the coding system.

Finally, I would like to thank my family. First, I'd like to thank my husband Isaac Tawil for his helpful remarks and encouragement through the lengthy process of the project. I also want to thank my parents, Antonia Fayena and Albert Fayena, and brother, Shaul Fayena, for their patience and support while working on my degree.

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Chapter 1:

Introduction and Literature Review

What is the nature of creative thought? In a prototypical creative domain, like drawing and painting, some individuals are capable of creating high-quality, original works that others find interesting, moving, or inspiring. How do they do this? What kind of thought processes occur during the act of creation? As an artist develops a work from a blank surface to a finished creative product, how does he or she guide the process so that the end result is aesthetically satisfying? How are creative artists' thought processes different from those of non-artists? These are basic but fundamental questions about the nature of creativity. However, obtaining empirical answers to these questions has remained elusive. The goal of this study is to begin to answer such questions.

Clearly, in order to get a rich understanding of creativity, it is necessary to know what people are thinking about while they are involved in a creative task. One previously popular view of the nature of creativity is a 'Romantic' view that characterizes creativity as having a mystical quality, which implies that it cannot be studied empirically (for discussions, see Runco & Nemiro, 1994; Simonton, 1994; Winner, 2000). However, in the last few decades, considerable progress has been made in demystifying and understanding creative thought in terms of normative, non-exotic cognitive processes (e.g., Perkins, 1981; Ward, 1994; Ward, Smith, & Finke, 1999; Weisberg, 1993). Simon (1991) encapsulated this view in stating that "the processes a person uses when he's doing creative thinking are indistinguishable from ordinary problem-solving processes" (p. 2). Examples of this perspective include the creative flexibility of language (in which people continually construct new, previously never heard, but easily comprehensible sentences) and constructing new abstract concepts based on our individual experiences (such as the ability of perceiving red, round, and hard and developing the concept 'apple') (Pinker, 1997).

This dissertation examines the thought processes of individuals as they are engaged in problem solving in an ill-defined creative task, namely, artistic drawing. To understand the issues involved, the basic nature of creative processes and the psychological literature on the goal-directed nature of problem solving are examined first. This review emphasizes the role of monitoring one's progress to understand how ill-defined problems are solved. Examining problem solving in the context of groups can also be useful since members of a group need to communicate and thus, the thought processes are made more explicit in group problem solving.

One important and well-established aspect of problem solving is the power of domain-specific expert knowledge in problem solving situations (Ericsson & Charness, 1994). Thus, the nature of these differences in the thought processes of experts and novices, as well as the related issue of looking at individual differences in creativity among experts will be examined. Since the main focus is the visual arts, special attention is paid to earlier research on the kinds of thought processes and behaviors that occur while artists are engaged in the task of creating an original drawing (e.g. Patrick, 1937; Getzels and Csikszentmihalyi, 1976; Kozbelt, 2002, in press). This overview will set the stage for addressing some unanswered questions about cognitive processes in artistic creativity by examining the thoughts of artists and non-artists while involved in a drawing task via verbal protocols. Specifically, the present study aims to richly and dynamically characterize the thought processes of artists and non-artists as they create original drawings.

Creativity as Ill-defined Problem Solving

Much of the research on the cognitive processes in creativity ultimately derives from the 'classic' cognitive psychological literature on problem solving (e.g., Newell, Shaw, & Simon, 1962; Newell & Simon, 1972). In this view, the problem solving process is seen as a search through a very large problem space that specifies every possible state of a particular problem. The problem space contains an initial state, where the problem solver begins, and a goal state, where the problem solver will finish if successful (Newell & Simon, 1972). Operators (tools or actions) are used to move from the initial to the goal state. Most problem spaces are very, very large. Thus, search through problem spaces must proceed by using heuristics, or rules of thumb, that are likely (but not guaranteed) to lead to a solution. When a problem solver encounters and attempts to solve a problem, he or she must represent the problem by specifying the initial state, goal state, operators, and restrictions on the operators (Hayes, 1989a). How a problem solver represents a problem has a major influence on how likely a problem is to be solved (Kotovsky, Hayes, & Simon, 1985).

This influential view of problem solving has been applied to various kinds of problems. For instance, in well-defined problems, the initial state, goal state, operators, and restrictions on the operators are completely specified by the problem description. Thus, well-defined problems generally have one correct solution. The challenge in well-defined problem solving is to find the goal state in a very large problem space. The problem space is the set of all possible states that can be reached in solving a problem as one moves, through the use of operators, from the initial state to the goal state. Newell and Simon (1972) used the examples of a simple maze or playing chess to show the large number of paths one can take to solve a problem, with one or several of these paths leading to a solution. Path constraints rule out some options or solutions, but the search space may still be very, very large. To reduce the search space and thus improve their efficiency, problem solvers must use heuristics rather than algorithms or exhaustive searches. Heuristics, such as means-ends analysis (Newell & Simon, 1972) and planning (Simons & Galotti, 1992; Hayes-Roth & Hayes-Roth, 1979; Read, 1987), allow the problem solver to break up problems into smaller sub-problems. This allows the problem solver to set up sub-goals that assist in making a problem tractable and reaching the final goal.

Many problems, including those we come across in our daily life, such as planning out our day or making a menu for a party, are very different from the well-defined problems just discussed. These types of problems are known as ill-defined problems because there are no clear statements at the outset of how the goal should be characterized or what steps one might take to reach a goal. Ill-defined problems are poorly structured, as opposed to well-defined problems, which are much more straightforward (Reitman, 1965). When a problem solver is faced with a complex, ill-defined problem, he or she must search through the problem space for possible solutions, just as with well-defined problems. However, in ill-defined problems, the search space might be essentially infinite. Also, in ill-defined problems like designing a house or making a painting, there is no "best" solution, so by definition there can be no algorithm for achieving it. To deal with such problems, a problem solver needs to add structure to the problem and generate a problem representation (Hayes, 1989a), which will eventually lead to a specified goal state and a set of operators to try to reach the goal state. One needs to identify the nature of the problem and the kind of goals, procedures, and information that will be needed to solve the problem. The choice of problem representation often plays a critical role in an individual's likely success in solving a problem, even in well-defined problems like the Tower of Hanoi (Kotovsky, Hayes, & Simon, 1985). Since ill-defined problems are far more open-ended, the nature of the structure imposed on ill-defined problems will also likely influence an individual's problem solving strategies and their success at solving the problem. The open-ended nature of these kinds of problems also means that, potentially, different persons will represent and strategize to solve the problem in very different ways, and sometimes come to very different solutions. Since ill-defined problems have multiple potential solutions, there is also the potential for creative solutions. A creative solution is often defined as a novel or divergent and valuable solution to an ill-defined problem (Lubart, 2000).

The problem solving literature views human beings as goal-directed agents (Newell & Simon, 1972) who use heuristics such as planning (for a review, see Hayes-Roth & Hayes-Roth, 1979; Mumford, Schultz, & Van Doorn, 2001) to attain goals (Read, 1987) and to guide the problem solving process (Chaiklin, 1984; McDermott, 1978). Most cognitive studies emphasize the problem representations and search strategies of problem solvers. However, this may not be the entire explanation for creative problem solving. Motivation is also important in that it propels problem solvers from the time of setting up a goal all the way through solving the problem and reaching the goal. In the course of complex, ill-defined problem solving, which may require the problem solver to work hard over prolonged periods of time with little payoff, great motivation is often necessary to achieve a solution (Collins & Amabile, 1999). The motivation of individuals allows the problem solving process to occur and to reach a solution.

Problem Finding

Some researchers view the motivation of individuals as one of the most important factors for problem solving. In contrast to cognitive psychological studies of problem solving, other researchers have focused much more intensively on the importance of other factors, including motivation, in understanding creative problem solving. Often this view focuses on the "problem finding" aspect of creativity (Dillon, 1982; Getzels & Csikszentmihalyi, 1976; Moore, 1985; Suwa, 2003). The construct of problem finding was introduced by Getzels and Csikszentmihalyi (1976), who made a distinction between presented and discovered problems and emphasized discovered problems for understanding creative thought processes. They argued that creative thought processes do not begin with an already formulated problem; rather, the problem needs to be discovered. Conscious or unconscious problems produce emotional tensions which drive an individual to behave in ways that reduce the cognitive or emotional tension and when the tension disappears at the solution of a creative problem, the activity ceases. Getzels and Csikszentmihalyi (1976) argued that this tension motivates creative activity. A problem solver involved in problem finding behavior is involved in the exploratory behavior until a problem is found. Through trial and error the problem solver comes closer to formulating the problem that he will thereafter try to solve.

In artistic situations, such as Getzels and Csikszentmihalyi's (1976) task of creating an original drawing from a set of objects, problem finding refers to actions such as the number of objects manipulated, the uniqueness of the objects chosen, and the length of time an object was manipulated, which usually occurs in the pre-drawing stage, that is the stage before an individual begins to draw. Getzels and Csikszentmihalyi (1976) found that these problem finding behaviors were correlated with the quality and originality of the final product, with art students who invested more time in these exploratory behaviors yielding better quality, more original final products. Moore (1985) found similar results in a study of student writers. Those writers that had the highest rated products were also involved in more problem finding behavior, such as exploring and changing their written product. These studies demonstrate that creativity appears to be associated with initially spending time keeping the structure of the problem open while exploring possibilities, and only later settling on a definitive way of structuring the problem. Thus, according to the problem finding view, what ultimately has an effect on the creativity of the final solution is the process of finding the problem, that is, how much time is spent exploring the problem before one begins to solve it in earnest.

This emphasis on the importance of problem finding processes as a distinct and necessary component of creative thinking is not universal, however. Several arguments have been made against focusing too much on problem finding, at the expense of other aspects of problem solving. For instance, Runco and Nemiro (1994) argued that while problem finding is important for many creative performances, other aspects of problem solving are important as well, such as evaluation of ones' progress while solving a problem. One argument states that problem finding is not unique to creative problem solving; it is something that occurs when an individual is involved in any task (Dudek & Côté, 1994). Furthermore, some problem finding behaviors, such as temporal length of the stage, are not always correlated with more creative outcomes. This can be demonstrated in an early study of how artists and non-artists created drawings (Patrick, 1937), which found that both groups spent a similar amount of time involved in the preparation stage of the task, suggesting no differences in the length of the problem finding stage. A second argument made against focusing on problem finding is that it is not limited to the first stage of problem solving. Problem finding continues throughout the process of creation, even after one decides on a way of solving the problem at hand (Dudek & Côté, 1994). A third argument is that when looking for a creative solution to a problem, the problem has often already been well known for years or decades. For instance, the problem of universal gravitation was posed to Isaac Newton by his contemporaries; what they (and posterity) admired was the fact that Newton was able to find a solution to the problem, not the fact that he had also formulated the problem independently (Simon, 1989). Furthermore, for certain types of creative tasks such as drawing certain objects, there is not really any problem to be found (Dudek & Côté, 1994). For instance, Dudek and Côté argued that Picasso's Cubism was not an explicit formulation of a problem as in problem finding, but a reflection of the environment of what was going on at that time. Picasso did not have to find a problem; rather he had to simply represent it in a painting. Most importantly, engaging in problem finding does not guarantee that the problem will be satisfactorily solved.

Problem Expression

As an alternative to problem finding, Dudek and Côté (1994) argued that creativity can occur without really finding and identifying a “problem” per se. For instance, another characterization of creative behavior might emphasize self-expression or personal development, such as when a person creates a drawing as a means of expressing one’s emotions. According to Dudek and Côté, problem expression is particularly important in the arts, unlike in the sciences, where problem finding may be more important. Dudek and Côté described problem expression as “reflecting the effects of emotional realities as they exist at a particular time and place” (p. 141). They viewed problem finding and problem solving as an expression or an index of emotional involvement rather than a purely cognitive search for originality. To deemphasize the importance of problem finding, Dudek and Côté use Picasso’s series of paintings that led to his famous Cubist style of painting. They argued that Picasso’s Cubism was not an overt formulation of a problem as in problem finding, but a reflection of the environment of what was going on at that time. Since Picasso’s painting was a manifestation of what was going on at that time in his country, there was no problem for him to discover; the problem was already out there. Picasso simply portrayed what was going on at the time in his painting. In this view, the creative process is an emotionally involved task where one expresses one’s feelings or ideas. Arguably, this view is itself limited, in that it does not account for individual differences in creativity or explain where, for instance, Picasso’s creativity came from. To develop his revolutionary painting styles, Picasso still had to explore possible ways of creating a painting that would be considered original and creative, rather than portraying the environment in some unspecified way.

Dudek and Côté (1994) illustrated the importance of problem expression (as contrasted with problem finding) in an empirical study with art students, who were instructed to create a collage. This was an ill-defined task since there was no clear statement of how the goal should be characterized at the start and because the task had multiple potential solutions, rather than one correct solution: one can create an interesting collage in many different ways. Interestingly, in contrast to the results of Getzels and Csikszentmihalyi (1976), Dudek and Côté found that the total number of exploratory behaviors (i.e., problem finding) in the preparation stage did not correlate with the quality and originality of the collage. However, the amount of labor and energy expended in the solution phase did correlate with both the quality and originality of the final product. They interpreted these results as indicating that the more effort invested in the solution through problem expression, the more likely ideas will emerge increasing the chances of arriving at a more original and higher quality final product. Similar results were found by Patrick (1937), who compared the behavior of artists and non-artists creating original drawings that illustrated a poem. Although overall time on the task was similar in the two groups, the artists took longer to draw each object, while non-artists simply drew more objects and spent less time on each. Dudek and Côté explained this result as indicating the importance for creativity of an artist's eagerness and desire to create something symbolic that is both emotionally releasing and original.

Problem Construction

Although problem finding and problem expression differ in several ways, they both focus on motivational factors that lead to more exploratory behavior (problem finding) or more energy spent on solving the problem (problem expression). While motivation is certainly an important factor in creative problem solving, a more recent focus has been on the problem construction aspect of ill-defined problem solving. Problem construction has been defined as the "process by which individuals structure an ill-defined problem and identify the goals and objectives of the problem-solving effort" (Reiter-Palmon, Mumford, & Threlfall, 1998, p. 187). Compared to the problem finding and problem expression views of ill-defined problem solving, the problem construction view is more cognitive in nature. Rather than focusing on motivational factors as most important in leading to creative products, the problem construction view emphasizes thought processes during problem solving and how the problem is represented. As noted earlier, problem representations include the initial state, goals and outcomes, procedures and operations needed to solve the problem, and constraints involved in problem solving (Hayes, 1989a).

The importance of representations in problem solving can be seen in a study of the Tower of Hanoi task and its isomorphs (Kotovsky, Hayes, & Simon, 1985). The Tower of Hanoi task contains three disks and each move involves transferring a disk from one peg to another, with only some moves being legal. It is possible to create alternative versions of this problem that are much more difficult, despite the fact that they share the same underlying structure. For instance, one isomorph of the Tower of Hanoi is a "monster problem" that requires monsters of different sizes to pass each other globes of different sizes, with only some moves being legal. The latter isomorph took far longer to solve than the basic Tower of Hanoi problem because it contained more units that had to be imagined to test whether a move was legal. However, when the two isomorphs have similar representations the second isomorph is solved much more quickly. This provides evidence for the importance of having an effective representation for successfully solving a problem (whether a problem is well-defined or ill-defined).

To be creative it is not enough to use the first problem representation that comes to mind and to apply it in the same manner to answer the new problem. Since creative solutions to problems require some originality, simply adapting the first representation that comes to mind is not enough. Instead, one usually needs to search through the problem space and come up with different problem representations that are of better quality, so that one does not become entrenched in one way of thinking. Researchers have found that problem construction ability, which is the ability to define a problem in multiple, creative ways and to look at a problem from multiple perspectives, is related to the creativity of the product, with high problem construction ability leading to more creative products (Reiter-Palmon, Mumford, Boes, & Runco, 1997). In one representative study, individuals were asked to develop an advertising campaign for a new product, the 3-D Holographic television (Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996). They found that different individuals applied different types of representational elements in problem construction. Those individuals who tended to construct the problem based on high quality procedures and use restrictions in problem construction, had final products that were of good quality. Findings like this suggest that the type of representational elements people tend to use in structuring novel, ill-defined problems, plays a part in their capability to produce truly creative solutions. It also begs the question of how to best characterize the problem representations (and other aspects of the thinking) of creative individuals.

Although these three ways of viewing creative problem solving (problem finding, problem expression, and problem construction) have different emphases, essentially they have much in common. First, they view individuals as goal-directed agents who are motivated to reach a goal or solve a problem. Second, they all stress the need to empirically study individuals' thought process as they are involved in creative problem solving. Third, they all emphasize the importance of evaluating one's progress, whether in the stage of formulating the problem or in the stage of solving the problem. Evaluating or monitoring one's progress is an important component of problem solving, which appears to contribute in an important way to the quality of the final product. While formulating, expressing and solving the problem, problem solvers may be continuously evaluating their progress and judging whether they should continue in the direction they are going or go in a different direction. This issue of monitoring progress, which remains quite understudied (Kozbelt, 2006), will be taken up again later in this chapter.

Group Problem Solving

The claims made above, such as the goal-directed nature of problem solving, the importance of planning and sub-goaling, and the importance of monitoring one's progress, are supported and reinforced by the psychological literature on how groups engage in problem solving. Many of the problems presented to workgroups are ill-defined and therefore by definition do not have predetermined solutions. In these cases managers are looking for adequate or workable solutions rather than optimal or "correct" ones (Grawitch, Munz, Elliot, & Mathis, 2003), just as when individuals work on ill-defined problems. Group problem solving has the additional complication of having more than one individual involved in a task. However, this can be a methodological advantage because the process of communicating thoughts and ideas need to be made more explicit in a group, compared to cases where a problem solver works individually. Finally, the group problem solving literature shows the robust importance of goals, planning, and monitoring progress because group work typically involves real-life, complex problems which may require creative solutions, as opposed to many examples of problem solving that involve simpler or well-defined laboratory tasks.

The literature on group problem solving posits a view similar to that of Newell and Simon (1972), namely that problem solving requires actions from an agent directed toward an end goal. Individuals in the group have goals, or desired states that they want to obtain in the future, and they strive to reach those goals via their actions, such as setting up more goals or sub-goals, developing plans to meet those goals, making decisions, and monitoring their progress towards those goals (Von Cranach, 1996). Whether in individuals or groups, goal-directed actions are sequentially and hierarchically organized. A solution can potentially have higher goals, which are more abstract; these higher goals include more functional goals at lower levels. Each sub-goal includes goals on an even more micro level, in principle all the way down to single movements (McGrath & Tschan, 2004). To reach higher goals it is first necessary to achieve smaller or more local goals. This is similar to the problem solving literature in which heuristics such as means-ends analysis and planning are used to make the goal or solution more reachable by dividing the task into smaller and smaller sub-goals, which are then dealt with sequentially (e.g., Hayes-Roth & Hayes-Roth, 1979; Newell & Simon, 1972). Planning not only makes the goal more accessible, but it is also an opportunistic process in which initial or current plans are monitored and used to forecast outcomes, which may lead to revisions of plans (Hammond, 1990; Hayes-Roth & Hayes-Roth, 1979; Scholnick & Friedman, 1993).

While opportunism in planning can be seen as a potential gateway to more interesting solutions that might not have been thought out beforehand, constantly revising plans can also lead to major problems in the search process. These include blind alleys or cul-de-sacs that make search highly inefficient, as well as the danger that changing plans will have a detrimental effect on the emerging creative product. This large potential down side reinforces the importance of monitoring one's progress in pursuing a goal, to be as confident as possible that changes in plans do not create more problems than they solve.

In addition to setting up sub-goals and plans to reach a goal, almost all tasks require the group to make decisions and to monitor their progress towards the goal, to adapt their behavior to that progress, and to stop acting if (and when) they have attained the goal (McGrath et al., 2004). The significance of monitoring one's progress and evaluating one's work can be seen in a study looking at groups while they solved the Tower of Hanoi task (Gundlach & Schultz, 1987; cf. Kotovsky, Hayes, & Simon, 1985). Gundlach and Schultz found a relationship between proposal-evaluation cycles and effectiveness of problem-solving performance. Specifically, the better performing groups, those that came up with more effective solutions, showed longer periods of discussion before proposing a move and spent more time evaluating those proposals. This finding suggests that in addition to the initial choice of problem representation, more strategic and dynamic factors like planning and evaluation can also contribute to the likely success or failure of problem solving. Such processes can happen at the group or individual level.

Differences between Experts and Novices

While the differences between the better and poorer performing groups discussed above are important for understanding creativity, these differences are not nearly as apparent and substantial as the differences found between experts and novices. One important aspect of problem solving is the power of domain-specific expert knowledge in problem solving situations. Thus, it is important to examine the nature of these differences in the thought processes of experts and novices for understanding creativity.

A large body of cognitive psychological research has shown that there are important differences in the way experts and novices approach, represent, and work to solve problems in a particular domain (for a review, see Ericsson & Charness, 1994). This leads to experts being more effective problem solvers compared to novices. While expert-novice differences have been a key focus of cognitive psychological research, other investigations have also examined the distinction between individuals who are more effective versus less effective problem solvers, regardless of level of expertise. In general, the findings suggest that more effective problem solvers tend to behave more like experts, compared to less effective problem solvers (Goldin & Hayes-Roth, 1981; Rostan, 1994; Suwa & Tversky, 2001).

Across domains, experts and novices differ in several key and systematic ways. For instance, in one classic representative study (Chi, Feltovich, & Glaser, 1981), physics experts and non-experts were compared on how they categorize physics problems.

Novices categorized problems by surface features, such as placing together all the problems involving springs and all the problems involving inclined planes (regardless of what physical principles were needed to solve the problem), while experts categorized problems by the deep structure of underlying physical principles, like conservation of momentum (regardless of changes in the problems' surface structures). Moreover, physics experts tend to use this categorization to generate an appropriate problem representation, and they then work forward from these principles to solve the problem. In contrast, non-experts tend to engage in means-ends analysis search, working backwards rather laboriously. Thus, not only do experts outperform non-experts on domain relevant tasks, but experts' and non-experts' problem representations and problem solving strategies are qualitatively different. This pattern has been found in numerous other domains, including chess (Charness, 1991; Chase & Simon, 1973; de Groot, 1965, 1966), the game of Gō, which entails memorizing board positions (Reitman, 1976), bridge and poker (Gilhooly, 1988), musical performance (Palmer & Drake, 1997), memorizing circuit diagrams (Egan & Schwartz, 1979), mathematics (Novick & Holyoak, 1991), anesthesiology (Xiao, Miligram, & Doyle, 1997), and diagnosing X-rays (Lesgold, Rubinson, Feltovich, Glaser, Klopfer, & Wang, 1988).

In addition to these "classic" cognitive psychological findings, other differences between experts and novices have also been observed, as well as differences between the more effective versus less effective problem solvers within an expert or novice group. One aspect that is especially relevant to the study of creativity is that besides generating more effective initial problem representations, experts (especially highly creative experts) also appear to be more flexible in adopting new problem representations and generating novel solutions, compared to novices. For instance, Rostan (1994) found that highly creative experts spend more time in exploratory behaviors before committing to a solution path in ill-defined puzzle-type tasks, compared to novices or to less creative experts. This suggests an openness to different kinds of representations early on in the problem solving process, at least among creative experts. Moreover, even when experts finally settle on a problem representation and a solution path, they appear to be less fixated on them than are novices. That is, experts can look at a problem from numerous viewpoints and take into account new possibilities when they arise. Other investigations (e.g., Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996; Reiter-Palmon et al., 1997) largely support these conclusions.

In a task of finding as many interpretations as possible for ambiguous drawings, Suwa and Tversky (2001) found that novices who regrouped parts of a drawing and looked at it from other viewpoints generated more interpretations of the ambiguous drawings than novices who did not adopt the strategy of looking at the drawings in different ways. Thus, we might expect expert problem solvers to be more opportunistic. Planning involves an opportunistic process whereby problem solvers make use of emerging opportunities that develop from the initial plan as well as foretell outcomes, which in turn may lead to revisions of the plan and a new representation of the problem at hand (Hammond, 1990; Hayes-Roth & Hayes-Roth, 1979; Scholnick & Friedman, 1993). Goldin and Hayes-Roth (1981) emphasized the importance of opportunistic planning in a study that looked at how individuals plan out their day when given necessary errands that need to be done as well as time constraints. They found that good planners form more loose initial plans which they later refine, while poor planners form more specific plans from the start, thus not giving themselves much room for change later on. Thus experts become less fixated on their chosen problem representation and solution path and are more welcoming to new interpretations compared to novices who choose a representation and stick to it.

As they work on a problem, besides being open to new possibilities, experts differ from novices in the extent and type of revisions they make. For instance, in a study on revising a poorly written letter, Hayes (1989b) found that experts focused on the more global problems such as problems of organization and purpose, while a group of freshmen dealt with local aspects of the letter such as the word or sentence level, fixing grammar and spelling. Thus, experts can and do look at the big picture, while novices focus on the details and remain entrenched in their thinking. In another study on creating original artistic drawings, Kozbelt (2002, in press) found that while artists whose final products were rated low in creativity spent almost no time reworking the drawing at all, the more creative artists engaged in reliably more revisions (including major revisions) at the start of the drawing phase and this largely increased as the sessions progressed.

The cognitive literature also suggests that experts and novices differ in their metacognition, that is, the ability to think about their own thinking and monitor their progress toward a goal. Suwa (2003) compared experienced designers and novices on a cognitive task where the coordination of perceptual reorganization and the production of new interpretations were required. The task was to generate as many interpretations as possible for an ambiguous drawing. Suwa found that experienced designers were able to recognize perceptually visuo-spatial representations and generate new ideas and interpretations, compared to novices. He interpreted this result as indicating that experienced designers were able to consciously strategize to generate new interpretations of the ambiguous drawings, another instance of better metacognition among experts.

Another way to measure metacognition is by looking at “feeling of warmth” ratings where individuals indicate how close they believe they are to a solution. For instance, Jausovec (1994) found that better problem solvers showed a wider range of “feeling of warmth” (or FOW) ratings across different problem types, and that the patterns they showed for each problem type tended to be more appropriate for that type. He also found that as better problem solvers work towards a solution to ill-defined problems, they show more spikes in FOW ratings that are both preceded and followed by worse evaluations. There was a correlation between problem solving performance and the number of metacognitive statements made in the protocols. These results demonstrate that more effective and less effective problem solvers differ in metacognition as evidenced by different FOW trajectories, as well as differences in the amount of time involved in metacognitive processes, with more effective problem solvers making more metacognitive statements. While ill-defined problems, such as drawing, do not have a single correct solution, artists still appear to work towards their own solution in a goal-directed manner (Kozbelt, 2002, in press).

A more recent investigation also strongly supports the view that better problem solvers are good monitors of their progress towards a goal (Jaarsveld & van Leeuwen, 2005). Jaarsveld and van Leeuwen looked at the intermediate products of novices involved in a design task. Here novices provided FOW ratings while creating new designs for a soft drink logo by rating each sketch that they produced as they evolved their designs. Participants whose final designs were the most favorably judged felt a greater sense of progress and improvement from sketch to sketch as they evolved their ideas.

The Visual Arts

Drawing is certainly one area where individuals can be creative. Indeed, the activity of visual artists has been an enduring prototype of the creative process, for laypersons and researchers alike (Kozbelt, in press). Just as experts and novices in general differ in their metacognitive process, we might expect artists to show potentially more vigilant monitoring of the creative process, compared to non-artists. In other words, artists may spend more time evaluating their progress (positively either as they monitor good progress towards a goal, or negatively as they prepare to revise their work), reacting to what has been done so far, potentially recasting their plans and goals, and monitoring their progress in the context of the entire drawing session. This view assumes that artists (as well as non-artists) act as goal-directed agents in the ill-defined problem solving task of creating a satisfactory drawing. Previous research on artists, architects, and designers (e.g., Akin, 1986; Chan, 1990; Kozbelt, 2002, 2006, in press; Mace & Ward, 2002; Suwa, Gero, Tversky, & Purcell, 2001) strongly supports this characterization.

There are several ways of studying the thought processes that occur while one is involved in a drawing task. Cognitive studies have examined the thought processes while involved in a drawing task by comparing artists and non-artists. In some of the earliest research in this tradition, Patrick (1937) examined the thought processes of artists and non-artists while involved in a drawing task by having participants speak aloud as they worked. Participants were asked to create a drawing about a particular poem they were instructed to read. Patrick found that the thought processes of artists and non-artists were quite similar, with both groups more or less following the four stages of creative thought described by Wallas (1926): preparation, incubation, inspiration, and verification. She found that three-fourths of the changes in their ideas occurred in the first quarter, most objects were drawn for the first time in the second and third quarter, and over three-fourth of revisions occurred in the third and fourth quarters, with over 40% in the last quarter. Although artists and non-artists showed some similarities in their approaches, they also differed in several respects. While non-artists drew more objects and more different kinds of objects, as well as depict features of everyday life, artists created drawings that included visual elements relating to topics not mentioned in the poem. This suggests that artists are able to think out of the box and do not become fixated on their initial representations. Furthermore, while non-artists depicted more objects in their drawing, artists concentrated on having better overall compositions, illustrating the point that experts focus on global aspects of the drawing instead of just on the details (as non-artists appear to do). These results are consistent with the literature on expertise. Experts, due to their domain specific knowledge, have a larger range of representations, and are therefore better able to generate various representations rather than become fixated on an initial representation (Noice, 1991; Rostan, 1994; Suwa & Tversky, 2001). Furthermore, experts are better able to chunk information, which gives them the opportunity to focus on the relations of units and therefore the overall structure of the problem, rather than getting swamped with the details of the problem (Chase & Simon, 1973; de Groot, 1965).

Eindhoven and Vinacke (1952) used a similar task as Patrick, but attempted a somewhat more naturalistic methodology, observing the behavior and sketches of artists and non-artists working in four sessions over several weeks. Again there were similarities and differences in the behaviors of the two groups. For instance, both began by establishing a basic motif and spatial arrangement; details were worked out later. However, artists evolved their products more gradually, experimenting early on and then concentrating on certain elements and reorganizing them in the final sketch. In contrast, non-artists showed less structure in their activity, working in about the same way throughout the process of creation.

In another classic study in this research tradition (which in large part forms the basis for the present investigation), Getzels and Csikszentmihalyi (1976) examined the behaviors of college-level art students while they worked on an open-ended drawing task. As noted earlier, they found that those individuals with the most creative drawings were more likely to engage in what they call "problem finding" or "exploratory behaviors." Such behaviors included number of objects manipulated, the uniqueness of the objects chosen (relative to the object choices made by all of the participants), and the length of time an object was manipulated, prior to drawing. Interestingly, the amount of exploratory behavior observed in the drawing session was positively correlated with success in the art world many years later (Csikszentmihalyi & Getzels, 1989).

Dudek and Côté (1994) conducted a study that was similar to that of Getzels and Csikszentmihalyi (1976) in many respects. However, unlike Getzels and Csikszentmihalyi, Dudek and Côté videotaped the behaviors of participants and used a collage task rather than a drawing task. In contrast to the findings of Getzels and

Csikszentmihalyi, Dudek and Côté found that the amount of labor and energy expended in the solution phase, but not in the preparation phase, was correlated with the quality and originality of the final product. As discussed earlier, Dudek and Côté (1994) interpreted this to indicate that problem expression, rather than problem finding, was centrally important in creative tasks.

More recently, Mace and Ward (2002) examined real life instances of creativity to provide a description of the artistic working process from the initial ideas for a work to the point of completing the work. They interviewed artists while involved in a self-initiated drawing task in their natural setting. Some of these drawings took up to eight months to finish. From these interviews, Mace and Ward inductively derived a four-stage model of the artistic process (artwork conception, idea development, making the artwork, and finishing the artwork), which involves numerous dynamically interactive subcomponents, rather than a linear process. However, Mace and Ward (2002) did not link this model to predicting differences in the creativity of the final products.

Finally, Kozbelt (2002, in press) videotaped college art students as they created original drawings from an array of objects, in a task that was very similar to that of Getzels and Csikszentmihalyi (1976). Judges reliably assessed the creativity of the drawings. Videos of the creation of ten high- and ten low-rated drawings were then coded frame-by-frame to quantify the extent to which artists engaged in several categories of activities (selecting objects, selecting media, pausing, drawing objects, drawing other visible elements, and drawing imaginary elements) plus reworking the drawing (erasing and revising). Video coding was used to model how the frequency of each measure fluctuated throughout each session. Kozbelt (2002, in press) found that the more creative artists spent more time prior to drawing compared to less creative artists and during this time they rejected more of the objects they handled and paused reliably less than did artists in sessions leading to less creative outcomes. This suggests that pre-planning, operationalized by spending a greater proportion of time pausing prior to drawing, is negatively associated with the creativity of the final product.

Kozbelt also analyzed artists' behaviors after drawing began. The frequency of each behavior was analyzed by hierarchical linear modeling, a regression technique that permits individual- and group-level analyses simultaneously. Results revealed substantial individual and group differences in the behavioral trajectories. In particular, both groups started by mainly drawing objects from the array, though this behavior was less frequent among artists who produced high-rated drawings. As the sessions progressed, the amount of time spent drawing objects from the array strongly decreased in both groups, but the two groups showed different subsequent trajectories. As they drew array objects less, artists in the high-rated group drew many more imaginary elements (this is similar to what Patrick [1937] found). In contrast, artists in the low-rated group spent more time drawing other visible elements like the wall, table, or cast shadows. The two groups also showed differences in other measures: artists in the high-rated group showed marginally reliable tendencies to select objects and media more frequently after drawing began; media selection showed a single-peaked function as sessions progressed. In contrast to the pre-drawing phase, the proportion of time spent pausing did not differentiate the two groups' trajectories. Finally, perhaps the most diagnostic difference between the trajectories of the two groups was the amount of time spent reworking the drawing. Patrick found that both artists and non-artists spent more time revising near the end of the session. However, Kozbelt found that this was only true for the more creative artists, not the less creative artists. Artists in sessions leading to low-rated final products spent almost no time reworking the drawing at all. In contrast, the more creative artists engaged in reliably more revision even at the start of the drawing phase and this largely increased as the sessions progressed. This discrepancy was likely due to Patrick's less stringent definition of revision: "shading an object to clarify it, the addition of detail, or the critical surveying of the picture as a whole" (Patrick, 1937, p. 42). In Kozbelt's study, revisions required a substantial alteration, not just adding more predictable detail. The results for reworking the drawing suggest creative artists have stringent evaluation standards and/or begin a drawing with only a vague sense of its eventual appearance and rework it as they search out a satisfactory solution. Overall, Kozbelt's (2002, in press) results support a positive association between creativity and opportunistic problem solving strategies, and a negative association between creativity and the pre-planned application of default problem representations.

In addition to these observational studies of contemporary artists at work, the nature of artists' creative processes has also been informed by studies of the "fossil evidence" of great creative achievements. In one representative study, Weisberg (2004) used Picasso's preliminary works (45 sketches) for his painting *Guernica*, to examine the nature of the thought processes involved in creating this great work of art. Weisberg found that Picasso had the basic compositional skeleton of *Guernica* in mind when he began to work, illustrating that the artist had a loose plan before beginning the sketches as well as the final painting. This is consistent with the general finding that experts tend to have a plan in mind before beginning to work. Second, Picasso initially worked on the overall layout of the composition and then moved to specific details, again illustrating that experts tend to focus on larger aspects of the problem, such as the overall composition, not just the details. Furthermore, the final painting was rather similar to many of Picasso's sketches, which demonstrates that the sketches were used for working out the relatively fine points of an idea. This points to problem solving and revising, rather than problem finding, as better characterizations of creative problem solving. Weisberg provided further evidence for this claim by noting that the final painting was similar to an earlier etching by Picasso, the *Minotauromachy*, in that it contained the same characters and similar spatial organization. Furthermore, there are similarities between Picasso's paintings and works of earlier artists, such as Goya. In sum, this fossil evidence suggests that Picasso was not attempting to "find" a problem or to engage in any exploratory behaviors; rather, he was just attempting to solve the problem of creating a good painting. While Weisberg's study suggests these conclusions about the creative process, a missing component of the process is a focus on evaluation. Weisberg's analyses were extremely descriptive.

In contrast, in a rather different study of artists based on "fossil evidence," Kozbelt (2006) had non-artists and artists rate the 22 in-progress states of Henri Matisse's 1935 painting, *Large Reclining Nude.* This study looked explicitly at changes in quality during the evolution of the painting instead of just descriptive or structural changes. Factor analyses revealed that the groups used different criteria to judge the paintings, with artists valuing originality and non-artists valuing realism and technique, consistent with other analyses (Getzels & Csikszentmihalyi, 1976; Hekkert & van Wieringen, 1996). This explains why non-artists judged the painting less favorably as Matisse transformed it from a realistic nude into a more abstract composition. Artists, on the other hand, saw the quality of the painting fluctuate as the painting emerged. However, the final painting was judged to be as good as or better than the earlier states. This result suggests that Matisse was able to evaluate his work (at least this particular painting) and use that information to revise and direct him to a successful final product, indicating the importance of metacognitive processes in problem solving. Presumably, the ability to reliably judge the quality of works in progress is a skill that many creators possess or learn to develop, at least to some degree. This proposition has not yet been directly tested in a large sample of experts. Indeed, from earlier research on visual artists' problem solving, the answers to even fairly basic questions on, e.g., how frequently artists versus non-artists engage in evaluations are unknown. However, one of the goals of the present investigation is to shed some light on this question.

Summary

In sum, the process of artistic creation is highly complex but also highly structured. Artists appear to work in goal-directed ways to solve the problem of creating an interesting original drawing, consistent with the cognitive psychological literature on problem solving. Motivational factors lead artists to engage in more exploratory behavior during the pre-drawing phase as well as spend more energy on solving the problem. Artists seem to be more flexible and less fixated on their first representations and they seem to think in more global terms, rather than focusing on the small details. Artists also seem to make more revisions, especially later on in the drawing process, again illustrating their flexibility and willingness to make changes. The cognitive processes of artists thus show some consistencies and some relations to findings in the research literatures on creativity and expertise. The thought processes of artists thus seem to be largely comprehensible, although more creative artists appear to be much more flexible in their approach than less creative artists.

While earlier research has addressed a number of issues in the creative thinking of artists, a number of unanswered questions remain. In particular, a detailed, fine-grained examination of the thought processes of a relatively large sample of artists and their relation to creativity has not been undertaken. The closest analog may be Kozbelt’s (2002, in press) fine-grained examination of the *behaviors* of artists as they created drawings. This line of research provides a basic methodology for dynamically characterizing artists’ behaviors as they work on a drawing from beginning to end and for linking differences in these behavioral trajectories to the judged creativity of the final products. However, artists’ behaviors tell only so much about what they are thinking. For instance, Kozbelt (2002, in press) found that more creative and less creative artists did not differ in the frequency of pausing at any point after drawing began. However, one might imagine that different artists would pause for very different reasons. One artist may be critically evaluating their work so far and pondering possibilities for a new approach. Another artist may simply be checking that the drawing has thus far unfolded as planned. Another artists’ mind may simply be blank and unsure of what to do next.

Some insight into these questions may be gained by obtaining reports of the thoughts of individuals as they work, through concurrent verbal protocols (Ericsson & Simon, 1984). Generally speaking, the statements that individuals make while working can be treated analogously to their behaviors. By devising a coding system that allows each statement or behavior to be categorized, overall differences in the frequency of each category throughout the drawing sessions, as well as fluctuations in the frequency of each category from the beginning to the end of sessions, can be measured. Individual and group differences in these trajectories, and their relations to the judged creativity of the final products, can also be examined.

The Present Study

The present study will compare the thought processes of college-level or graduate art students and non-artists while they are involved in a creative drawing task similar to that of Getzels and Csikszentmihalyi, (1976); Kozbelt, (2002, in press); and Patrick, (1937). Of considerable interest is simply a descriptive analysis of the frequency of different kinds of thoughts among artists and non-artists, since no other study in the literature has reported answers to this question via verbal protocols in a large sample of artists and non-artists. Also of interest are inferential comparisons of the overall frequencies of different categories of thought among artists and non-artists, and analyses of how these thoughts unfold over time as the drawings progress. Some previous research (e.g., Dudek & Côté, 1994; Getzels & Csikszentmihalyi, 1976) has only divided each session into just two basic phases (preparation and execution), without more refined analyses of trends during the sessions. Thus, this approach does not inform how behaviors within one of the phases might change over time. Patrick (1937) did subdivide each drawing session, but the drawing sessions were relatively brief, averaging 18 minutes, and the protocols were only split into equal quarters. The drawing sessions in the present study are much longer, running for about 60 to 90 minutes, and the protocols are divided more finely, into five-minute intervals. Thus, the present study will allow temporal analyses that are outside the scope of previous investigations.

Presently, participants' thought processes are investigated in great depth via a concurrent protocol analysis methodology, in which participants verbalize their conscious thoughts as they draw (Ericsson & Simon, 1984). This method has been used effectively by other researchers studying architects' or designers' cognitive processes while involved in a design task (e.g., Chan, 1990; Suwa, Gero, Tversky, & Purcell, 2001). Although it has been argued that giving concurrent thinking-aloud verbal reports may interfere with task performance (Nisbett & Wilson, 1977), a review by Ericsson and Simon (1984) found that in many tasks, this is simply not the case. That is, to the extent that providing verbal reports does not force participants to have to think of things they normally wouldn't think about, interference is kept to a minimum. Ericsson and Simon also argued that the analysis of think-aloud protocols has been a very effective and informative method when looking for insights into human thought processes in complex cognitive tasks. In the present investigation, we opted to obtain concurrent verbal protocols rather than retrospective reports because with retrospective reports there are the concerns of selective recall and memory decay. Also, while providing a concurrent verbal protocol may slow down some aspects of task performance (Ericson & Simon, 1984), since verbal clauses rather than elapsed real time were of primary interest presently, again, concerns about the validity of the data were minimized.

Goals

The present study has several main goals. Several of the goals involve preliminary analyses that will put the main analyses on a firmer foundation. One such goal is to compare the judged creativity of the final drawings of the artist and non-artist groups. For later expertise comparisons between artists and non-artists to be meaningful, it is necessary to show that there was a difference in the creativity of the final drawings produced by individuals in the two groups. A second preliminary goal is to develop and test the reliability of a coding system that will allow us to categorize participants' thoughts in the context of their problem solving goals, evaluations, and behaviors. To this end, a categorization system used by Stein, Trabasso, Folkman, and Richards (1997) into which the contents of participants' narratives can be fitted was adapted. Stein et al. coded the narratives of bereaved caregivers of AIDS patients in order to assess predictors of psychological well-being. While this situation is very different from the creation of artworks in a laboratory, the basic view of people as goal-directed agents who devise, execute, and monitor the progress of plans to solve problems, is essentially the same. The system was adapted to better reflect the present task. As part of the development of the coding system, the system's reliability was checked using Cohen's kappa to diagnose any problems and to improve the system for future research. Having a reliable and workable system will enable a sound descriptive analysis of the kinds of thought processes individuals engage in while creating original artistic drawings. Since no previous investigations have closely examined and reported what individuals think about as they are involved in a creative drawing task, this in and of itself would be interesting.

Perhaps the most important major goal of the study is simply to document and compare the kinds of thoughts reported by artists and by non-artists in the drawing task. This will first be done as general measures summarizing the pre-drawing and drawing phases of the session. The prediction is that artists will focus more on the global aspects of the drawing, while non-artists will focus more on the details of the drawing, consistent with the results of Hayes (1989b) and Kozbelt (2002, in press). Another prediction is that artists will make more metacognitive statements that take in the whole drawing compared to novices, consistent with the results of Jausovec (1994) and Jaarsveld and van Leeuwen (2005).

A final goal is to examine how artists' and non-artists' thoughts unfold dynamically over time, as the drawing phase of the session progresses. Drawing sessions will be divided into five-minute intervals after drawing begins, in order to see how the frequencies of kinds of thoughts may change throughout the session, among artists and non-artists. We expect artists to be more metacognitive and monitor their progress more as the drawing unfolds and comes to an end, rather than staying at the same consistent level throughout the drawing task. These analyses will thus parallel those of Kozbelt (2002, in press), who examined how more creative versus less creative artists differed on several behavioral dependent measures throughout the drawing session.

Chapter 2:

Method

Drawing Task

Participants

A total of 46 individuals participated. Twenty-three of the participants were considered expert artists. All had extensive experience drawing and painting. Most were graduate studio art students at Brooklyn College who were focusing on painting and drawing; some were professional artists or undergraduates, who also were focusing on painting and drawing. Artist participants were recruited by announcements posted in the art department and by referrals of other participants. These participants were paid $40 each for their participation.

The remaining 23 participants were considered novices; they had no substantial experience drawing. Novice participants were recruited through the Brooklyn College Psychology Department subject pool and received subject pool credit for participation.

One additional pilot participant had had some experience drawing in the past but was not currently involved in art. Since this participant was, strictly speaking, neither an expert nor a novice, her data were used to help develop our coding system but were not included in subsequent analyses.

Materials

Participants worked in a mock studio setting. Two tables were provided, one with a sheet of heavy white 18x24-inch paper, taped to the table in landscape orientation, and a box of dry, black-and-white drawing media, including pencils, charcoal, and pastels.

The other table held an assortment of about 30 objects (See Appendix A for the assortment of objects). Participants could choose from among these objects as a basis for their drawing. Among the objects included were two artist mannequins, a sneaker, a wine bottle, a menorah, a set of plastic leaves, a book with photographs, a tricycle wheel, etc. Objects were chosen to have a variety of sizes, shapes, and uses, and to be visually interesting.

A Sony TRV-33 digital video camera and 90-minute Maxell DV tapes were used to record the participants' drawing sessions. Recording included participants' actions and verbalizations. The video camera was positioned above and slightly behind the participant's right shoulder, providing a complete view of the emerging drawing and each participant's behaviors. These were often useful in clarifying participants' verbal comments. Video recording covered the entire session, from the moment participants began to choose objects and drawing media, until after they had declared the drawing finished.

Procedure

Participants were tested individually. They first received a set of verbal and written instructions, and when they indicated that they understood the task and were ready, signed the consent form and began. Participants were told that their goal was to create a drawing using whatever they wanted from the set of objects. Participants were asked to choose as many objects as they would like to include in their drawing and to set them up however they would like on a second table. They were permitted to draw in any style and were asked to work on the drawing until they felt happy with it. Participants were permitted to draw as long as they liked, but one hour was suggested as a target working time. Participants could stop drawing at any point when they were adequately happy with the drawing. Examples of the drawings that participants produced can be found in Appendices B and C. Appendix B shows the high-rated drawings (all done by artists), and Appendix C shows the low-rated drawings (all done by non-artists).

Participants were also instructed to speak aloud any thoughts that came to mind throughout the task. Participants were given several specific guidelines on how to give a concurrent verbal report, taken from Perkins (1981, p. 33). These included the following:

1- Say whatever's on your mind. Don't hold back any comments.
2- Speak as continuously as possible. Say something at least every five seconds, even if only, "I'm drawing a blank."
3- Speak audibly. Watch out for your voice dropping as you become involved.
4- Don't worry about speaking in complete sentences.
5- Don't over explain or justify. Analyze only as much as you would normally.
6- Get into the pattern of saying what you're thinking now, not of thinking for a while and then describing your thoughts.

An observer was present throughout the whole task to answer questions and prompt a participant if they fell silent for more than a few seconds. Such prompts were usually questions such as 'What are you thinking now?' or 'What else is on your mind?'

When a participant declared the drawing finished, they were thanked and debriefed.

Protocol parsing

Each participant's completed verbal protocol was transcribed word for word into a MS Word document. Each protocol was then parsed into segments, each of which was then classified into one of several categories, described below. These codes represent the main measures of interest in the present study. Participants' transcribed narratives were parsed into segments using similar criteria as Stein, Trabasso, Folkman, and Richards (1997), with minor changes to fit our purpose. Specifically, the narratives were parsed according to the following rules:

1) There should be only one main verb per parse.

2) An interruption is considered a continuation of a statement, therefore, still follow rule of one main verb per parse. For example: "Subject: I don't know what color to make the legs Exp: Right. Subject: and the hands."

3) If subject rambles on, still parse one main verb per line.

4) If there is a straight repetition still follow rule of one main verb per parse. For Example: "So let's get rid of that, get rid of that".

5) If there is an adjective with an implied verb, then parse the adjective as though there is a verb. For example: "terrible hand, terrible hand".

6) If an extra miscellaneous clause is at the end of a line and has its own verb then parse it separately and code it as miscellaneous.

7) Dialogue with experimenter, specifically questions and answers, parse as usual with one verb per parse and code as miscellaneous.

8) If the same verb is used twice, keep it as one parse. For example: "I kind of like… I kind of like it".

9) If there is one verb but two objects, and the verb applies to both objects, keep as one parse. For example: "I like the eyes and the nose".

10) If statements convey no information, but contain a main verb, parse separately and code as miscellaneous. For example: "And so as I'm working".

11) If statement has a verb but no object, parse separately but code as miscellaneous. For example: "Uhm, kinda in deciding at this point".

Almost all of the parsed clauses contained one main verb. The segments ranged from a few words to a complete sentence. As an illustration, here is a passage from one protocol that has been parsed into clauses:

Hand goes up there.
I'm doing more than I originally planned.
So, yeah, the head's down from the photograph.
No, I don't want to do that anymore.
I'm trying to do what I can from what I have here.
Put a little bit more line.
And, realizing that yes, it kind of, maybe just roughing it from what I had originally.

Coding Categories

To develop a coding system that would be appropriate for our task, the researchers discussed possible categories using as a basis a categorization system used by Stein, Trabasso, Folkman, and Richards (1997), research in the group problem solving literature (Brauner, 1994), and the verbal protocol from a pilot study conducted. The system of coding categories was evolved and refined during many lab meetings over a period of many months, with frequent interim reliability checks. The final set of codes is now described.

Each parsed statement could potentially be assigned two codes, a function code and an emotional code, each of which was subdivided into categories. The function codes consisted of the following four main kinds of categories: Cognition, Metacognition, Habitual Statements, and Miscellaneous Statements. Each is now described in turn.

1. COGNITION: This was defined as thought processes occurring while involved in drawing that pertain to the drawing task. Cognition included the following three categories, which are crucially important for the present analyses:

a) Description Statements: This category included statements in which the participant described what he or she was doing at the present time (i.e., statements in the present tense) as well as statements describing the drawing, objects, or drawing materials. Key words for this category included *making*, *drawing*, *shading* (i.e., words ending in "-ing"). Statements coded as descriptions included:

> Gets bigger at the base that's on this side
> I think the shape reminds me of a cartoon character
> I'm drawing the hand now.

b) Plan Statements: This category included statements of actions participants would take in the immediate future in order to reach their goals. Plans were identified by key words such as *gonna* and *let's*. Statements coded as plans included:

> Let's bring this out
> Well let's start shading
> Gonna do this guy first

c) Goal Statements: This category included statements related to what the participant wanted to do on the particular drawing in the future. Statements that were made in the future tense were included in this category. Goals were identified by key words such as *wish*, *want*, and *need to*. Statements coded as goals included:

> Could use some more shapes

I'm just trying to decide what to add now
I might have to draw an object

While these criteria allowed reasonably clear coding of many parsed statements, for some parsed statements it was difficult to decide between a Plan code and a Goal code, due to the lack of information in the parsed statement about the time frame of the action. This included statements such as:

Try to make him look happy
Maybe I can try to use something else to make it appear in front of
Just kinda want to fill in space
I'm trying to improve it

In these instances the video recording of the session was used to decide between these two codes, a Plan code and a Goal code. If the participant made the statement and then engaged in the action immediately after, the parsed statement was coded as a Plan. If the participant made the statement but did not engage in the action immediately after, and instead was involved in a different action, the parsed statement was coded as a Goal. In general, Goals were conceptualized as more general, abstract, and global than Plans, which were conceptualized as more concrete, specific, and local and leading more directly to action.

Another complication was that for some parsed statements it was difficult to decide between a Description code and a Plan code, due to the lack of information in the parsed statement about the tense or time frame of the action. Such cases of ambiguity included statements such as:

Erase the nose
Make the flute smaller

Let's shade the face
Add the eyes

In these instances the video recording of the session was again used to decide between a Description code and a Plan code. If the participant made the statement while simultaneously involved in the action, the parsed statement was coded as a Description. If the participant made the statement but was not yet involved in the action, the parsed statement was coded as a Plan. This is consistent with the conceptualization of Descriptions as being, strictly speaking, a present tense code, versus Plans, which were conceptualized as being in the near-future tense.

In sum, the three basic Cognition categories (Descriptions, Plans, and Goals) were defined to be mutually exclusive and exhaustive. It was expected that these three categories would account for a large proportion of total parsed segments. However, not all of participants' comments are expected to fall into the Cognition categories. Next, the second major category of codes, Metacognition, is described.

2. METACOGNITION: The second major category of codes involved Metacognition, or thinking about one's own thought processes, rather than Cognition per se. Metacognition included statements where the participant stood back, took in the whole drawing, and monitored their progress to see whether their goal was reached; looked at other possible plans they might have or might have not taken; or compared different points in time. The Metacognition category included the following three categories:

a) Meta-descriptions (Comparison of Different Points in Time Statements): These are descriptive statements that compare multiple points in time because they are comparing what was already done to what was being done at the present time. Thus, Meta-descriptions differ from the Description category of Cognition in that those Descriptions involved only one point in time (the present). Note that, strictly speaking, Meta-descriptions are not necessary to complete the task. However, if a participant is monitoring their progress by comparing the present state of the drawing with an earlier state, the participant will make a Meta-description. Meta-descriptions were identified by key words such as *ended up with, started with*, and *turned* into. Statements coded as Meta-descriptions included:

> Right now everything is going to the right of the paper
> Since this kinda turned into more graphic abstractive drawing
> Since it's what I ended up with
> Since I didn't start with any particular idea
> I didn't start with a very clear picture of what I was going to draw
> Gonna have a lot of eraser marks on this

b) Meta-plans (Past tense plans-regret/ hypothetical plans Statements): Meta-plans are statements of regret where a participant mentioned alternate plans that they regretted not taking or hypothetical statements where they offered other options for plans to reach their goals. Meta-plans differ from the Plans category of Cognition in that Meta-plans are plans that were or are not being implemented. Again, strictly speaking, Meta-plans are not necessary to complete the task. However, if a participant is thinking about the kinds of plans that could potentially be made, the participant will make a Meta-plan. Meta-plans were identified by key words such as *that will…, if I…,* and *should have.* Statements coded as Meta-plans included:

That'll help (future tense plan)
If I look at it / I'll mess it up
because if I have one part that I think is successful,/ I am gonna try and make another part successful, using the same technique.
Should've seen them (past tense regret)

c) Meta-goals (Goal Resolution Statements): Meta-goals included several kinds of statements. One kind are statements where participants stood back and looked at the whole drawing, implying that they were evaluating their drawing in progress and monitoring their progress to check to see if they reached a goal. Meta-goals were identified by key words such as *stand back*, *looking*, *getting there*. Such statements coded as Meta-goals included:

And look at what I have in front of me
This drawing doesn't feel like it's totally done yet
It's missing something there
So I'm starting to get to the point where I'm happy with this
I didn't put where the body stops and meets the platform
But I think it's getting there
I'm just trying to imagine what this would look like as a finished product

Meta-goals also included evaluative statements participants made about their knowledge of their own ability to do something for the drawing, as well as evaluative statements referring to the ease or difficulty of a particular task. These types of statements have an evaluative component, whether it is about a participant's own ability or about the difficulty of the task. (Note that this kind of evaluation is not an evaluation of the quality of the drawing per se.) These kinds of statements imply consideration of some of the constraints on the kinds of goals that are reasonable for that participant to make in the context of the task. For instance, if a participant commented on feeling unable to draw a particular object or to work in a particular style, this will limit the kinds of goals they will likely set. Such statements coded as Meta-goals were identified by key words such as *difficult, easy,* and *can't*. This included statements such as:

> No this I probably won't be able to do
> I can't really do this gesture
> Oh this is hard to make
> Oh boy. That's gonna be difficult
> I can make the nose better then that

In addition to the two main categories of codes, Cognition and Metacognition (each of which was divided into descriptions, plans, and goals), two more categories were necessary to classify all of the statements made by participants in their verbal protocols. While these additional categories (Habitual statements and Miscellaneous) are of less intrinsic interest for the research questions, they are nonetheless now described.

3. HABITUAL STATEMENTS: This third category included statements of participants' usual ways of drawing (outside of this particular session). Habitual statements were often identified by key words such as *often, always,* and *usually*. Statements coded as Habitual statements included:

> I don't know if I often do that or not
> That's why I move when I get stuck
> Usually I have an idea when I'm starting
> It's always easier to move around the whole picture
> I try not to get stuck on any one idea
> I always need a few minutes to think about it

While Habitual statements can be informative about participants' usual ways of working, they are only so useful in the present context of comparing artists and non-artists.

Because artists will naturally have more developed habits of art-making and a larger repertoire of procedures than non-artists, it is expected that artists will make many more Habitual statements than non-artists.

4. MISCELLANEOUS STATEMENTS: This fourth category included statements that were fragments or that did not convey any information or that did not pertain to the drawing. Statements coded as Miscellaneous included:

> I might have a better
> And as you can see
> Now I'm starting to think about that
> I have to get a present for my brother's birthday

Obviously, Miscellaneous statements are uninformative about the content of participants' thoughts. However, in the interest of complete coding of the protocols, this category was necessary, since participants were free to think whatever they wanted (and to report whatever came to mind), they often made comments that were fragmentary or unrelated to the task of drawing.

In contrast to the four categories of function codes, which were applied to every single parsed segment, the emotion codes were only used when applicable to particular segments. Emotion codes will be useful to assess questions of an evaluative nature, such as how frequently participants make positive or negative evaluations, or how often they express uncertainty in what they are planning to do, all of which bear on important questions about artists' cognition (see, e.g., Dudek & Côté , 1994; Galenson, 2001; Getzels & Csikszentmihalyi, 1976; Kozbelt, 2002, 2006, in press; Perkins, 1981).

Three categories of emotion codes were used. In cases where segments did not get an emotion code, a neutral code was given.

1. POSITIVE EVALUATIONS: These included statements that were positive in nature about a participant's drawing, experience, or anything else they were thinking about. Positive Evaluations were identified by key words such as *like*, *better*, *interesting*, *happy*, *working*. Cases that were ambiguous, that is, that might be interpreted as positive or neutral, were not coded as Positive Evaluations. Statements coded as Positive Evaluations included:

> Okay, that looks about right
> Works pretty good
> Because I'm fairly happy with it

2. NEGATIVE EVALUATIONS: This category included any negative evaluation about a participant's drawing, experience, or anything else they were thinking about. Negative Evaluations were identified by key words such as *don't like*, *horrible*, *terrible*, *messed up*, *too much*. Cases that were ambiguous, that is, that might be interpreted as negative or neutral, were not coded as Negative Evaluations. Statements coded as Negative Evaluations included:

> I don't think I have a very good composition in front of me
> It's not a good shape
> Now this is throwing me off

3. UNCERTAINTY: This category included statements where participants were unsure of something, in doubt about what to do next, or questioned themselves. Uncertainty was

identified by key words such as *don't know*, *unsure*, and *maybe*. Statements coded as Uncertainty included:

> Maybe I should start shading in
> Maybe I'll use the vine for that
> So I don't know what to do next

4. NEUTRAL: This category included statements that had no emotional code attached to them. Statements coded as Neutral included:

> Okay, so we got some religious images
> And we've got an eraser
> Okay, we're gonna start with her arm here

The participants' protocols were split between two coders and were parsed and coded independently by one of the two coders. One coder worked on all of the 23 non-artists' protocols as well as nine of the artists' protocols. The second coder worked on the remaining 14 of the artists' protocols. Once all of the protocols were parsed, the two coders independently coded the participants' protocols they worked on. Each parsed segment was given one function code and one emotion code (in cases where there was no emotion code, a neutral code was given). Information on the reliability of coding is given in the results chapter.

Judgment Task

As noted earlier, in order to fully motivate the comparison of artists' and non-artists' thought processes while drawing, it is necessary to show that there was indeed a difference in the creativity of the drawings of the two groups. Therefore, in a separate task we had 31 judges rate the drawings' creativity. Judges were divided into two groups. The first group included nine artists, which consisted of volunteers who had considerable experience at drawing and painting. The second group consisted of 22 non-artists, which consisted of current Brooklyn College undergraduate students not majoring in art who had no substantial experience drawing. The artist group was made up of six females and three males, with a *M* (*SD)* age of 46 (18). The non-artist group was made up of 17 females and five males, with a *M* (*SD*) age of 21 (6).

When participants arrived for the study, they first received a set of verbal and written instructions. When they indicated that they understood the task and were ready, they signed a consent form and began. Participants were told that their goal was to rate each of a total of 71 drawings. The 71 drawings included all of the drawings by artists and non-artists whose verbal protocols were examined later, plus some filler drawings and some drawings by artists who did not give a verbal protocol while working. Participants were instructed to rate each drawing on three different measures: the overall quality, the originality, and the technical skill of each drawing. Participants rated each drawing on these three items using a paper-and-pencil survey. The scales ranged from 1 through 6, with 1 being low and 6 being high. (See Appendix D for the evaluation form.) Participants were told that there were no right or wrong answers and that they should evaluate the drawings based on what *they* felt the ratings should be, rather than what other people would think. They were asked to give thoughtful and honest ratings. Participants were unaware of which drawings were created by the artists or non-artists; indeed, judges were told nothing about who made the drawings until the end of the judgment task. Participants worked individually.

Each drawing was given a randomly assigned ID number between 1 and 71. The order of presentation of drawings was counterbalanced across raters. Some participants rated the drawings in ascending order from drawing 1 through drawing 71, while others rated the drawings in descending order from drawing 71 to drawing 1. The judgment task took about one hour to complete, on average. The non-artists were given subject pool credit for their time spent on the task. When participants completed the task, they were thanked and debriefed.

Chapter 3:

Results

The results are structured as follows. The primary goal was to examine and compare the thought process of artists and non-artists as they created original artistic drawings. Prior to the main analyses, several preliminary analyses were conducted. First among the preliminary analyses, the rated creativity of the drawings was examined. This was done to assess each rater group's aesthetic judgment criteria, to examine the reliability of ratings, and mainly to determine whether there was truly a difference in the creativity between the drawings of the two groups; not surprisingly, artists show a very strong advantage over non-artists. Next, the reliability of the coding system was assessed, because of the great amount of data provided by each participant and because of the novelty of the coding system we developed. Fortunately, coding reliability was sufficiently high to permit the main analyses.

After the preliminary analyses, the main analyses concern the participants' verbal protocols. First, the proportion of segments in each coding category for artists and non-artists during the pre-drawing phase of the task were compared. Several reliable differences were evident during the pre-drawing phase. Specifically, artists made more Descriptive statements and Positive Evaluations and fewer Plans compared to non-artists during the pre-drawing phase of the task. Next, the proportion of segments in each coding category for artists and non-artists during the lengthier drawing phase were compared. Again, several reliable differences were found. Specifically, artists made more global Goals and fewer local Plans, and more Positive Evaluations and fewer

Negative Evaluations compared to non-artists. The proportion of segments in each category for the pre-drawing and drawing phases combined were also examined for artists and non-artists. Several reliable differences between artists and non-artists were found. Specifically, artists made more overall Descriptive statements and Positive Evaluations and fewer local Plans compared to non-artists. Furthermore, the proportion of segments in each coding category for the pre-drawing and drawing phases were compared. Several reliable differences between the pre-drawing and drawing phases were also found. More specifically, participants tended to make fewer Descriptions, Plans and Goals and more Negative Evaluations during the drawing phase, compared to the pre-drawing phase. Interactions between task phase (pre-drawing versus drawing) and participant group (artists versus non-artists) were also examined. Several reliable interactions were evident. More specifically, artists made more Descriptive statements during the pre-drawing phase, compared to non-artists, but the same proportion of Descriptive statements as non-artists during the drawing phase. Artists also made more Metacognitive statements and fewer Cognitive statements during the drawing phase, compared to non-artists, and fewer Metacognitive statements and more Cognitive statements during the pre-drawing phase, compared to non-artists. Artists also made fewer Meta-goal statements in the pre-drawing phase and slightly more Meta-goal statements in the drawing phase, compared to non-artists. For the emotion codes, artists made more Negative Evaluations in the pre-drawing phase and fewer Negative Evaluations in the drawing phase, compared to non-artists.

Finally, to examine how these thought processes dynamically unfold during the drawing phase, the proportion of segments made for each category for each five-minute interval after the drawing had begun was also examined. Again, several reliable differences were found. Specifically, while artists and non-artists showed the same proportion of Cognitive and Metacognitive statements overall, the way these types of statements unfolded over time was different for the two groups, with artists making more Metacognitive statements and fewer Cognitive statements over time, compared to non-artists. This general pattern of results gives a detailed picture of the thought processes of artists and non-artists as they engaged in a creative drawing task.

Throughout, since many of the analyses involve artist versus non-artist comparisons, we often used independent groups *t* tests for each of the coding categories. In order to use the independent groups *t* test, the assumptions of normality of the distribution and equality of variances had to be met. Therefore, in cases where the independent groups *t* test was used, the data were examined for any violations of the assumptions. When one or both of the assumptions were violated, the independent groups *t* test was supplemented by the non-parametric Mann-Whitney *U* test, which does not have these assumptions. In general, the results of the Mann-Whitney were mostly consistent with those of the independent groups *t* test. The few cases of divergence of these results are highlighted in the text.

Preliminary Analysis 1: Evaluation of drawings

The primary goal of the study was to examine and contrast the reported thought processes of the artist and non-artist groups. For this comparison to be meaningful, it is methodologically useful to establish that there was a difference in the creativity of the final drawings produced by individuals in the two groups. Frequently, studies of expertise or expert performance simply assume that group performance differences exist, without actually testing whether or not that assumption is true (Ericsson & Charness, 1994). To avoid this potential limitation in the present study, the artists' and non-artists' drawings were rated by judges who included both artists and non-artists. The drawings were rated on three separate items: quality, originality, and technical skill, as in, for example, Getzels and Csikszentmihalyi's (1976) study. All three criteria are important components of creativity judgments. Moreover, for the comparison between artists' and non-artists' thoughts to be meaningful, not only must there be a reliable difference in the judged creativity of the final drawings, but raters should show reasonably high reliability in their judgments.

Analyses of judges' ratings are structured as follows. First, for the analysis of the evaluations of the drawings, the ratings given by artist and non-artist judges were examined separately, since earlier research has shown that artists and non-artists have rather different aesthetic criteria (Getzels & Csikszentmihalyi, 1976; Hekkert & van Wieringen, 1996; Kozbelt, 2006). The first analyses examined the inter-rater reliability by calculating pairs of correlations amongst the artist raters, the non-artist raters, and between artist and non-artist raters on each of the three measures: quality, originality, and technical skill. Correlations between average ratings given by artists and non-artists on all three measures were also computed, to ensure that our three measures were measuring overall creativity. Most importantly, to make sure that there truly was a difference in the creativity of the final drawings of the two groups, independent *t* tests were used on the z transformations of the ratings of artists' and non-artists' drawings for each of our three measures.

Our method of examining participants' thought processes was through the use of verbal protocols. However, it has been argued that concurrent thinking-aloud verbal reports may interfere with task performance (Nisbett & Wilson, 1977). Therefore, as part of the analysis, the ratings of our artists' drawings produced while giving verbal protocols were compared with another set of drawings coming from the same artist group while giving no verbal protocols, by using paired *t* tests on *z* transformations. These analyses were done to ensure that there were no reliable differences in the creativity of these two sets of drawings from the artist group that may have occurred through the use of concurrent verbal protocols. These latter drawings were not included in any of our other data analyses, other than to examine differences between drawings created while using verbal protocols and drawings created while using no verbal protocols. In the analyses that follow, unless otherwise noted, only the drawings relevant to a particular research question were included, rather than all 71 drawings.

Preliminary Analysis 1a: Correlations among raters for each of three measures

For the comparison of the judged creativity between artists' and non-artists' drawings to be meaningful, the raters of the drawings should show reasonably high reliability in their judgments. Therefore, the inter-rater reliability was examined by looking at pairs of correlations amongst the artist raters, the non-artist raters, and between artist and non-artist raters, for each of the three measures: quality, originality, and technical skill. To calculate inter-rater reliability, Pearson correlations were computed on every possible pairs of raters; the Pearson correlations were then transformed into *z* scores using Fisher's *r* to *z* transformation, in order to calculate the average correlation.

Once the average z scores were computed, those scores were transformed back to their corresponding Pearson correlation coefficient.

Among the artist judges, high positive correlations on each of our three measures were found. The average inter-rater correlations for quality, originality, and technical skill were .50, .36, and .56, respectively. Since these numbers represent average correlations, they are not, strictly speaking, subject to the procedure of null hypothesis testing. However, as a heuristic for interpretation, given the corpus of 46 drawings, each of these correlations would be reliable at the $p < .05$ level (indeed quality and technical skill would be reliable at the $p < .01$ level). Moreover, the respective values of r^2 for quality, originality, and technical skill, respectively, would be .25, .13, and .31, which represent mostly large or medium to large effect sizes.

Similar results were found for the non-artist judges. The average inter-rater correlations for quality, originality, and technical skill were .61, .47, and .66, respectively. Again, as a heuristic for interpretation, given the corpus of 46 drawings, each of these correlations would be reliable at the $p < .01$ level. Moreover, the respective values of r^2 for quality, originality, and technical skill, respectively, would be .37, .22, and .44, which represent large effect sizes.

The reliability between the ratings of the artist and non-artist groups was also examined by computing pairs of correlations between individual artists and non-artists, then transforming the correlations into z scores to compute the average, which were then transformed back into their corresponding Pearson correlation coefficients. The correlations between artist and non-artist raters were high as well.

The average inter-rater correlations for quality, originality, and technical skill were .54, .43, and .60, respectively. Again, as a heuristic for interpretation, given the corpus of 46 drawings, each of these correlations would be reliable at the $p < .01$ level. Moreover, the respective values of r^2 for quality, originality, and technical skill, respectively, would be .29, .19, and .36, which represent mostly large effect sizes.

In sum, high inter-rater reliability was found amongst the artist and non-artist judges, as well as between artist and non-artist judges. Since dealing with reliability at the level of individuals' ratings involves the maximum amount of noise in the data, inter-rater reliability between artist and non-artist judges was also examined by computing correlations for the average ratings for each measure for each rater group, rather than pairs of correlations. First, for each of the three measures, each of the judges' ratings was individually transformed into *z* scores. This was done to remove any effects of different judges having different critical standards. Once scores on each measure were individually *z* transformed, the average *z* score was computed for each drawing on each measure. This was done for artist judges and non-artist judges separately.

Next, correlations between the average ratings of artists' and non-artists' drawings for each of the three measures were computed. Reliable positive correlations were found on all three measures. Specifically, for quality, originality, and technical skill of the drawings, the correlations were, $r(44) = .90$, $p < .001$, $r^2 = .81$, a large effect size, $r(44) = .90$, $p < .001$, $r^2 = .81$, a large effect size, and $r(44) = .93$, $p < .001$, $r^2 = .86$, a large effect size, respectively. When eliminating some of the noise introduced by individual differences, the already high inter-rater reliability between artist and non-artist judges increased substantially. Although the inter-rater reliability increased when average ratings were examined, even when individuals' ratings were examined and the noise was present, most correlations were reliable at the .01 level.

Preliminary Analysis 1b: Correlations between the three measures

Next, correlations between the three measures (quality, originality, and technical skill) were examined to determine whether these measures were measuring the overall creativity of the drawings. If all three measures are highly positively inter-correlated, this suggests all three items are measuring a common construct, namely, creativity (Getzels & Csikszentmihalyi, 1976; Kozbelt, 2002, in press). To compute the correlations between the three measures, the ratings across all judges in a particular group for each drawing were averaged. This resulted in having one average rating per drawing per measure in each group. Then pairs of correlations between the measures were examined. This was done separately for ratings given by artist and non-artist judges.

For the artist judges, reliable positive correlations between the three measures were found. Specifically, the correlations were $r(44) = .825$, $p < .001$, $r^2 = .681$, a very large effect size, between the quality and originality of the drawings, correlation of $r(44) = .965$, $p < .001$, $r^2 = .931$, a very large effect size, between the quality and technical skill of the drawings, and correlation of $r(44) = .762$, $p < .001$, $r^2 = .581$, a very large effect size, between the originality and technical skill of the drawings. These high correlations indicate that these three measurements are measuring basically a unitary construct, namely, the creativity of the final drawings. Correlations between the three measures were also examined for the non-artists' ratings. When including the drawings of both the artists' and non-artists', reliable positive correlations for all pairs of our measures were found. A correlation of $r(44) = .902$, $p < .001$, $r^2 = .814$, between the quality and originality of the drawings, a correlation of $r(44) = .988$, $p < .001$, $r^2 = .976$, between the quality and technical skill of the drawings, and a correlation of $r(44) = .878$, $p < .001$, $r^2 = .771$, between the originality and technical skill of the drawings, was found. All represent extremely large effect sizes.

Overall, we found reliable positive correlations between our three measures. Part of the reason for the high correlations through these preliminary analyses involves the very wide range of final products, ranging from quite sophisticated and complex, well-rendered depictions to simple, almost child-like doodles (see Appendices B and C, respectively). How much of this variability is due to the difference between artists' versus non-artists' drawings? This is taken up in the next analysis.

Preliminary Analysis 1c: Differences in ratings between artists' and non-artists' drawings

As an additional preliminary analysis, the ratings of the drawings of the artist and the non-artist groups were compared to determine whether artists truly produced more creative drawings, compared to the non-artists. Superior reproducible performance is an assumption of expertise, but it isn't always empirically tested (Ericsson & Charness, 1994). To compare the two groups, on each measure, individually *z*-transformed ratings were used. Once scores on each measure were individually *z* transformed, the average *z* score was computed for each drawing. This was done for artist judges and non-artist judges separately. An independent groups *t* test was then used to examine any differences in the creativity of the drawings between artists and non-artists. This was done for each of the three measures.

Not surprisingly, very large differences were found between the artists' and non-artists' drawings on each measure, with the artists showing superior performance across the board. This held for both groups of raters. For ratings given by artist judges, artists' drawings were rated higher than the non-artists on all three measures: quality $t(44) = 9.143$, $p < .001$, $\eta^2 = .655$, a very large effect size, M (SD) = .595 (.480) and -.595 (.400) for artists and non-artists, respectively; originality $t(44) = 7.017$, $p < .001$, $\eta^2 = .528$, a very large effect size, M (SD) = .469 (.408) and -.469 (.494) for artists and non-artists, respectively; and technical skill $t(44) = 9.475$, $p < .001$, $\eta^2 = .671$, a very large effect size, M (SD) = .626 (.494) and -.626 (.396) for artists and non-artists, respectively. This is no surprise, since the artists were very experienced at drawing, while the non-artists had virtually no drawing experience.

The results of the artist judges are more relevant to understanding differences between the groups, since artist judges are better able to judge the creativity of a product due to their experience in drawing. However, the ratings of the non-artist judges were also examined. Similar results were found as with the artist judges. For the ratings of the non-artist judges, reliable differences were found between the artists' and non-artists' drawings, with the artists' drawings having higher ratings than the non-artists' drawings on all three measures: quality $t(44) = 6.966$, $p < .001$, $\eta^2 = .524$, a very large effect size, M (SD) = .560 (.629) and -.560 (.447) for artists and non-artists, respectively; originality $t(44) = 5.943$, $p < .001$, $\eta^2 = .445$, a very large effect size, M (SD) = .457 (.463) and

-.457 (.575) for artists and non-artists, respectively; and technical skill $t(44) = 7.059$, $p <$ .001, $\eta^2 = .531$, a very large effect size, *M* (*SD*) = .585 (.650) and -.585 (.459) for artists and non-artists, respectively. These results again indicate a reliable difference between the creativity of the drawings of the artists and the non-artists. Again, since the creativity of the drawings between the artist and the non-artist groups were reliably different, we might infer that any differences in the creative thought processes between the two groups explains the differences in the creativity of the drawings of the participants.

The preliminary analyses reported so far have examined the reliability of ratings within and between rater groups, the aesthetic judgment criteria of artist and non-artist raters, and the difference in quality, originality, and technical skill of drawings created by artists versus non-artists. These analyses give a clear picture of artists' (not surprisingly) superior performance on the task of creating original artistic drawings, compared to non-artists. Before proceeding to the next main set of preliminary analyses, which examine the reliability of the coding system for participants' verbal protocols, a final set of analyses related to the ratings given by the judges is now reported.

Preliminary Analysis 1d: Differences in ratings for artists with and without verbal protocols

The ratings given by artist and non-artist judges permit examination of a separate question having to do with whether providing verbal protocols may have interfered with task performance. The rationale for this comparison comes from those researchers who argue that concurrent thinking-aloud verbal reports may interfere with task performance (e.g., Nisbett & Wilson, 1977). In this analysis, the ratings of the drawings created by artists who gave concurrent verbal protocols while drawing were compared to ratings of another set of drawings created by that same artist group in the same drawing task, while they did not give concurrent verbal protocols. (The latter drawings were not part of any of our other analyses, but they were rated in the same judgment task as the other drawings.) This data set included a total of 34 drawings, that is, two drawings for each of 17 artists. To assess differences between the two sets of drawings coming from the artist group, first each of the judges' ratings on each measure were individually transformed into *z* scores, as before. This was done for each rater separately. The average *z* score for each drawing was then computed. This was done separately for artist and non-artist judges. Paired *t* tests were then used to compare the two sets of drawings on each of our three measures.

As expected, the two sets of artists' drawings were rated similarly on all three measures by both rater groups, indicating no differences in the creativity of the two sets of drawings. More specifically, for the ratings of the artist judges, similar ratings were found for quality $t(16) = .501$, $p = .623$, $\eta^2 = .016$, a small effect size, M (SD) = .055 (.574) and -.055 (.677) for protocol and no protocol, respectively; originality $t(16) = .833$, $p = .417$, $\eta^2 = .042$, a small effect size, M (SD) = .067 (.476) and -.067 (.599) for protocol and no protocol, respectively; and technical skill $t(16) = -.072$, $p = .944$, $\eta^2 < .001$, small effect size, M (SD) = -.009 (.592) and .009 (.752), for protocol and no protocol, respectively. Thus, providing verbal protocols did not appear to interfere with artists' task performance.

For the non-artists' ratings, similar results were found. Again, similar ratings were found between the artists' drawings with verbal protocols and artists' drawings with no verbal protocols on all three measures: quality $t(16) = .402$, $p = .693$, $\eta^2 = .010$, a small effect size, M (SD) = .047 (.698) and -.047 (.766), for artists with verbal protocol and artists with no verbal protocol, respectively; originality $t(16) = 1.402$, $p = .180$, $\eta^2 = .109$, a medium effect size, M (SD) = .142 (.566) and -.142 (.675), for artists with verbal protocol and artists with no verbal protocol, respectively; and technical skill $t(16) = .339$, $p = .739$, $\eta^2 = .007$, a small effect size, M (SD) = .041 (.715) and -.041 (.798), for artists with verbal protocol and artists with no verbal protocol, respectively. Again, these results indicate similarities between the creativity of the two sets of drawings by the artist group.

Overall, similar ratings were found between the two sets of artists' drawings. This indicates that giving a verbal protocol did not distract the artists from the task at hand. Similar results have been reported by Ericsson and Simon (1984), who argued that as long as providing verbal reports do not force participants to have to think of things they normally wouldn't think about, interference is kept to a minimum.

Since it was established that a difference exists between the creativity of the drawings of artists and non-artists, the next step was to examine and compare the thought processes of artists and non-artists. Thought processes were examined by categorizing participants' parsed protocols into a set of categories we developed. Because of the novelty of our coding system, it was necessary to diagnose the reliability of the coding system before performing any statistical analyses on the data.

Preliminary Analysis 2: Inter-coder reliability

One of the main goals of this project was to develop a coding system consisting of a set of categories into which the contents of the participants' protocols can be fitted in a mutually exclusive and exhaustive way, and to test the system's reliability. To develop a coding system that would be appropriate for our task, possible categories developed using as a basis several verbal protocols from a pilot study and from the group problem solving literature (Brauner, 1994). The development of the coding system was a lengthy process that took about a year to completely refine, which consisted of on average weekly meetings to determine the best way to categorize participants' thoughts as well as work on the reliability between coders. Once the coding system was developed, the researchers working on the development of the coding system were involved in many coding trials until inter-rater reliability, as measured by Cohen's kappa, was acceptable.

Once participants' verbal protocols were collected, each protocol was transcribed verbatim into a MS Word document. Each protocol was then parsed into segments according to the rules mentioned earlier. Almost all the parsed clauses contained one main verb. Segments ranged from a few words to a complete sentence. Each parsed segment was assigned two codes, a function code and an emotional code. After the verbal protocols had been divided into two sets and the two researchers independently completed classifying participants' segments, a subset of the data was randomly chosen to use for the inter-rater reliability check. Because these data are categorical, rather than numerical variables, and because one needs to account for possible coding overlap due to chance, Cohen's kappa was used as a reliability statistic. To calculate Cohen's kappa, about one hundred segments were randomly chosen for each of 12 artists and 12 non-artists, for a total of 2,520 segments. These segments were chosen randomly from the entire session, which included the pre-drawing and the drawing phase. Two experimenters, who had experience helping collect protocol data, transcribed the protocols, and helped develop the coding system, then coded these segments independently. For the function codes, all 2,520 segments, coding agreement was 83%; Cohen's kappa for these data was .76 ($p < .001$). This level of agreement is far above what would be expected purely by chance, which is equal to 27%. While not perfect, this level of agreement is sufficient for the coding to be meaningful.

Table 1 shows the number of agreed-upon and disagreed-upon totals for each category for 24 of the subjects combined. One rater's codes are in rows; the other rater's codes are in columns. The numbers that fall on the diagonal and are in bold are the agreed-upon totals for each category between the two coders. The numbers that fall off of the diagonal are the disagreed-upon totals for each category between the two coders. The most prominent disagreed-upon totals between the two coders are distinguished in the table by the underlined numbers. As Table 1 shows those segments that Coder 1 categorized as Descriptions, Coder 2 distributed them between the Plans and Miscellaneous categories. Similarly, those items that Coder 2 categorized as Descriptions, Coder 1 distributed them between the Plans and Miscellaneous categories.

Table 1.

Result of computing Cohen's kappa for 24 subjects combined for the function category.

	Desc.	Plans	Goals	Meta-desc.	Meta-plans	Meta-goals	Habit.	Misc.	SUM
Descriptions	**941**	35	4	3	4	21	7	52	1067
Plans	43	**412**	22	0	15	4	0	10	506
Goals	9	22	**28**	0	1	7	0	0	67
Meta-desc.	6	0	1	**5**	1	3	0	0	16
Meta-plans	10	11	3	0	**56**	3	2	1	86
Meta-goals	10	8	2	1	1	**89**	2	5	118
Habitual	14	2	0	0	8	0	**102**	4	130
Miscellaneous	30	10	2	0	6	1	28	**453**	530
SUM	1063	500	62	9	92	128	141	525	**2520**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

In addition to the overall analysis that combines data from 24 participants, the artists and the non-artists participant's data were also examined separately and separate Cohen's kappa computations were performed for each group to determine whether the overall observed pattern holds for each group, the artists and the non-artists. When this was done, similar values for Cohen's kappa were found for each of the groups with some minor differences between artists and non-artists. For the protocols of the 12 artists (1,204 segments total), coding agreement was 81%; Cohen's kappa for these data was .74 ($p < .001$). This level of agreement is far above what would be expected purely by chance, which is equal to 27%. Table 2 shows the number of agreed-upon and disagreed-upon totals for each category for 12 of the artists examined. The numbers that fall on the diagonal and are in bold are the agreed-upon totals for each category between the two coders. The most prominent disagreed-upon totals between the two coders have been distinguished in the table by the underlined numbers. As table 2 shows, for the artist group those segments that Coder 1 categorized as Plans, Coder 2 tended to categorize as Descriptions.

Table 2.

Result of computing Cohen's kappa for 12 artists combined for the function category.

	Desc.	Plans	Goals	Meta-desc.	Meta-plans	Meta-goals	Habit.	Misc.	SUM
Descriptions	**472**	11	2	2	1	14	4	13	519
Plans	<u>30</u>	**177**	12	0	11	1	0	3	234
Goals	8	17	**15**	0	0	2	0	0	42
Meta-desc.	3	0	0	**3**	1	3	0	0	10
Meta-plans	6	7	0	0	**32**	1	0	1	47
Meta-goals	6	4	1	1	1	**27**	0	2	42
Habitual	14	2	0	0	6	0	**86**	1	109
Miscellaneous	16	5	1	0	3	0	15	**161**	201
SUM	555	223	31	6	55	48	105	181	**1204**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

For the protocols of the 12 non-artists (1,316 segments total), coding agreement was 85%; Cohen's kappa for these data was .79 ($p < .001$). This level of agreement is far above what would be expected purely by chance, which is equal to 28%. Table 3 shows the number of agreed-upon and disagreed-upon totals for each category for 12 of the non-artists examined. The numbers that fall on the diagonal and are in bold are the agreed-upon totals for each category between the two coders. The most prominent disagreed-upon totals between the two coders have been distinguished in the table by the underlined numbers. As can be seen, for the non-artist group those segments that Coder 1 categorized as Descriptions, Coder 2 distributed them between the Plans and Miscellaneous categories.

Table 3.

Result of computing Cohen's kappa for 12 non-artists combined for the function category.

	Desc.	Plans	Goals	Meta-desc.	Meta-plans	Meta-goals	Habit.	Misc.	SUM
Descriptions	**469**	24	2	1	3	7	3	39	548
Plans	13	**235**	10	0	4	3	0	7	272
Goals	1	5	**13**	0	1	5	0	0	25
Meta-desc.	3	0	1	**2**	0	0	0	0	6
Meta-plans	4	4	3	0	**24**	2	2	0	39
Meta-goals	4	4	1	0	0	**62**	2	3	76
Habitual	0	0	0	0	2	0	**16**	3	21
Miscellaneous	14	5	1	0	3	1	13	**292**	329
SUM	508	277	31	3	37	80	36	344	**1316**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

In summary, although the results of Cohen's kappa show some differences between the artist and the non-artist groups in the categories where there were disagreements, the pattern shows that the instances of substantial disagreement fall under the same three categories: Descriptions, Plans, and Miscellaneous. The systematic pattern of disagreements across our coding indicates that reliability can likely be improved at a later time. Although there were instances of disagreement between the two coders, the kappa values show high reliability between the two coders.

In addition to examining the reliability of the function codes between the two coders, the inter-coder reliability for the emotion codes was also examined. When including the protocols of the 12 artists and 12 non-artists (2,520 segments total), Cohen's kappa was .82 ($p < .001$). This level of agreement is far above what would be expected purely by chance. Table 4 shows the number of agreed-upon and disagreed-upon totals for each category for 24 of the subjects combined. One rater's codes are in rows; the other rater's codes are in columns. The numbers that fall on the diagonal and are in bold are the agreed-upon totals for each category between the two coders. The numbers that fall off of the diagonal are the disagreed-upon totals for each category between the two coders. The most prominent disagreed-upon totals between the two coders are distinguished in the table by the underlined numbers. As Table 4 shows those segments that Coder 1 categorized as Neutral, Coder 2 distributed between the Negative and Positive Evaluations categories. Also, those items that Coder 2 categorized as Neutral, Coder 1 categorized as Uncertainty.

Table 4.

Result of computing Cohen's kappa for 24 subjects combined for the emotion category.

	Positive Evaluations	Negative Evaluations	Uncertainty	Neutral	SUM
Positive Evaluations	**185**	0	2	<u>54</u>	241
Negative Evaluations	1	**89**	1	<u>53</u>	144
Uncertainty	1	1	**148**	12	162
Neutral	4	5	<u>20</u>	**1944**	1973
SUM	191	95	171	2063	**2520**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

In addition to the overall analysis that combines data from 24 participants, the artists and the non-artists data were also examined separately. For the protocols of 12 artists (1,204 segments total), Cohen's kappa was .85 (p < .001). This level of agreement is far above what would be expected purely by chance. Table 5 shows the number of agreed-upon and disagreed-upon totals for each category for 12 of the artists examined. The numbers that fall on the diagonal in boldface are the agreed-upon totals and the underlined numbers are the most prominent disagreed-upon totals between the two coders. For the artist group those segments that Coder 1 categorized as Neutral, Coder 2 categorized as Positive or Negative Evaluations.

Table 5.

Result of computing Cohen's kappa for 12 artists combined for the emotion category.

	Positive Evaluations	Negative Evaluations	Uncertainty	Neutral	SUM
Positive Evaluations	**101**	0	1	32	134
Negative Evaluations	0	**31**	1	18	50
Uncertainty	1	1	**74**	5	81
Neutral	2	2	6	**929**	939
SUM	104	34	82	984	**1204**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

For the protocols of 12 non-artists (1,316 segments total), Cohen's kappa for these data was .81 ($p < .05$). This level of agreement is above what would be expected purely by chance. Table 6 shows the number of agreed-upon and disagreed-upon totals for each category for 12 of the non-artists examined. Again, the numbers that fall on the diagonal and are in bold are the agreed-upon totals for each category between the two coders and the underlined numbers are the most prominent disagreed-upon totals between the two coders. As Table 6 shows, for the non-artist group those segments that Coder 1 categorized as Neutral, Coder 2 distributed them between the Positive and Negative Evaluations categories.

Table 6.

Result of computing Cohen's kappa for 12 non-artists combined for the emotion category.

	Positive Evaluations	Negative Evaluations	Uncertainty	Neutral	SUM
Positive Evaluations	**84**	0	1	<u>22</u>	107
Negative Evaluations	1	**58**	0	<u>35</u>	94
Uncertainty	0	0	**74**	7	81
Neutral	2	3	14	**1015**	1034
SUM	87	61	89	1079	**1316**

Note. Boldfaced entries on the diagonal represent cases of agreement. Underlined entries represent instances of substantial disagreement.

In summary, although the results of Cohen's kappa were not perfect for the emotion codes, they were significant at the .001 level for all participants combined as well as for the artist group separately, and at the .05 level for the non-artist group separately. Our reasonably high reliability for coding both the artist and the non-artist groups for the function and emotion codes indicated that at the very least we were beginning to tap into the phenomenon of interest. Therefore, the two coders who helped develop the coding system split the protocols. One coder worked on all of the 23 non-artists' protocols as well as nine of the artists' protocols. The second coder worked on the remaining 14 of the artists' protocols. The coders independently parsed and coded their assigned verbal protocols. None of the codes were changed as a result of having done the comparison for Cohen's kappa. We now confidently proceed with the coding system and compare the coding results.

Primary Analyses of the Coding Categories

For the preliminary analysis, the raw number of parsed segments between the artist and the non-artist groups was compared. A reliable difference was found between the two groups, and therefore proportions were used for the remaining analyses, rather than raw counts. Next, since the main interest was to examine the thought process of individuals while they created drawings, the proportions of segments in each category for the pre-drawing and drawing phase of the task were examined. Reliable differences between artists and non-artists were found for several of the coding categories. The interaction between task phase and participant group was also examined. Several reliable interactions were found. To determine how thoughts unfold over time as the drawing progresses, the proportions of segments made for each category for each five-minute interval after the drawing had begun were examined. Several reliable differences were found in the way thoughts of artists and non-artists unfold over time.

Overall Analyses of the Drawing Sessions

For the preliminary analyses, the total number of segments made during the drawing phase of the task by the artist and the non-artist groups were compared, to determine whether there were differences between the groups. If a difference exists, this in turn may affect the results in all other categories since any group differences could be explained by the sheer frequency of types of comments, rather than differences in the proportions of kinds of comments. If this is the case, then the proportions of segments for each category would have to be used rather than the raw counts for each category. To compare the total number of segments made by the two groups, the average number of segments per session was computed for each group separately. While the artists' sessions had an average of 704 segments, the non-artists' sessions had an average of 490 segments. The two groups were reliably different in the total number of segments made, $t(44) = 2.364$, $p = .023$, $\eta^2 = .113$, a medium effect size, *M* (*SD*) raw number of segments = 704 (377) and 490 (216), for artists and non-artists, respectively. However, due to violations of normality of the data and equality of variances, a natural logarithm transformation was used to normalize the data. Even when the log transformations were used, the reliable difference in the number of segments made by the two groups remained, $t(44) = 2.069$, $p = .044$, $\eta^2 = .089$, a medium effect size, *M* (*SD*) logs of raw counts = 6.4 (0.58) and 6.1 (0.55) for artists and non-artists, respectively.

As a complement to the analyses of numbers of segments, the average temporal duration of the artists' and the non-artists' sessions (which included the pre-drawing and drawing phases) was also measured, as a possible explanation for the reliable difference in the total number of segments. A reliable difference was found between the durations of the two groups' sessions, $t(44) = 2.860$, $p = .006$, $\eta^2 = .157$, a large effect size, *M* (*SD*) length of session = 77 (28) and 57 (21) minutes, for artists and non-artists, respectively. Thus, the artists' drawing sessions were reliably longer than those of the non-artists. The substantial difference in session length explains the group difference in the total number of segments. In sum, because there was a reliable difference in the number of total segments made by the artist and the non-artist groups, proportions of segments in each category were used, rather than raw counts, in all subsequent analyses.

Because the Habitual and Miscellaneous categories are intrinsically unrelated to the present drawing task, and the Habitual category refers to previous experience and the artists obviously have had more experience than non-artists, differences for these two categories between artists and non-artists were first examined, prior to removing these categories from further analyses. While artists made an average of 246 Miscellaneous and Habitual segments combined (an average proportion of .30 of all segments), the non-artists made a total of 159 Miscellaneous and Habitual segments combined (an average proportion of .31). The two groups did not differ reliably in the proportion of segments made in the Miscellaneous and Habitual categories combined, $t(44) = -.287$, $p = .776$, $\eta^2 = .002$, a small effect size, M (SD) = .30 (.20) and .31 (.16) for artists and non-artists, respectively. The two groups were also compared in the proportion of segments made for Miscellaneous and Habitual separately since we would expect artists to make more habitual statements, compared to non-artists. For Miscellaneous, artists and non-artists did not reliably differ in the proportion of segments, $t(44) = -1.263$, $p = .213$, $\eta^2 = .035$, a small effect size, M (SD) = .22 (.18) and .29 (.15) for artists and non-artists, respectively. The Miscellaneous category was removed from further analyses, since it did not offer any information on the thought processes while drawing and it is intrinsically uninformative. For Habitual statements, artists had reliably more segments, compared to non-artists $t(44) = 2.709$, $p = .010$, $\eta^2 = .143$, a large effect size, M (SD) = .08 (.08) and .03 (.03) for artists and non-artists, respectively. The Habitual statements category was removed from further analysis since this category refers to previous experience and the artists obviously have had more experience than non-artists and because it did not offer any information on the current drawing process.

The Miscellaneous and Habitual categories were removed from further analyses. Because these types of statements do not offer much information about the creative thought process, removing these two categories from further analyses was justified. The focus is now on the remaining categories.

For the next set of analyses the proportions of segments made in each category, as well as the proportions for several possible combinations of the categories were examined. More specifically, each of our function categories was measured. This included the following six categories: Descriptions, Plans, Goals, Meta-descriptions, Meta-plans, Meta-goals. All Cognitive (Descriptions, Plans, and Goals) segments combined as well as all Metacognitive (Meta-descriptions, Meta-plans, and Meta-goals) segments combined are reported. Next, all Descriptive segments (Cognitive and Meta-cognitive descriptions) combined, all Plan segments (Cognitive and Meta-cognitive plans) combined, and all Goal segments (Cognitive and Meta-cognitive goals) combined are reported. Finally, each of the emotion categories is reported. These included the following four categories: Positive Evaluations, Negative Evaluations, Uncertainty, and Neutral statements.

For both the function and emotion codes, the proportion of segments for each category was computed by counting the number of relevant segments divided by the total number of segments (having previously removed Miscellaneous and Habitual statements from the corpus to be analyzed). Separate counts were made for each participant and for the pre-drawing versus drawing phases. Descriptive statistics for artists and non-artists in the pre-drawing phases are reported, followed by descriptive statistics for artists and non-artists in the drawing phase. For completeness, unpaired *t* tests are also performed on these data to explore the pattern of differences. Although computing several *t* tests on the same data runs the risk of alpha inflation, because this study is exploratory in nature, conducting all of these tests was justified.

In the subsequent section, these data will be analyzed by repeated-measures analysis of variance, comparing artists and non-artists on the task overall, comparing the pre-drawing and drawing tasks on both groups combined, and examining the interaction between participant group and drawing phase. Finally, since such global analyses do not say anything about how participants' thoughts might unfold over time as the drawing progresses, the proportion of statements made for each category for each five-minute interval after the drawing had begun was also examined. Several reliable differences were found in the way thoughts of artists and non-artists unfold over time. In total, these results give some idea about the thought processes of artists and non-artists as they were engaged in a creative drawing task.

Pre-drawing phase

Before examining the overall analysis of the drawing phase of the session, the pre-drawing phase of the session was examined. The rationale for this originally comes from Getzels and Csikszentmihalyi (1976; see also Dudek & Côté, 1994; Suwa, 2003) who made a distinction between problem finding, the exploratory behavior one engages in until a problem is found, and problem solving, the working out of the ideas via drawing.

As noted earlier, since a reliable difference was found in the overall number of segments made by the artist and the non-artist groups, proportions of each category were used, rather than raw counts of each category. For the first set of analyses the proportion of codes in the pre-drawing phase only was examined. This phase was relatively brief, *M* (*SD*) = 2.28 (1.42) minutes across all participants. In addition, the length of the pre-drawing session was measured for artists and non-artists separately to determine whether there were any differences between the two groups. Artists spent more time in the pre-drawing phase, *M* (*SD*) = 3.08 (1.56) minutes, compared to non-artists, *M* (*SD*) = 1.47 (1.05) minutes. Getzels and Csikszentmihalyi (1976) found similar results: those participants who spent more time in the exploratory, pre-drawing stage had more creative final products. The pre-drawing phase involved participants selecting and arranging objects and choosing drawing media. To examine the proportion of codes of artists and non-artists in the pre-drawing phase the average proportion of codes in each category was calculated for each group separately. The proportion of codes for artists combined and non-artists are shown in Table 7.

Table 7.

Proportions of statements in each category for artists and non-artists: pre-drawing phase.

Categories	Artists *M*	Artists *SD*	Non-Artists *M*	Non-Artists *SD*	Artists minus Non-Artists	*t*(44)	*p*	η^2
Descriptions	.518	.161	.359	.248	**.159**	**2.578**	**.013**	**.131**
Plans	.339	.131	.431	.243	-.092	-1.596	.118	.055
Goals	.099	.133	.081	.107	.018	.504	.616	.006
Meta- Descriptions	.000	.000	.000	.000	.000	.000	-	-
Meta-Plans	.018	.026	.057	.167	-.038	-1.086	.283	.026
Meta-Goals	.026	.027	.073	.090	**-.047**	**-2.379**	**.022**	**.114**
All Cognition	.956	.048	.871	.213	.085	1.868	.068	.073
All Metacognition	.045	.048	.129	.213	-.085	-1.868	.068	.073
Desc. & Meta-Desc.	.518	.161	.359	.248	**.159**	**2.578**	**.013**	**.131**
Plans & Meta-Plans	.357	.134	.487	.232	**-.130**	**-2.33**	**.024**	**.110**
Goals & Meta-Goals	.125	.131	.154	.126	-.029	-.755	.454	.013
Positive Evaluations	.163	.091	.079	.111	**.085**	**2.825**	**.007**	**.154**
Negative Evaluations	.026	.040	.015	.045	.011	.894	.376	.018
Uncertainty	.102	.074	.139	.165	-.037	-.988	.329	.022
Neutral	.708	.091	.767	.182	-.059	-1.385	.173	.042

Note. Entries in bold represent categories showing reliable differences between artists and non-artists.

As Table 7 shows, during the pre-drawing phase, artists' reported thoughts were predominately Descriptive (52% of all thoughts). A substantial amount of Plans (33%) and some Goals (10%) were also evident during this phase of the task. These results indicate that individuals set up goals for themselves and through planning they strive to meet those goals. This is consistent with the view of human beings as goal-directed individuals (Newell & Simon, 1972; von Cranach, 1996) who use the process of planning to attain those goals (Hayes-Roth & Hayes-Roth, 1979; Mumford, Schultz, & van Doorn, 2001). While most of the reported thoughts of the artist group were Cognitive in nature, 5% of reported thoughts were Metacognitive. Among the emotion codes, artists made evaluations, Positive and Negative, 19% of the time, while showing Uncertainty 10% of the time. Both the evaluative and metacognitive segments suggest that participants evaluate their ideas during the pre-drawing phase, which shows that individuals frequently monitor their progress while solving problems (Jaarsveld & van Leeuwen, 2005; Jausovec, 1994; Suwa, 2003).

Similar thought patterns were also found amongst the non-artists. More specifically, non-artists' reported thoughts were predominantly occupied on Plan making (43%) and somewhat less Descriptive (36%). They also made about 10% Goal statements. Again, the planning and goal segments illustrate that individuals are goal-directed and try to achieve their goals through planning. While 87% of the non-artists' reported thoughts were Cognitive in nature, 13% of their thoughts were Metacognitive. Among the emotion codes, non-artists made evaluations, Positive and Negative, 9% of the time and showed Uncertainty 14% of the time. Again, the metacognitive segments along with the evaluative segments suggest that participants monitored their progress as they were involved in the pre-drawing task.

As illustrated in Table 7, the thoughts of artists and non-artists during the pre-drawing phase appear to be mostly similar. Now that a descriptive picture of what artists and non-artists think about during the pre-drawing phase has been identified, differences in the pre-drawing phase between the artist and non-artist groups were examined.

Since one of the main goals was to compare the thought processes of artists and non-artists, independent groups *t* tests were performed in order to detect any reliable differences *between* the two groups. The differences in proportions for each category between artists and non-artists are given in Table 7, with the reliable differences shown in boldface.

Among the function codes, artists showed fewer Meta-goals, $t(44) = -2.379$, $p = .022$, $\eta^2 = .114$, a medium effect size, and fewer Overall Plans (including cognitive and meta-cognitive plans), $t(44) = -2.33$, $p = .024$, $\eta^2 = .110$, a medium effect size, compared to non-artists. Artists also made more Descriptive statements, $t(44) = -2.578$, $p = .013$, $\eta^2 = .131$, a medium to large effect size, as well as more Overall Descriptions (includes cognitive and meta-cognitive descriptions), $t(44) = -2.578$, $p = .013$, $\eta^2 = .131$, a medium to large effect size, compared to non-artists. (The overall descriptions category was only reliable because of the large proportions of descriptive statements; there were no meta-descriptive statements made by either artists or non-artists during the pre-drawing phase.) Among the emotion codes, artists made reliably more Positive Evaluations, $t(44) = -2.826$, $p = .007$, $\eta^2 = .154$, a large effect size, than non-artists.

Since independent groups *t* tests were used to examine group differences, violations of normality and equality of variances were examined. For some of the categories the assumptions of normality and/or equality of variances were violated; therefore, in addition to independent *t* tests, the Mann-Whitney *U* test was used. A comparison of the reliable differences between artists and non-artists for the independent *t* test and the Mann-Whitney *U* test are shown in Table 8, with the reliable differences highlighted in bold. The results of the Mann-Whitney *U* test were predominantly similar to those of the *t* test with a few minor differences. With the Mann-Whitney *U* test the Meta-goal category was no longer reliable at the .05 level. Interestingly, with the Mann-Whitney *U* test, a reliable difference was found between artists and non-artists in the Negative Evaluations category (p = .024), with artists making slightly more negative evaluations, *M* (*SD*) = .024 (.040), compared to non-artists, *M* (*SD*) = .015 (.045). This last result is somewhat mysterious, since normally the *p* value of a non-parametric test will be higher than the *p* value of its corresponding parametric test (since non-parametric tests are less powerful). However, an examination of the raw data showed numerous “0” entries for Negative Evaluations in the pre-drawing phase (many more than for any of the other categories except Meta-descriptions, where every single participant had a “0” entry). This led to a very large number of ties in the rank-ordering, which likely affected the results of the Mann-Whitney *U* test.

Table 8.

A comparison of reliable or marginally reliable differences between the artist and the non-artist groups using the *t* test and Mann-Whitney *U* test: Pre-drawing phase.

Categories	*p* value for *t* test	*p* value for Mann-Whitney *U* test
Descriptions	**.013**	**.023**
Meta-Goals	**.022**	.136
Descriptions/Meta- Desc.	**.013**	**.023**
Plans/ Meta-plans	**.024**	**.044**
Positive Evaluations	**.007**	**.001**
Negative Evaluations	.376	**.024**

Note. Entries in bold represent categories showing reliable differences between artists and non-artists at the $p < .05$ level.

In summary, when evaluating the pre-drawing phase the data show that artists made about one and one-half times the proportion of Descriptive statements as non-artists did (.518 versus .359). This is interesting because it suggests that during the pre-drawing phase artists were more involved in thinking and making descriptive verbalizations about the objects and drawing materials set up for the drawing. Getzels and Csikszentmihalyi (1976) found similar results: those artists who were more involved in the exploratory problem finding stage had more creative final products. In their study, exploratory behaviors included number of objects manipulated, the uniqueness of the objects chosen (relative to the object choices made by all of the participants), and the length of time an object was manipulated, prior to drawing. In our study the reliably higher proportion of descriptive statements made in the pre-drawing phase by the artists, compared to the non-artists, possibly means that they were more preoccupied with the objects, perhaps not through their physical behaviors, but at least through their verbal behaviors. Furthermore, since artists made more verbalizations about the potential use of the objects, this suggests that artists kept an open mind before settling on any one idea for the drawing.

Artists also made only about one-third the proportion of Meta-goal statements made by the non-artists (.026 versus .073). Some of the types of statements that fall under the Meta-goal category are statements of ability and difficulty of the task. Thus, the results suggest that during the exploratory stage the non-artists worried more about their ability to draw the objects as well as the difficulty of the task. These results make sense since non-artists have no experience drawing and are new to the task; therefore, they are more likely to comment on the difficulty of the task and their inabilities pertaining to the task. The fact that non-artists made more Meta-goal statements and Overall Plans (including Plans and Meta-plans) also suggests that non-artists were thinking more about the final product and how to achieve their goal early on. They were therefore fixated on specific goals early on, as well as the more local plans. This is important because creativity is often associated with initially spending time keeping the structure of the problem open while exploring possibilities, and only later settling on a particular way of structuring the problem (Mumford et al., 1996; Reiter-Palmon et al., 1997; Rostan, 1994). The findings suggest that the non-artists were already thinking about the goals and planning early on in the pre-drawing phase, which should be negatively associated with creativity.

Artists also made about two times the proportion of Positive Evaluations as non-artists did (.163 versus .079). These results suggest that artists made more positive, optimistic statements before beginning the drawing task. This is reasonable to expect since artists knew what they were doing and were therefore more optimistic about the task.

Drawing phase

Besides examining the thoughts of the artist and the non-artist groups during the pre-drawing phase of the task, the reported thoughts of each group during the lengthier drawing phase were also examined. The drawing phase started from the time the participants first began to draw and ended when the participants declared the drawing finished. To examine the proportion of codes of artists and non-artists in the drawing phase, the average proportion of codes in each category was calculated for each group separately. The proportion of codes for artists combined and non-artists combined are shown in Table 9, which is perhaps the most important and informative table in the present study. Since Table 9 contains a large amount of descriptive and inferential results that distill many of the main findings of the very extensive and fine-grained protocol analyses, it will be discussed in some detail.

Table 9.

Proportions of statements in each category for artists and non-artists: Drawing phase.

Categories	Artists *M*	Artists *SD*	Non-Artists *M*	Non-Artists *SD*	Artists minus Non-Artists	$t(44)$	p	η^2
Descriptions	.563	.090	.563	.083	-.001	-.019	.985	.000
Plans	.245	.072	.290	.072	**-.046**	**-2.140**	**.038**	**.094**
Goals	.059	.044	.031	.025	**.028**	**2.616**	**.012**	**.135**
Meta-Descriptions	.012	.010	.006	.007	.005	1.992	.053	.083
Meta-Plans	.046	.031	.036	.026	.011	1.270	.211	.035
Meta-Goals	.076	.043	.074	.033	.003	.237	.814	.001
All Cognition	.866	.053	.884	.044	-.018	-1.293	.203	.037
All Metacognition	.134	.053	.116	.044	.018	1.293	.203	.037
Desc. & Meta-Desc.	.574	.089	.569	.085	.005	.182	.857	.001
Plans & Meta-Plans	.291	.076	.326	.070	-.035	-1.627	.111	.057
Goals & Meta-Goals	.135	.076	.105	.043	.030	1.665	.103	.059
Positive Evaluations	.122	.049	.070	.044	**.052**	**3.791**	**<.001**	**.246**
Negative Evaluations	.055	.029	.084	.052	**-.029**	**-2.353**	**.023**	**.112**
Uncertainty	.080	.042	.079	.042	.001	.044	.965	.000
Neutral	.743	.056	.766	.089	-.024	-1.070	.290	.025

Note. Entries in bold represent categories showing reliable differences between artists and non-artists.

Since there is no other study in the literature on problem solving and creativity that has examined a comparably large corpus of artists' (and non-artists') verbal protocols as they create original artistic drawings, even the basic descriptive findings of the present study are of particular interest. As Table 9 shows, more than half of the parsed segments of artists' reported thoughts during the drawing phase were Descriptions of their current activity (a total of 56%). In addition, artists reported a substantial amount of Planning (25% of segments) and some Goals (6% of segments) during the drawing phase of the task. This finding supports a view of artists as goal-directed agents (Kozbelt, 2002, in press) who, as they draw, set up goals for themselves (e.g., Newell & Simon, 1972; von Cranach, 1996) and strive to meet them through planning processes (Hayes-Roth & Hayes-Roth, 1979; Mumford, Schultz, & van Doorn, 2001). In sum, the Cognitive categories (Descriptions, Planning, and Goals) made up 87% of all segments during the drawing phase. However, there was also a Metacognitive component to artists' thinking (a total of 13% of the parsed segments). In particular, the metacognitive component consisted mainly of Meta-goal statements (8% of segments) and Meta-plans statements (5% of segments), with very few Meta-descriptive statements (only 1% of segments). The more global, Meta-goals category included statements of standing back and examining how close one was to attaining their goal, as well as statements of ability and difficulty of task. The more local, Meta-plans category included statements of hypothetical plans that participants don't end up carrying out and statements of regret where participants mentioned alternate plans that they regret not taking.

Among the emotion codes, artists evaluated their drawings for a substantial amount of time (18%), both Positively (12%) and Negatively (6%), suggesting a metacognitive component of judging one's progress. These evaluations along with the metacognitive statements demonstrate that there is a metacognitive component to problem solving; artists do stand back and monitor their progress (Jaarsveld & van Leeuwen, 2005; Jausovec, 1994; Suwa, 2003).

Interestingly, artists also showed a fair amount of Uncertainty (8% of segments) about what they were doing. Most of the uncertainty came from the Descriptions and Plans categories. This indicates that artists were at times uncertain about what they had done, such as whether they were happy or unhappy about something they had done to the drawing, as well as being uncertain about plans, that is what they should be doing next to try to attain their goals.

Similar thought patterns were found with the non-artist group. Non-artists' reported thoughts were predominantly Descriptive (a total of 56%). There was also a substantial amount of time spent Planning (29%) and setting up Goals (3%). Again, this suggests that individuals work in a goal-directed manner when solving a problem. There was also a metacognitive component to non-artists' thinking (12% of all thoughts), with individuals making Meta-descriptive (1%), Meta-plans (3%) and Meta-goal (3%) statements. Among the emotion codes, non-artists spent a substantial amount of time making evaluations (15%), both Positive (7%) and Negative (8%). Again, this suggests that individuals monitor their progress as they work towards solving a problem. Like the artists, non-artists showed Uncertainty 8% of the time. The cases of uncertainty involved uncertainty of the Descriptions category as well as the Plans category, similar to the artists' cases of uncertainty.

Next, to compare proportions of categories *between* artists and non-artists, the data for all 23 artists were combined and the data for all 23 non-artists were combined. To measure differences between the two groups, the average proportion of segments for each category was calculated for each group separately beginning from the time they began drawing. To compare the groups, independent *t* tests were computed on these averages. On the whole, artists and non-artists showed fairly similar proportions across most categories. However, as can be seen in Table 9, there were reliable differences in several categories: Goals/Plans and Positive/Negative Evaluations (listed in boldface in Table 9). More specifically, artists made reliably more Goal statements, $t(44) = 2.616$, $p = .012$, $\eta^2 = .135$, a medium to large effect size, and fewer Plan statements, $t(44) = -2.140$, $p = .038$ $\eta^2 = .094$, a medium effect size, compared to non-artists. Artists also made more Meta-descriptive statements than non-artists. These results were marginally reliable, $t(44) = 1.992$, $p = .053$, $\eta^2 = .083$, a medium effect size. Among the emotion codes, artists made more Positive Evaluations, $t(44) = 3.791$, $p < .001$, η^2 .246, a large effect size, and fewer Negative Evaluations, $t(44) = -2.353$, $p = .023$, $\eta^2 = .112$, a medium to large effect size, compared to non-artists.

To check that the assumptions of the *t* test had not been violated, the skewness and kurtosis of the distribution were examined, in order to confirm that the distributions were approximately normal, as well as the equality of variances of each category. For some categories the assumptions of the independent *t* test were violated, therefore, the non-parametric Mann-Whitney *U* test, was performed on the proportion of segments made by the artist and the non-artist groups. As Table 10 shows, the results of the Mann-Whitney *U* test were very similar to that of the *t* test. Using the Mann-Whitney *U* test, artists made fewer Plan statements ($p = .049$), and more Goal statements ($p = .025$), more Meta-descriptive statements ($p = .061$), and more Positive Evaluations ($p < .001$), compared to non-artists. The only difference between the results of the *t* tests and the Mann-Whitney *U* test was that the *t* test showed a reliable difference between artists and non-artists in the Negative Evaluation category with artists making fewer negative evaluations than non-artists. The results of the Mann-Whitney *U* test demonstrated a marginally reliable difference in the Negative Evaluation category ($p = .052$). Thus, the results of the two sets of tests were quite comparable.

Table 10.

A comparison of reliable or marginally reliable differences between the artist and the non-artist groups using the *t* test and Mann-Whitney *U* test: Drawing phase.

Categories	*p* value for *t* test	*p* value for Mann-Whitney *U* test
Plans	**.038**	**.049**
Goals	**.012**	**.025**
Meta- Descriptions	.053	.061
Positive Evaluation	**<.001**	**<.001**
Negative Evaluations	**.023**	.052

Note. Entries in bold represent categories showing reliable differences between artists and non-artists at the $p = .05$ level.

In summary, during the drawing phase of the session, artists made only about four-fifths the proportion of Plans (.245 versus .290) and two times the proportion of Goal statements (.059 versus .031), as non-artists did. This shows that while non-artists made more near future local plans, the artists thought more about the overall goal for the drawing. These results are reasonable considering the fact that non-artists weren't skilled in drawing, and therefore had to focus on the more local plans. In contrast, since artists have expertise in the drawing task artists are more effective in using schemas and chunking information, thus allowing them the opportunity to focus on the larger overarching picture (the more global goals), rather than the more local plans. This is consistent with other research on expert-novice differences (e.g., Hayes, 1989b; Patrick, 1937).

Among the emotion codes, artists made about twice the proportion of Positive Evaluations, as non-artists did (.122 versus .070). These results are interesting because they suggest that artists can evaluate their work-in-progress. These results demonstrate a metacognitive component to artists' creative processes; artists might have insight about their own knowledge concerning their expertise and may be able to monitor themselves (Jaarsveld & van Leeuwen, 2005). Artists also made only about three-fifths of the proportion of Negative Evaluations made by non-artists (.055 versus .084). Since non-artists have no expertise or experience, they negatively evaluated their drawing. Surprisingly no differences were found in the proportions of other categories, as well, between artists and non-artists, suggesting that there is overall quite a lot of consistency in the way people think about the task. This is especially true of high frequency categories, such as the descriptive category, where both artists and non-artists spent 56% of the time making descriptive statements.

Integrating participant groups and task phases

The descriptive results and associated *t* tests reported above inform the basic nature of artists' and non-artists' thought processes throughout the task. However, since the two phases and two groups of participants were examined separately, they do not inform how participants and phases might statistically interact. To examine this question, and to supplement the previous analyses, a repeated measures analysis of variance was performed on each category of statements separately, as before. Overall differences between artists and non-artists over the entire task (Table 11), differences between the pre-drawing and drawing phases (Table 12), and interactions between participant group and task phase (Table 13) are reported.

Table 11.

Proportions of statements in each category for artists and non-artists: Entire task (pre-drawing and drawing combined).

Categories	Artists *M*	Artists *SD*	Non-Artists *M*	Non-Artists *SD*	Artists minus Non-Artists	*F*(1, 44)	*p*	ηp²
Descriptions	.540	.126	.461	.165	**.079**	**4.823**	**.033**	**.099**
Plans	.292	.102	.360	.158	**-.068**	**3.927**	**.054**	**.082**
Goals	.079	.088	.056	.066	.023	1.283	.263	.028
Meta-Descriptions	.006	.005	.003	.004	**.003**	**3.966**	**.053**	**.083**
Meta-Plans	.032	.028	.046	.096	-.014	.606	.440	.014
Meta-Goals	.051	.035	.073	.062	-.022	3.424	.071	.072
All Cognition	.911	.050	.878	.128	.033	2.113	.153	.046
All Metacognition	.089	.050	.122	.128	-.033	2.113	.153	.046
Desc. & Meta-Desc.	.546	.125	.464	.166	**.082**	**5.122**	**.029**	**.104**
Plans & Meta-Plans	.324	.105	.407	.151	**-.083**	**6.287**	**.016**	**.125**
Goals & Meta-Goals	.130	.104	.129	.085	.001	.001	.972	.000
Positive Evaluations	.143	.070	.074	.078	**.069**	**15.411**	**<.001**	**.259**
Negative Evaluations	.041	.034	.050	.049	-.009	.813	.372	.018
Uncertainty	.091	.058	.109	.103	-.018	.686	.412	.015
Neutral	.726	.073	.767	.136	-.041	2.135	.151	.046

Note. Entries in bold represent categories showing reliable (or marginally reliable) differences between artists and non-artists.

Table 12.

Mean differences in proportions of statements in each category between the pre-drawing and drawing phase: all participants.

Categories	Pre-drawing *M*	Pre-drawing *SD*	Drawing *M*	Drawing *SD*	Pre-drawing minus Drawing	$F(1, 44)$	*p*	ηp²
Descriptions	.438	.222	.563	.086	**-.125**	**16.799**	**<.001**	**.276**
Plans	.385	.199	.267	.075	**.117**	**20.174**	**<.001**	**.314**
Goals	.090	.120	.045	.038	**.045**	**7.128**	**.011**	**.139**
Meta- Descriptions	.000	.000	.009	.009	**-.009**	**48.121**	**<.001**	**.522**
Meta-Plans	.038	.120	.041	.028	-.003	.032	.859	.001
Meta-Goals	.049	.070	.075	.038	**-.026**	**5.678**	**.022**	**.114**
All Cognition	.913	.158	.875	.049	.038	2.343	.133	.051
All Metacognition	.087	.158	.125	.049	-.038	2.343	.133	.051
Desc. & Meta-Desc.	.438	.222	.572	.086	**-.134**	**19.339**	**<.001**	**.305**
Plans & Meta-Plans	.422	.198	.308	.074	**.114**	**18.522**	**<.001**	**.296**
Goals & Meta-Goals	.140	.128	.120	.063	.020	1.089	.302	.024
Positive Evaluation	.121	.109	.096	.053	.025	2.588	.115	.056
Negative Evaluations	.021	.043	.070	.044	**-.049**	**43.098**	**<.001**	**.495**
Uncertainty	.121	.128	.080	.041	**.041**	**5.674**	**.022**	**.114**
Neutral	.738	.146	.755	.075	-.017	.796	.377	.018

Note. Entries in bold represent categories showing reliable differences between the pre-drawing and the drawing phases.

Table 13.

Interactions between participant group and task phase.

Categories	$F(1, 44)$	p	ηp^2
Descriptions	**6.860**	**.012**	**.135**
Plans	.788	.379	.018
Goals	.081	.777	.002
Meta- Descriptions	**3.966**	**.053**	**.083**
Meta-Plans	1.757	.192	.038
Meta-Goals	**5.269**	**.027**	**.107**
All Cognition	**4.361**	**.043**	**.090**
All Metacognition	**4.361**	**.043**	**.090**
Desc. & Meta-Desc.	**6.433**	**.015**	**.128**
Plans & Meta-Plans	3.244	.079	.068
Goals & Meta-Goals	2.486	.122	.053
Positive Evaluation	1.099	.300	.024
Negative Evaluations	**7.292**	**.010**	**.142**
Uncertainty	1.206	.278	.027
Neutral	.890	.351	.020

Note. Entries in bold represent categories showing reliable (or marginally reliable) interactions between participant group and task phase.

As Tables 11, 12, and 13 illustrate, numerous effects were reliable. The effects are now discussed, one dependent variable at a time, beginning with Descriptions. In general, artists made reliably more Descriptive statements, compared to non-artists, $F(1, 44) = 4.823$, $p = .033$, $\eta p^2 = .099$. Furthermore, participants made more Descriptive statements during the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 16.799$, $p < .001$, $\eta p^2 = .276$. A reliable interaction shows that artists made more

Descriptive statements compared to non-artists in the pre-drawing phase but the same proportion of Descriptive statements as non-artists in the drawing phase, $F(1, 44) = 6.860$, $p = .012$, $\eta p^2 = .135$.

Artists also made more Meta-descriptive statements, compared to non-artists, $F(1, 44) = 3.966$, $p = .053$, $\eta p^2 = .083$. Participants also made more Meta-descriptive statements during the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 48.121$, $p < .001$, $\eta p^2 = .522$. In addition, there was a marginally reliable interaction in the Meta-descriptions category with artists having the same average proportion of Meta-descriptive statements as non-artists in the pre-drawing phase, but more Meta-descriptive statements compared to non-artists in the drawing phase, $F(1, 44) = 3.966$, $p = .053$, $\eta p^2 = .083$.

Not surprisingly, given the results for Descriptions and Meta-Descriptions, artists also made more Overall Descriptions, compared to non-artists $F(1, 44) = 5.122$, $p = .029$, $\eta p^2 = .104$. Furthermore, participants made more Overall Descriptions during the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 19.339$, $p < .001$, $\eta p^2 = .305$. A reliable interaction was also found with artists having more Overall Descriptions compared to non-artists, especially in the pre-drawing phase, $F(1, 44) = 6.433$, $p = .015$, $\eta p^2 =.128$.

Reliable results were also found in the Plans category. Artists made fewer Plans than non-artists, $F(1, 44) = 3.927$, $p = .054$, $\eta p^2 = .082$. These results were marginally reliable. During the drawing phase participants also made fewer Plans, compared to the pre-drawing phase, $F(1, 44) = 20.174$, $p < .001$, $\eta p^2 = .314$. There was no reliable interaction between participant group and task phase.

While no reliable results were found for the Meta-plans category, artists made fewer Overall Plans (i.e., including Plans and Meta-plans), compared to non-artists, $F(1, 44) = 6.287$, $p = .016$, $\eta p^2 = .125$. Furthermore, participants made more Overall Plans in the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 18.522$, $p < .001$, $\eta p^2 = .296$. No reliable interaction was found for Overall Plans.

Participants also made fewer Goals in the drawing phase, compared to the pre-drawing phase $F(1, 44) = 7.128$, $p = .011$, $\eta p^2 = .139$. No reliable difference was found in the proportion of Goal statements between artists and non-artists, as well as no interaction between participant group and task phase.

Participants made more Meta-goal statements in the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 5.678$, $p = .022$, $\eta p^2 = .114$. A reliable interaction shows that artists made fewer Meta-goal statements in the pre-drawing phase and slightly more Meta-goal statements in the drawing phase, compared to non-artists, $F(1, 44) = 5.269$, $p = .027$, $\eta p^2 =.107$. No effects for Overall Goals were found.

While no differences were found in the proportion of Cognitive and Metacognitive statements between the pre-drawing and drawing phase and between artists and non-artists, reliable interactions were evident in these categories. While artists made more Cognitive statements in the pre-drawing phase compared to non-artists, they made fewer Cognitive statements compared to non-artists in the drawing phase, $F(1, 44) = 4.361$, $p = .043$, $\eta p^2 = .090$. Inversely, artists made fewer Metacognitive statements in the pre-drawing phase compared to non-artists and more Metacognitive statements in the drawing phase compared to non-artists, $F(1, 44) = 4.361$, $p = .043$, $\eta p^2 = .090$.

Among the emotion codes, artists made more Positive Evaluations, compared to non-artists, $F(1, 44) = 15.411$, $p < .001$, $\eta p^2 = .259$. No differences were found between the pre-drawing and drawing phase and no interaction was found between participant group and task phase.

Participants also made more Negative Evaluations in the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 43.098$, $p < .001$, $\eta p^2 = .495$. A reliable interaction was found in the Negative Evaluations category with artists making more Negative Evaluations in the pre-drawing phase and fewer Negative Evaluations in the drawing phase, compared to non-artists, $F(1, 44) = 7.292$, $p = .010$, $\eta p^2 = .142$.

Finally, participants in general made fewer Uncertainty statements in the drawing phase, compared to the pre-drawing phase, $F(1, 44) = 5.674$, $p = .022$, $\eta p^2 = 114$. However, differences were not found between artists and non-artists and no interaction was found between participant group and task phase.

In summary, as shown above, several reliable differences were found between artist and non-artist groups, between the pre-drawing and drawing phase of the task, as well as interactions between participant group and task phase. For the Descriptions category, participants made about one and a quarter the proportion of Descriptive statements during the drawing phase compared to the pre-drawing phase (.563 versus .438). This large difference contradicts what would be expected of the artists, because as Getzels and Csikszentmihalyi (1976) found those with the more creative final products were more involved in the exploratory problem finding stage; thus, we expected that artists would be more descriptive during the pre-drawing rather than the drawing phase. However, the overall analysis includes both artists and non-artists, which could contaminate the results. When comparing the proportion of Descriptive statements between artists and non-artists, we found that artists made one and a quarter times the proportion of Descriptive statements as non-artists did (.540 versus .461). This still does not illustrate whether artists were more descriptive during the pre-drawing phase, compared to non-artists. However, when taking into account both, participant group and task phase, a reliable interaction was found. More specifically, artists made more Descriptive statements compared to non-artists (.518 versus .359) in the pre-drawing phase but the same proportion of Descriptive statements as non-artists (.563 versus .563) in the drawing phase. This illustrates that artists were more involved in making verbalizations about the objects and drawing media in the pre-drawing phase, and thus more involved in the exploratory problem finding stage, compared to non-artists. This is consistent with Getzels and Csikszentmihalyi (1976) who found that those with the more creative final products were more involved in the exploratory problem finding stage. This also suggests that artists kept their options open by making more verbalizations about the potential use of objects, compared to non-artists, rather then settling on an idea early on. This is consistent with other research on expert-novice differences (Rostan, 1994; Mumford et al., 1996).

There were also reliable differences in the Meta-descriptions category. More specifically, participants made reliably more Meta-descriptive statements in the pre-drawing, compared to the drawing phase (.000 versus .009); this difference, however, was very small. When comparing artists and non-artists, the results show that artists made slightly more Meta-descriptions than non-artists (.006 versus .003). Although these results were marginally reliable, again the difference between the two groups was very small. There was also a marginally reliable interaction in the Meta-descriptions category with artists and non-artists making no Meta-descriptive statements in the pre-drawing phase (.000 versus .000), but artists making slightly more Meta-descriptions compared to non-artists (.012 versus .006) in the drawing phase. This illustrates that artists were slightly more metacognitive in the drawing phase, at least in the Meta-descriptions subcategory, compared to non-artists.

Reliable or marginally reliable differences were found in the Overall Descriptions category with participants making more Overall Descriptive statements in the drawing phase, compared to the pre-drawing phase (.573 versus .438). Furthermore, artists made about one and a quarter times the proportion of Overall Descriptions as non-artists did (.546 versus .464). A reliable interaction was also found, with artists having more Overall Descriptions compared to non-artists especially in the pre-drawing phase (.518 versus .359) versus the drawing phase (.574 versus .569). The reliable differences in the Overall Descriptions category, can be explained by the fact that the Description and Meta-description categories, which make up the Overall Descriptions category, were reliable.

For the Plans category, participants made only about four-fifths the proportion of Plan statements during the drawing phase, compared to the pre-drawing phase (.267 versus .385). This is interesting because it suggests that more of the planning was done before the drawing had begun, so participants had an idea of what they would do for the drawing. This is consistent with Weisberg (2004), who found that Picasso had the basic compositional skeleton of *Guernica* in mind when he began to work, illustrating that the artist had at least a loose plan before beginning the painting. A marginally reliable difference was also found between the two participant groups with artists making about four-fifths the proportion of Plans compared to non-artists (.292 versus .360). This is interesting because it suggests that non-artists focused more on the local aspects of the drawing. While it's important for participants to have at least a loose plan before beginning a drawing, it is also important to focus on the more global aspects of the drawing, as opposed to the more local aspects. In our coding system, plans refer to the more local near-future actions, while goals refer to the more global future actions. Expert-novice research has shown that while experts focus on global aspects of a problem, novices focus on the local aspects (e.g., Hayes, 1989b; Patrick, 1937). As expected, non-artists focused more on the local aspects of the drawing compared to artists.

Participants also made more Overall Plans in the pre-drawing phase compared to the drawing phase (.422 verses .308). Furthermore, artists made about four-fifths the proportion of Overall Plans compared to non-artists (.324 versus .407). The reliability of this category was driven by the fact that the Plans category, which largely makes up the Overall Plans category, was reliable. This again shows that artists were less preoccupied with the more near-future local plans than non-artists. This comes as no surprise, since the expert knowledge literature shows that experts tend to focus on the more global aspects of a problem while novices focus on the more local aspects of the problem. Since non-artists weren't skilled in drawing, they had to focus on the more local plans. In contrast, since artists have expertise in the drawing task, artists are more effective in using schemas and chunking information, thus allowing them the opportunity to focus on the larger overarching picture, rather than the more local plans. This is consistent with other research on expert-novice differences (e.g., Hayes, 1989b; Patrick, 1937).

For the Goals category, a reliable difference in the proportion of statements was found between the pre-drawing and drawing phase with participants making only one-half the proportion of Goals statements (.045 versus .090) in the drawing phase, compared to the pre-drawing phase. These results, along with the results found in the Plans category just mentioned, suggest that participants have an idea at the start of what they want their drawing to look like. While differences were found between the pre-drawing and drawing phase, no difference was found between the artist and non-artist groups, as well as no interaction between participant group and task phase.

For the Meta-goal category, participants made about one and a half times the proportion of Meta-goal statements during the drawing phase, compared to the pre-drawing phase (.075 versus .049). This suggests that during the drawing phase, participants were more likely to monitor their progress and evaluate whether they were getting closer to their goals, compared to the pre-drawing phase of the task. This makes sense because during the drawing phase participants have a product to monitor. No reliable difference in the proportion of Meta-goal statements was found between artists and non-artists; however, there was a reliable interaction with artists making about one-third the proportion of Meta-goal statements compared to non-artists (.026 versus .073) in the pre-drawing phase and slightly more Meta-goal statements compared to non-artists (.076 versus .074) in the drawing phase. Again, this suggests that artists are more likely to monitor their progress more often during the drawing phase of the task, compared to non-artists.

For the overall Cognitive and Metacognitive categories, there were no reliable differences between the pre-drawing and drawing phase of the task, as well as between the artist and non-artist group. However, reliable interactions between participant group and task phase were evident. More specifically, artists made about one and a quarter times the proportion of Cognitive statements compared to non-artists (.956 versus .871) in the pre-drawing phase, and somewhat fewer Cognitive statements compared to non-artists (.866 versus .884) in the drawing phase. Furthermore, artists made about one-third the proportion of Metacognitive statements compared to non-artists (.045 versus .129) in the pre-drawing phase and about one and a quarter times the proportion of Metacognitive statements compared to non-artists (.134 versus .116) in the drawing phase. These results illustrate that artists are more involved in metacognitive processes during the drawing phase than the pre-drawing phase, more so than non-artists. Thus, although artists and non-artists did not reliably differ in the proportion of statements in the Cognitive and Metacognitive categories, there were reliable results in the way these two categories were distributed between the two phases of the drawing, with the artist group making reliably more Metacognitive statements during the drawing phase of the session. This suggests that artists monitor their progress more in the drawing phase as the drawing is under way, compared to non-artists.

Among the emotion codes, artists made about twice the proportion of Positive Evaluations, as non-artists did (.143 versus .074). These results are interesting because they suggest that artists frequently positively evaluate their work-in-progress. These results help demonstrate a metacognitive component to artists' creative processes; artists may be able to monitor themselves more effectively (Jaarsveld & van Leeuwen, 2005).

There were no reliable differences in the proportion of positive evaluations between the pre-drawing and drawing phase, as well as no interaction between participant group and task phase.

Reliable results were also found in the Negative Evaluation category. More specifically, participants made about three times the proportion of Negative Evaluations during the drawing phase, compared to the pre-drawing phase (.070 versus .021). This makes sense since participants would be more likely to make negative evaluations once they have something to evaluate, once they have already begun to draw. This suggests a metacognitive component where participants evaluate their work in progress. A reliable interaction was also found in the Negative Evaluations category with artists making more Negative Evaluations compared to non-artists (.026 versus .015) in the pre-drawing phase and fewer Negative Evaluations compared to non-artists (.055 versus .084) in the drawing phase. This illustrates that when the drawing had begun, artists were less unhappy about what they had on paper compared to non-artists. This comes as no surprise since artists are experts in the domain and they know what they are doing, while non-artists had no real experience at drawing and are therefore more likely to judge their work less favorably. No interaction was found between participant group and task phase.

For the Uncertainty category, participants made only about three-fifths the proportion of Uncertainty statements during the drawing phase, compared to the pre-drawing phase (.080 versus .121). These results suggest that since the present drawing task is an ill-defined one and as a result can unfold in many different ways, participants show uncertainty as to how to proceed with the task at hand as well as keep an open mind as to what the final goal should be, during the pre-drawing phase. There was no reliable difference between artists and non-artists in the proportion of Uncertainty statements, nor a reliable interaction effect.

Dynamic analysis of proportion of statements over time

Thus far the results suggest several differences between artists and non-artists in the drawing and pre-drawing phase of the session, in terms of the proportions of thoughts assigned to each category. However, these results say nothing about how these categories might unfold over time, especially after drawing begins. It is reasonable to expect that the kind of thinking someone engages in as they are starting to draw might be quite different from the kind of thinking they engage in when they are completing the drawing.

To examine how thinking unfolds over time while involved in the drawing task, each participant’s narrative was split into five-minute intervals from the time drawing began to the end of the drawing. Since the drawing was unlikely to end exactly at the conclusion of a five-minute interval, excess drawing time after the last full interval was included with the preceding interval if the excess time was less than 2.5 minutes, or made into a new interval if the excess time was greater than 2.5 minutes. While the artist group had an average of 15 five-minute intervals, the non-artist group had an average of 11 five-minute intervals, which shows again that the length of the artists’ session was longer than that of the non-artists.

To examine how thoughts unfold over time, the proportion of statements in each category for each of the five-minute intervals was calculated. Graphing the data showed no consistent trend across participants, or for artists versus non-artists, although they showed different trends for different individuals. The average differences in correlations between artists' and non-artists' thoughts were also examined. To do so, correlations between time into the drawing (at five-minute intervals each) and the proportion of codes from each category for each participant were computed. Correlations for all the participants were then transformed into *z* scores to allow for the comparison of the average differences *between* the artist and the non-artist groups across the different coding categories. Table 14 shows the averages for the artist and non-artist groups, as well as differences between the two groups.

Table 14.

Average *z* scores for the correlations between each coding category and time interval in the drawing phase: Artists and non-artists.

Categories	Artists *M*	Artists *SD*	Non-Artists *M*	Non-Artists *SD*	Artist minus Non-artist	*t*(44)	*p*	η^2
Descriptions	-.147	.471	-.015	.489	-.132	-.932	.357	.019
Plans	.010	.478	-.005	.418	.016	.118	.907	.000
Goals	-.163	.390	-.217	.570	.054	.367	.715	.003
Meta-Descriptions	.089	.265	.009	.570	.080	.556	.582	.010
Meta-Plans	-.019	.349	-.118	.694	.099	.613	.543	.008
Meta-Goals	.423	.256	.195	.484	**.228**	**1 .992**	**.053**	**.083**
All Cognition	-.342	.305	-.104	.424	**-.238**	**-2.185**	**.034**	**.098**
All Metacognition	.340	.305	.104	.424	**.236**	**2.168**	**.036**	**.096**
Desc. & Meta-Desc.	-.137	.475	-.033	.474	-.104	-.746	.460	.012
Plans & Meta-Plans	-.015	.462	-.013	.467	-.002	-.012	.991	.000
Goals & Meta-Goals	.250	.444	-.005	.462	.255	1.907	.063	.076
Positive Evaluation	.145	.355	.072	.342	.073	.714	.479	.011
Negative Evaluation	-.070	.398	-.107	.504	.036	.268	.790	.002
Uncertainty	.022	.442	-.144	.480	.166	1.221	.228	.033
Neutral	-.040	.522	.072	.376	-.112	-.834	.409	.016

Note. Entries in bold represent categories showing reliable (or marginally reliable) differences between artists and non-artists.

While Table 14 shows the average *z* scores of artists and non-artists, to express how the proportion of statements for each category unfolded over time, the average *z* scores for artists and non-artists were transformed back into their respective Pearson correlation coefficients for this in-text discussion. (Each correlation reported here represents the relation between time interval into the session and the proportion of segments of a particular category in the intervals.) Since the *z* scores reported in Table 14 represent average correlations, they are not, strictly speaking, subject to the procedure of null hypothesis testing, especially since the degrees of freedom were different across sessions (since the sessions themselves varied in duration). Moreover, since the number of five-minute time intervals per session was typically rather small (averaging about 13 intervals per session), there is limited statistical power in the correlational analyses. However, some of the correlations were moderately high and are therefore worth examining. As the drawing progressed, artists made proportionately fewer Descriptions, $r = -.14$, $r^2 = .02$, a small effect size, and fewer Goal statements, $r = -.16$, $r^2 = .03$, a small effect size, which largely drove the overall decrease in Cognitive statements, $r = -.33$, $r^2 = .11$, a medium to large effect size. Artists also made proportionately more Meta-goals, $r = .40$, $r^2 = .16$, a large effect size, and more Meta-descriptions, $r = .09$, $r^2 = .01$, a small effect size, as the drawing progressed, which largely drove the overall increase in Metacognitive statements, $r = .33$, $r^2 = .11$, a medium to large effect size, over the course of the session. These findings illustrate that as the drawing unfolds, artists' tend to become less concerned with descriptions and setting up goals and that they become substantially more metacognitive, making proportionately more Meta-goals and Meta-descriptions. These results make sense because as artists were nearing the end of the drawing task they should have had their goals set up and been working towards attaining those goals. Furthermore, as artists worked towards attaining those goals, it was important for them to stand back and monitor their progress to see how close they were to attaining those goals they were working towards. Interestingly, in contrast to these effects, Plans, r = .01, r^2 = .00, a virtually nonexistent effect size, and Meta-plans, r = -.02, r^2 = .00, also a virtually nonexistent effect size, showed no systematic trends over time; artists engaged in a fairly consistent amount of planning and meta-planning throughout the session.

For the emotion codes, artists also made proportionately more Positive Evaluations, r = .14, r^2 = .02, a small effect size, and proportionately fewer Negative Evaluations, r = -.07, r^2 = .01, a small effect size, as the drawing was nearing the end. These results are reasonable to expect since artists should be happier with their drawing and making fewer negative evaluations as their drawing was becoming a finished product. The fact that they made more positive evaluations presumably led them to regard the drawing as a finished or close to a finished product (Jaarsveld & van Leeuwen, 2005). Interestingly, artists showed virtually no systematic changes in Uncertainty, r = .02, r^2 = .00, no effect size, over time. The lack of change in uncertainty is noteworthy since one might expect uncertainty to decrease as the drawing process concludes; however, this is evidently not the case, at least among artists.

As with the artist group, none of the correlations between time into the drawing and proportion of statements for the non-artist group were reliable. Although non-reliable, some of the correlations were moderately high, thus painting a picture of how thoughts unfold over time. As the drawing progressed, non-artists made proportionately fewer Goals, r = -.21, r^2 = .04, a small to medium effect size, and proportionately more Meta-goals, r = .19, r^2 = .04, a small to medium effect size. These results illustrate, just as with the artists, that non-artists monitor their progress more often as the drawing nears the end, and they make fewer goals at the end, since non-artists already have their set goals by then. Non-artists also made proportionately fewer Meta-plans, $r = -.12$, $r^2 = .01$, a small effect size, as the drawing progressed. Interestingly, Descriptions, $r = -.01$, $r^2 = .00$, Plans, $r = .00$, $r^2 = .00$, and Meta-descriptions, $r = .01$, $r^2 = .00$, showed no systematic trends over time at all. As with the artists, non-artists made proportionately somewhat fewer Cognitive statements $r = -.10$, $r^2 = .01$, a small effect size, and more Metacognitive statements $r = .10$, $r^2 = .01$, a small effect size, as the drawing unfolds, demonstrating that even non-artists monitor their progress somewhat more often as the drawing unfolds.

For the emotion codes, non-artists made proportionately somewhat more Positive Evaluations, $r = .07$, $r^2 = .01$, a small effect size, and fewer Negative Evaluations, $r = -.10$, $r^2 = .01$, a small effect size, as the drawing progressed. These results are similar to the artists, where participants were happier with their drawing towards the end of the task. Non-artists also made fewer Uncertainty statements, $r = -.14$, $r^2 = .02$, a small effect size, as the drawing progressed. These results suggest that non-artists were more certain about the task as it was coming to an end.

Both artists and non-artists showed similar trends for many of the categories, indicating that a large portion of the thoughts of artists and non-artists unfold in a similar pattern. For instance similarities were found in Cognitive (-.33 and -.10) and Metacognitive (.33 and .10) statements, with Cognitive statements decreasing and Metacognitive statements increasing as the drawing unfolds. Furthermore while Goals (-.16 and -.21, for artists and non-artists, respectively) decreased and Meta-goals (.40 and .19, for artists and non-artists, respectively) increased, Plans (.01 and .00, for artists and non-artists, respectively) stayed consistent throughout the task. Among the emotion codes, Positive Evaluations (.14 and .07, for artists and non-artists, respectively) increased and Negative Evaluations (-.07 and -.10, for artists and non-artists, respectively) decreased as the drawing came to an end.

While many similarities in the thought patterns of artists and non-artists were apparent, there were also differences in the thought patterns of the two groups. For one, while the Descriptive statements (r = -.14) decreased and the Meta-descriptive (r = .09) statements increased for the artists, these two categories remained at the same consistent rate for the non-artists (r = -.01 for Descriptions and r = .01 for Meta-descriptions). Furthermore, while the Meta-plans category (r = -.02) remained at a consistent rate throughout the task for artists, the Meta-plans category (r = -.12) decreased for the non-artists as the drawing unfolds. Among the emotion codes, while the Uncertainty category (r = .02) remained at a consistent rate throughout the task for artists, this Uncertainty category (r = -.14) decreased for the non-artists. While there were differences in the thought patterns of artists and non-artists, these differences may or may not be reliable. To examine whether the observed differences in the way the thoughts of artists and non-artists unfold over time were reliable, independent t tests were conducted on the average z scores computed in Table 14.

As shown in Table 14, there were many similarities in the way the thoughts of artists and non-artists unfold over time. Now that there's a picture of the main consistencies in how participants' thoughts unfold as the drawing progresses, the focus is on the differences in the dynamic thought patterns of artists versus non-artists. As Table 14 shows, there were several reliable differences between artists and non-artists. More specifically, the groups differed in the way the Meta-goal category, $t(44) = -1.992$, $p = .053$, $\eta^2 = .083$, a medium effect size, unfolded over time; artists made more Meta-goal statements over time, compared to non-artists. Reliable differences were also found in the way the Cognitive, $t(44) = 2.185$, $p = .034$, $\eta^2 = .098$, a medium to large effect size, and Metacognitive, $t(44) = -2.168$, $p = .036$, $\eta^2 = .096$, a medium to large effect size, categories unfold over time, with artists making more Metacognitive statements and fewer Cognitive statements over time, compared to non-artists.

Since the assumptions of the *t* test were violated for some of the categories, the Mann-Whitney *U* test was also used. The results were very similar to the results found with the *t* test. A comparison of the reliable and marginally reliable differences between artists and non-artists for the independent *t* test and the Mann-Whitney *U* test are shown in Table 15, with the reliable differences highlighted in bold.

Table 15.

A comparison of reliable or marginally reliable differences between the artist and the non-artist group using the *t* test and Mann-Whitney *U* test: Drawing phase.

Categories	*p* value for *t* test	*p* value for Mann-Whitney *U* test
Meta-Goals	**.053**	.077
All Cognition	**.034**	**.030**
All Metacognition	**.036**	**.030**

Note. Entries in bold represent categories showing reliable differences between artists and non-artists, on average at the $p = .05$ level.

In summary, these results show a marginal difference between artists and non-artists with artists making more Meta-goal statements as the drawing progressed. This suggests that artists monitor their progress and they stand back to see if their goal has been reached more frequently as the drawing unfolds. Thus, they monitor their progress more and more often towards the end. There were also reliable differences between artists and non-artists with artists making more Metacognitive statements and fewer Cognitive statements, compared to non-artists, as the drawing unfolds. Since these two categories, Cognition and Metacognition, are mutually exclusive, there's a tradeoff between them; as one increases the other must decrease. However, the difference between them was large enough to be reliable. Again, the results point to artists being more metacognitive as the drawing unfolds, suggesting that they evaluate their progress more often over time as the drawing unfolds rather than evaluating their progress at a consistent rate throughout the entire drawing. Therefore, towards the end artists appear more metacognitive, compared to non-artists.

Summary

Overall these results gave us a picture of the thought processes of artists and non-artists as they were engaged in a creative drawing task. The results show the thoughts of artists and non-artists during the pre-drawing and drawing phase of the task, as well as how thoughts unfold over time as the drawing progresses for artists and non-artists. More specifically, artists and non-artists thoughts were predominantly descriptive. Artists and non-artists were also involved in a lot of planning and goal making, which is consistent with the view of human beings as goal-directed individuals (Newell & Simon, 1972; von Cranach, 1996) who use the process of planning to attain those goals (Hayes-Roth & Hayes-Roth, 1979; Mumford, Schultz, & van Doorn, 2001). Furthermore, although most of the thoughts were cognitive in nature, participants also made Metacognitive statements, especially towards the end as the drawing unfolded. Participants were also involved in the evaluation of the drawing, both positively and negatively, suggesting that participants frequently monitor their progress while solving problems (Jaarsveld & van Leeuwen, 2005; Jausovec, 1994; Suwa, 2003).

In addition to the thought process of the individuals, the results also reveal reliable differences in the thoughts of artists and non-artists as they are engaged in the drawing task. These differences between artists and non-artists are consistent with previous psychological research on expert-novice differences across domains. More specifically, artists were more descriptive during the pre-drawing phase, which suggests that artists were more involved in thinking and making descriptive verbalizations about the objects and drawing materials set up for the drawing. This is consistent with Getzels and Csikszentmihalyi (1976) who found that those artists who were more involved in the exploratory problem finding stage had more creative final products. This also suggests that artists were more flexible and kept their options open by making more verbalizations about the potential use of objects, compared to non-artists, rather then settling on an idea early on. This is consistent with the results of Rostan (1994) and Mumford et al. (1996). Furthermore, during the drawing phase artists were more involved in the global goals and less involved in the more local plans, compared to non-artists. This is consistent with other research on expert-novice differences (e.g., Hayes, 1989b; Patrick, 1937), which shows that experts have expertise in their domain and are therefore more effective in using schemas and chunking information, thus allowing them to focus on the larger overarching picture (the more global goals), rather than the more local plans. On the other hand, since novices have no skills in the particular domain, they had to focus on the more local plans. Artists also made more Positive Evaluations and fewer Negative Evaluations during the drawing task, compared to non-artists. This comes to no surprise; since artists are experts in their field, they are more likely to evaluate their drawing positively. Non-artists are not experienced in the field, thus they have no skills and are more likely to evaluate their drawing negatively. Furthermore, while the two groups made the same proportion of Metacognitive statements, the proportion of these statements, especially statements where individuals stand back and monitor their work in progress, unfolded differently for the two groups, with artists making reliably more Metacognitive statements and monitoring their progress much more as the drawing unfolded over time.

Overall, our results gave us a picture of what individuals think about while involved in a creative drawing task, as well as any differences in thought patterns between artists and non-artists. We are now one step closer to using this information for understanding the nature of artists' cognitive processes and how they are similar to or different from those of non-artists.

Chapter 4:

Discussion

While earlier research has dealt with several issues on the creative thinking of artists, a number of unanswered questions remained. A detailed examination of the thought processes of a relatively large sample of artists and their relation to creativity had not yet been undertaken. Whereas Kozbelt (2002, in press) conducted a fine-grained examination of the *physical behaviors* of artists as they create drawings, in the present study an examination of the thoughts of artists, measured via their *verbal behaviors,* as they create drawings was conducted. To gain insight into some of these unanswered questions, reports of the thoughts of individuals were obtained as they worked, through concurrent verbal protocols (Ericsson & Simon, 1984).

Goals

The present study was conducted with several goals in mind. One goal of the study was to compare the judged creativity of the final drawings of the artist and non-artist groups. Since the primary goal of the study was to examine and contrast the reported thought processes of the artist and non-artist groups, for this comparison to be meaningful, it is necessary to show that there was a difference in the creativity of the final drawings produced by the individuals in the two groups. To this end, we had artist and non-artist judges rate the creativity of the drawings.

A second goal of the study was to develop and test the reliability of a coding system that would allow us to categorize participants' thoughts in the context of their problem solving goals and evaluations. To this end, a categorization system used by Stein, Trabasso, Folkman, and Richards (1997) into which the contents of participants' narratives can be fitted was adapted. The system was adapted to better reflect the present task. The coding system included both function categories (Descriptions, Plans, Goals, Meta-descriptions, Meta-plans, Meta-goals, Miscellaneous, and Habitual) and emotion categories (Positive Evaluations, Negative Evaluations, Uncertainty, and Neutral). As part of the development of the coding system, the system's reliability was checked using Cohen's kappa to diagnose any problems and improve the system for future research.

Since no one has conducted a study that illustrates what artists *think* about as they are involved in a creative drawing task, our primary goal was to examine the thoughts of artists and non-artists as they were engaged in a drawing task. The prediction for both artists and non-artists was that they would behave in a goal-directed manner (Newell & Simon, 1972), and they would engage in planning behavior in order to guide the problem solving process and attain their goals (Chaiklin, 1984; Hayes-Roth & Hayes-Roth, 1979; McDermott, 1978; for a review, see Mumford, Schultz, & Van Doorn, 2001; Read, 1987). Furthermore, we expected participants to monitor their progress and make evaluative statements during the task, to see if they were any closer to attaining their goals (Jaarsveld and van Leeuwen, 2005; Jausovec, 1994).

In addition to examining the thoughts of artists and non-artists, the study aimed to compare and contrast the kinds of thoughts reported by artists and non-artists in the drawing task. This was done first as a general measure summarizing the pre-drawing and drawing phases of the session, as well as dividing the drawing session into five minute intervals, in order to examine how the frequencies of kinds of thoughts may change throughout the session, as well as look for consistent differences between artists and non-artists. The prediction was that artists would be more flexible and open to new ideas; thus, they would spend more time during the pre-drawing phase verbalizing about potential objects, consistent with the results of Getzels & Csikszentmihalyi (1976), Rostan (1994) and Mumford et al. (1996), rather than settling on any one idea early on and becoming entrenched in one way of thinking. Another prediction was that artists would focus on the more global goals of the drawing, while non-artists focused on the more local plans. Finally, another prediction was that artists would not only make more metacognitive statements that take in the whole drawing, compared to novices, consistent with the results of Jausovec (1994) and Jaarsveld and van Leeuwen (2005), but that artists would also be more metacognitive and monitor their progress more frequently as the drawing unfolded and came to an end, rather than staying at the same consistent frequency throughout the drawing task. The present study was conducted to test these hypotheses.

Judgment task

Since the primary goal was to examine and contrast artist and non-artist thoughts, the comparison between the two groups would only make sense if a difference exists in the creativity of the final product between the two groups. Therefore, final drawings were rated by artist and non-artist judges on three measures: quality, originality, and technical skill. Correlations between the ratings of these three measures were high, which indicated that we were measuring the overall creativity of the drawing. Person-to-person inter-rater reliability was measured as well. Reliable positive correlations were found within each group, as well as between artists and non-artists. Finally, a reliable difference was found in the judged creativity of the drawings, with artists' final drawings being rated as more creative, compared to non-artists. This suggests that any differences in thoughts between artists and non-artists can be explained by the differences in the creativity of the final product.

Ratings of the drawings were also used to examine differences in the creative final product of artists while they gave verbal protocols and while they did not give verbal protocols. No differences were found between the two groups, suggesting that giving concurrent verbal protocol does not interfere with the task at hand. Similar results have been reported by Ericsson and Simon (1984), who argued that as long as providing verbal reports do not force participants to have to think of things they normally wouldn’t think about, interference is kept to a minimum.

Inter-coder reliability

One of the goals of the study was to develop a coding system and increase its’ reliability. When testing the reliability, high inter-coder reliability for both the function codes and emotion codes as rated by Cohen’s kappa was found. This was true for all participants combined as well as for artists and non-artists separately. Although not perfect, the kappa values were reliably high ($p < .001$). Furthermore, a systematic pattern of disagreements across the codes was found, which indicates that reliability can be improved at a later time.

Analysis of the drawing session

One of the main goals of the study was to examine the thought processes of artists and non-artists as they were engaged in a creative drawing task. To examine the thoughts of participants, the proportions of segments made in each category from their verbal protocols were used. The reason for the use of proportions, rather than total counts, is that artists' sessions were reliably longer and had more total segments compared to non-artists. Thus any differences in the total number of counts in any category may be due to the fact that artists had more segments, compared to non-artists. Furthermore, the Habitual and Miscellaneous categories were examined at the beginning and removed from further analysis because they do not offer any new information on the current thought processes while drawing.

After removing the Habitual and Miscellaneous categories, proportions of all other statements were examined for the pre-drawing and the drawing phase. Much consistency was found between the thoughts of artists and non-artists. Both artists and non-artists' reported thoughts were predominately descriptive for both the pre-drawing and drawing. As expected artists and non-artists also made plan and goal statements throughout the task. This is consistent with the literature which shows that individuals are goal-directed agents (Newell & Simon, 1972; von Cranach, 1996) who use planning (Mumford, Schultz, & Doorn, 2001) to guide them in the problem solving process in order to attain their goals. Participants added structure to the ill-defined problem of creating a drawing by setting up goals and then breaking up those goals into plans to make the problem more solvable. Both artists and non-artists were also involved in metacognitive and evaluative processes, illustrating that besides structuring the problem by setting up goals and plans, participants also monitored their progress throughout the task (Jaarsveld & van Leeuwen, 2005). The results imply that monitoring one's progress is an important factor for attaining one's goal. As illustrated, the thoughts of artists and non-artists were very similar and they were consistent with other research on problem solving.

Artists vs. Non-artists: Pre-drawing

While the thoughts of artists and non-artists showed similarities, we expected to find differences between the groups as well. The prediction was that for the most part these differences would parallel the differences found between experts and novices, which is what our data showed. The pre-drawing and drawing phase were analyzed separately, since other researchers made the distinction between these two phases (Dudek & Côté, 1994; Getzels & Csikszentmihalyi, 1976).

During the pre-drawing phase artists made reliably more Descriptive and Positive statements and fewer Meta-goals and Overall Plans, compared to non-artists. These results suggest a few important differences between artists and non-artists. First, Descriptive statements included statements pertaining to participants actions at the moment as well as statements about the objects or drawing media of the task. The fact that artists made more Descriptive statements during the pre-drawing phase indicates that artists' thoughts were more preoccupied with the objects and their potential use in their drawings, compared to non-artists. This suggests that artists were more involved in the exploration of the objects, what Getzels and Csikszentmihalyi refer to as problem finding. In a similar task, Getzels and Csikszentmihalyi (1976) found that this exploratory behavior was associated with more creative drawings. Therefore, we expected artists to make more verbalizations about the objects, compared to non-artists. Furthermore, the fact that artists made more Descriptive statements, and thus more comments about the objects, might also suggest that artists kept their options open by considering more of the objects, before fixating and settling on one or several goals. Other researchers have also found this flexibility to be important for creativity (Rostan, 1994; Suwa & Tversky, 2001).

Artists also made reliably more positive evaluations, compared to non-artists, which was reasonable to expect since artists were supposedly more optimistic about the task at hand due to their experience in the domain of drawing. On the other hand, artists made reliably fewer Meta-goal statements, compared to non-artists. Since the Meta-goal category included statements of ability and difficulty of the task, these results suggest that non-artists worried more about their ability to draw the objects and the difficulty of the task. Since non-artists had no substantial experience drawing, these types of statements were expected of the non-artists. This may have also limited the non-artist group to drawing only objects they believed themselves capable of drawing, rather than keeping their options open. This is important because, again, creativity is associated with initially spending time keeping the structure of the problem open while exploring possibilities, and only later settling on a way of structuring the problem (Mumford et al., 1996; Reiter-Palmon et al., 1997; Rostan, 1994). The non-artists inability to draw many of the objects may have led them to structure the problem early on and keep a closed mind about the other objects.

Artists also made reliably fewer Overall Plans, compared to non-artists, demonstrating that non-artists were from the very beginning making more plans to attain their goals, thus suggesting that they settled on a goal early on. Again, creativity is associated with being flexible, rather than fixating on a goal or problem representation early on (Mumford, et al. 1996; Reiter-Palmon et al., 1997; Rostan, 1994).

Artists vs. non-artists: Drawing

Important differences between artists and non-artists in the drawing phase were found as well. Artists made reliably more Goals and Positive Evaluations and fewer Plans and Negative Evaluations. These results were consistent with other research on expert and novice differences. During the drawing phase artists made reliably more Goal statements, suggesting that artists continuously came back to their goals and either reviewed them, changed or refined them, or set up new goals. Again, this points to the importance of flexibility for creativity, rather than fixation on a specific goal (Mumford et al., 1996; Reiter-Palmon et al., 1997; Rostan, 1994).

Artists also made reliably fewer Plans, compared to non-artists, demonstrating that while artists set up more global goals, non-artists were engaged in the more local plans. Since artists had more expertise in the drawing task, they may have effectively chunked information, thus allocating their resources towards focusing on the larger underlying goals, rather than the more local plans. Because non-artists lack the training in drawing, they were more preoccupied with the details of the task, such as how to draw the objects, rather than the goals of the task, such as what they want the final drawing to look like. These results are consistent with other research on expert-novice differences

(Hayes, 1989b; Patrick, 1937), which demonstrate that while experts focus on the more global aspects of a problem, non-artists are preoccupied with the more local plans and details of a problem.

While artists made reliably more positive evaluations, they made fewer negative evaluations, compared to non-artists. The higher proportion of positive evaluations made by the artists, suggests that artists were evaluating their work-in-progress to see how close they were to attaining their goals. This demonstrates a metacognitive component in the creative problem solving process (Jaarsveld & van Leeuwen, 2005). Artists also made reliably fewer negative evaluations, compared to non-artists, which makes sense because non-artists lack the training in drawing and thus negatively evaluated their drawing.

Integrating participant groups and task phases

In addition to examining the differences between artists and non-artists during the pre-drawing and drawing phase of the task, a repeated measures analysis of variance was conducted to see how participant group and task phase would interact. More specifically, the repeated measure analysis of variance examined overall differences between artists and non-artists across the entire task, differences between the pre-drawing and drawing phase of the task, and interactions between participant group and task phase. Several reliable differences were evident.

For the Descriptions category, most of the Descriptive statements were made during the drawing phase, compared to the pre-drawing phase. Furthermore, artists made more Descriptive statements compared to non-artists. More specifically an interaction effect shows that while artists made more Descriptive statements during the pre-drawing phase, compared to non-artists, they had the same amount of Descriptive statement during the drawing phase as the non-artists. This illustrates that artists were more involved in making verbalizations about the objects and drawing media in the pre-drawing phase, and thus more involved in the exploratory problem finding stage. This is consistent with Getzels and Csikszentmihalyi (1976) who found that those with the more creative final products were more involved in the exploratory problem finding stage. Furthermore, these results suggest that artists kept an open mind, examining potential objects for their drawing at a higher proportion, rather than settling on any one idea early on.

Most of the Plan and Goal statements were made during the pre-drawing phase suggesting that individuals have a plan and goal in mind before they begin to solve the problem, consistent with Weisberg (2004). Furthermore, artists made fewer Plan statements compared to non-artists. This illustrates that non-artists were more focused on the near-future local plans of the drawing. This is consistent with the expert-novice research, which shows that experts focus on global aspects of a problem while novices focus on the local aspects of a problem.

Most of the Meta-goal statements were made during the drawing phase, compared to the pre-drawing phase. This makes sense because during the drawing phase participants have something to monitor. Furthermore, while artists made fewer Meta-goal statements during the pre-drawing phase, compared to non-artists, they made more Meta-goal statements during the drawing phase, compared to non-artists. This illustrates the importance of monitoring one's progress, especially during the solution phase when something is already down on paper.

While no differences were found between the pre-drawing and drawing phase or between the artist and non-artist group for the Cognitive and Metacognitive categories, interactions were found for these categories. More specifically, artists made more Cognitive statements during the pre-drawing phase, and fewer Cognitive statements during the drawing phase, compared to non-artists. Furthermore, artists made fewer Metacognitive statements during the pre-drawing phase, and more Metacognitive statements during the drawing phase, compared to non-artists. These results illustrate the importance of monitoring one's progress and being more metacognitive during the drawing phase, once the drawing is under way and there is something there to monitor.

Among the emotion codes, artists made more positive evaluations, compared to non-artists. This is expected since artists are experts in the domain of drawing and thus would judge their work more favorably, compared to non-artists who have little or no experience drawing.

Participants also made more negative evaluations during the drawing phase, compared to the pre-drawing phase. This makes sense because during the drawing phase there is something there for participants to evaluate and judge. A reliable interaction was also found with artists making more Negative Evaluations compared to non-artists in the pre-drawing phase and fewer Negative Evaluations compared to non-artists in the drawing phase. This illustrates that when the drawing had begun, artists were less unhappy about what they had on paper compared to non-artists. This comes as no surprise since artists are experts in the domain and they know what they are doing, while non-artists had no real experience at drawing and are therefore more likely to judge their work less favorably.

Finally, participants made fewer Uncertainty statements in the drawing phase, compared to the pre-drawing phase. These results illustrate that since the present drawing task is an ill-defined one and as a result can unfold in many different ways, participants show uncertainty as to how to proceed with the task at hand as well as keep an open mind as to what the final goal should be, during the pre-drawing phase.

Dynamic analysis

In addition to dividing the task into the pre-drawing and the drawing phase, the task was also divided into five-minute intervals from the time the drawing began to the end of the drawing. Dividing the task so finely allowed for a more thorough examination of how thoughts changed over time. Although no trends were found across different individuals, differences between artists and non-artists were evident. More specifically artists made more Meta-goal and Overall Metacognitive statements and fewer Cognitive statements as the drawing progressed, compared to the non-artists. This demonstrates that artists monitored their progress more frequently as the drawing unfolded, suggesting that evaluating one's progress more often towards the end, rather than evaluating one's progress at the same consistent rate throughout the entire drawing, is important for creativity.

Limitations

The present study was very informative on the creative thought processes of individuals. The study revealed the thoughts of individuals, as well as differences in the thoughts of artists and non-artists, while engaged in the drawing task. Although such a detailed fine-grained examination of participants' thoughts as they were engaged in a drawing task has never been undertaken, there are limitations in the present study that can be examined or improved at a later time.

While reliability checks of the coding of participants' verbalizations as they were engaged in a drawing task yielded high reliability results measured by Cohen's kappa, we do believe that the coding system can likely be improved. As demonstrated from the inter-coder reliability check, the largest cases of disagreement came from the Plans, Descriptions, and Miscellaneous categories, among the function codes, and the Neutral, Positive Evaluations, and Negative Evaluations, among the emotion codes. The systematic pattern of disagreement suggests that these categories can be better defined to improve inter-coder reliability at a later time.

Second, at least one of the categories in our coding system can be refined. The Meta-goal category clumps together several types of statements that give somewhat different information. The Meta-goal category included the following types of statements: those of ability, difficulty of task, and evaluation of goal attainment. Although they all have a metacognitive component to them, there are important differences among them. While we would expect artists to stand back and evaluate whether or not their goal has been reached, more often than non-artists, we would expect non-artists to make more statements about their inabilities and the difficulty of the task, compared to artists, since non-artists have no substantial experience drawing. By clumping all these statements together under one large category we can't be certain that there were no differences between artists and non-artists in these three sub-categories. One can remedy this problem by giving these types of statements the usual Meta-goal code along with a subcategory code that differentiates these types of Meta-goal statements. This can then reveal any differences in these types of statements between artists and non-artists.

As part of the study, the sessions were videotaped in order to get a recording of participants' verbalizations. While the videotapes were used in the few cases of uncertainty while coding, they were not used routinely. The consistent use of the participants' recorded session while coding can be used to better differentiate between these categories and perhaps increase inter-rater reliability.

Furthermore, the present study examined participants' thoughts by calculating the proportion of statements for each category. While that is informative in telling us what thoughts occurred and the frequency of these thoughts, it does not provide any information on how these thoughts follow each other consecutively. For instance, while two individuals can make a negative evaluation, what they do about it cannot be determined from the present analyses. While one participant may make negative evaluations and never revise or correct the problems, another may make negative evaluations and refine their plans to correct the problems. As another example, while one participant can make a plan statement and not follow through with it, another participant may make a plan statement and then carry it out. Both of these cases would be given a plan code, but there would be no way to differentiate these two cases. The limitation of the present study was that while it examined the thoughts of participants, it did not examine how different thoughts follow and relate to each other. Examining how these codes relate to each other would result in a better understanding of the creative thought process by giving us a bigger picture of what participants were thinking about.

While examining artist and non-artist differences was a primary goal in the present study, differences within groups was not examined in our study. The problem solving literature shows that experts and novices differ in several important ways when solving a problem (for a review, see Ericsson & Charness, 1994). But research has also shown that the more effective problem solvers differ from the less effective problem solvers within the expert and novice group (Goldin & Hayes-Roth, 1981; Rostan, 1994; Suwa & Tversky, 2001). Differences within the groups have not been examined in the present study. However, differentiating the more creative from the less creative artists can be useful in understanding what real successful artists think about and how they differ from the less successful ones. Any differences within the groups can shed some light on the thought processes of successful artists while engaged in a drawing task.

Creativity and Education

The aim of the present study was to obtain information on the thought processes of individuals while engaged in a creative drawing process and how they unfold over time, as well as discovering differences between artists and non-artists thought processes. The present study revealed the thoughts of artists, as well as distinguished their thoughts from non-artists' thoughts. The information obtained from the present study can be used for educational purposes to train individuals on how to approach a similar task in order to help them produce more creative final products. Other studies have found that training programs are effective in enhancing creativity. In a study with business people, Fontenot (1992) found that an 8-hr experiential training program in creativity was effective in developing their abilities in fluency (ability to generate many problem statements) and flexibility (number of categories of alternate problem statements developed); these abilities have been found to be related to creativity. Fontenot (1992) believes and his study suggests that creativity differs from individual to individual only in degree and can be enhanced through training.

A training program similar to Fontenot's can be used with artists, in an attempt to enhance their creativity. For instance, since the present study found that having different representations and being flexible may yield more creative products we can train artists to keep their options open and not settle on a goal at the beginning of the task. Mumford, Reiter-Palmon, and Redmond (1994) found that people were more likely to apply the first available representation when not given a reason to spend time and energy on problem construction. Thus, individuals could be trained not to fixate on a specific goal at the beginning of a task; rather, they can be trained to look at the task and represent it in many different ways. Furthermore, since the present study found that making more verbalizations about the objects during the pre-drawing phase of the task was associated with more creative drawings, we can train individuals to spend more time thinking about and exploring the objects before settling on a goal. Finally, we can train individuals to spend more time on metacognitive processes, especially as the drawing unfolds. The present study illustrated that artists spent more time monitoring their progress towards the end of the session as it unfolds, rather than monitoring their progress at the same consistent rate throughout the task.

Future directions

Discovering the thought processes that differentiate the artist from the non-artist group can help us instruct individuals to think in the most effective manner in order to enhance their creativity. However, instructing artists to think in this manner may not necessarily enhance their creativity. To test this out, we can implement these instructions in a future study and examine the differences in the creative products between artists (as well as non-artists) that have received the instructions and artists (as well as non-artists) that have not. This can help us ascertain how effective these instructions and training sessions can be in enhancing the creativity of the final products. Furthermore, the present study only examined a creative drawing task. Whether the results found in this type of task can be generalized to other types of creative tasks such as the related task of painting, or the more distant task of architecture, has yet to be tested.

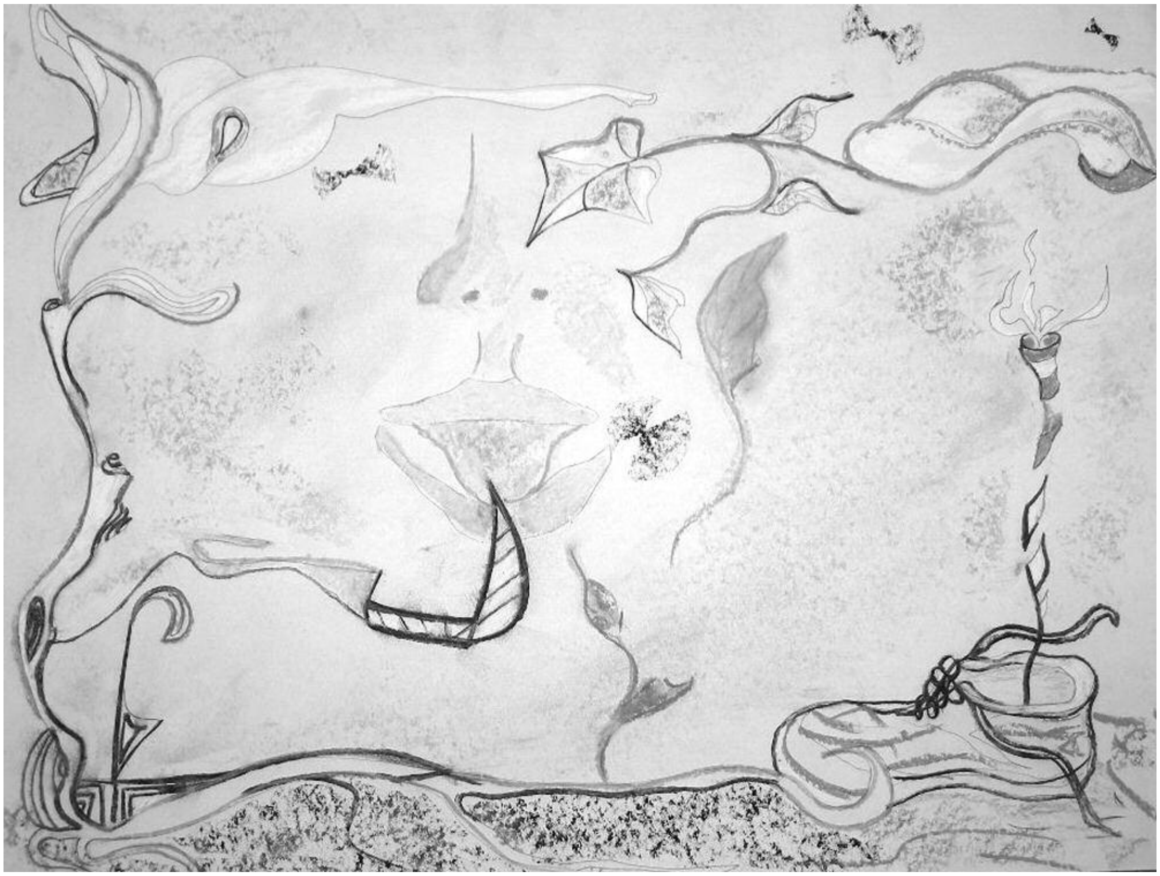
In the future, our coding system can also be used with other factors to help us understand creativity. For instance, thoughts of artists via our coding system can be examined along with the behaviors (erasing, refining, etc.) artists partake in while engaged in a drawing task. This can help obtain a more complete view of creativity. For instance, someone may make a negative evaluation and do nothing about it, while another may make revisions to remedy the problem. By using artists' verbalizations along with their behaviors, we can get a better picture of what was going on in their minds.

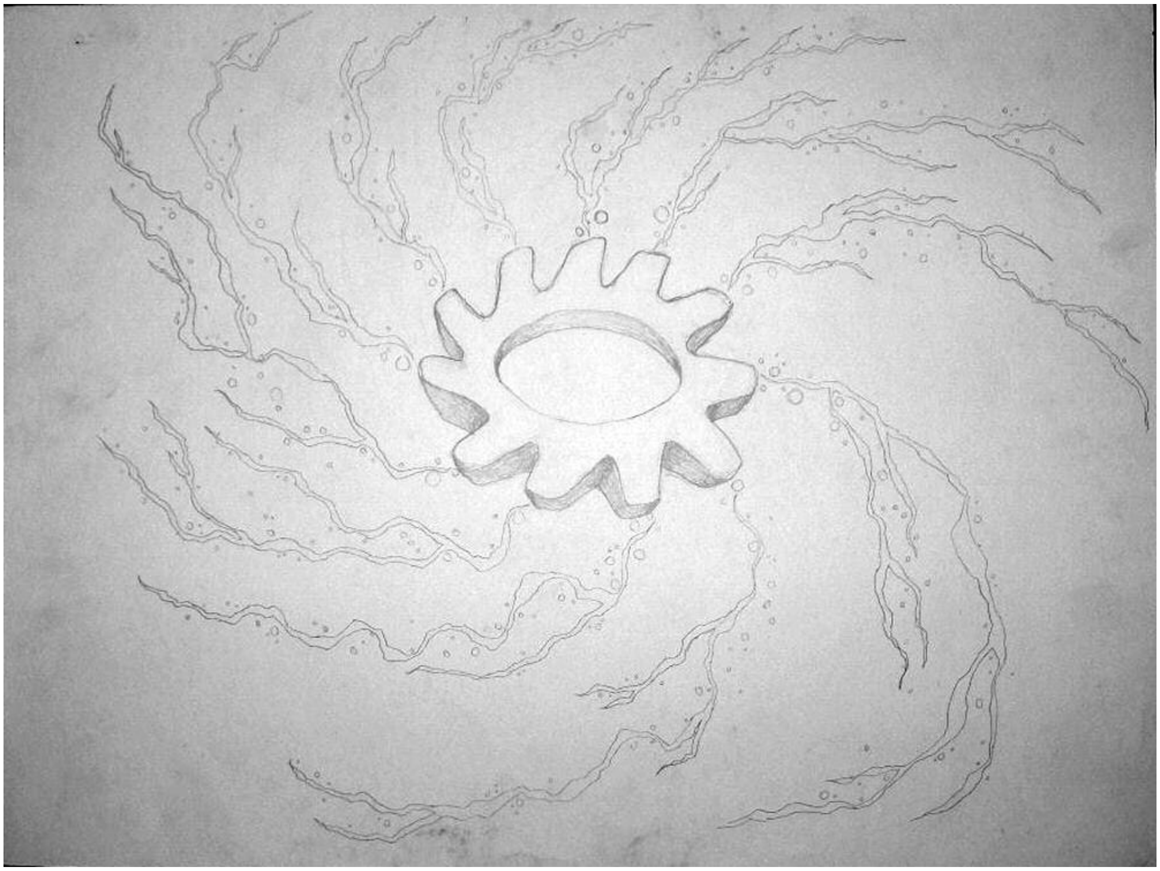
While the present study examined the differences between artist and non-artist groups, it did not examine differences between the more effective and less effective performers within the artist and non-artist groups. At a later date, we plan on reevaluating the data using hierarchical linear modeling, which is a regression technique that analyzes individual and group differences simultaneously. Kozbelt (in press) used HLM to examine individual and group differences to analyze the behaviors of artists and non-artists in a similar task. The present data can also be reanalyzed using HLM to examine individual and group differences in participants' thoughts. The literature shows differences between the more effective and less effective problem solvers. Examining these within group differences can help us obtain a better understanding of creativity.

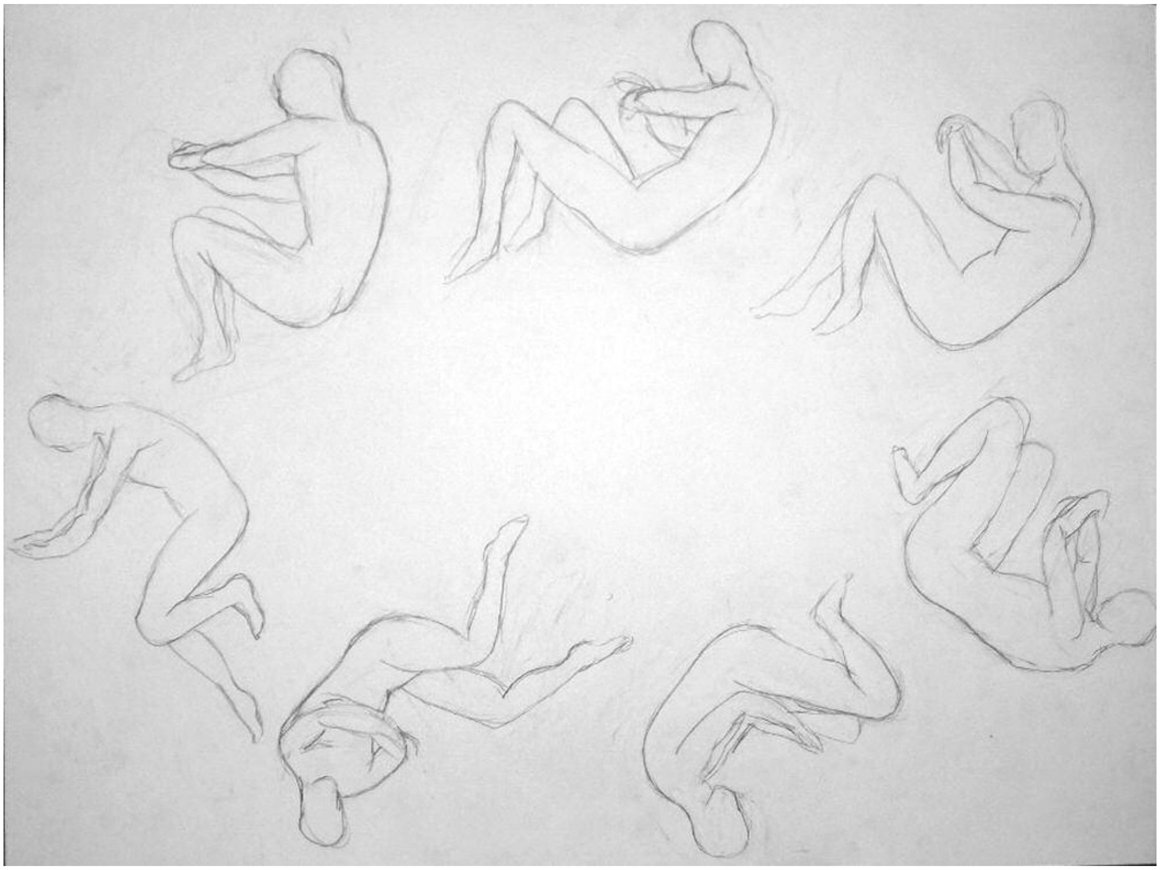
In addition to furthering our research using the cognitive approach, in order to have a holistic view of creativity and learn how to enhance it, a more integrative view of creativity is necessary. Research on personality, culture, and motivation, among other areas has contributed to our understanding of creativity. Eventually, an integration of these other factors along with the knowledge obtained on the creative thought process will be necessary in order to have a complete view of creativity. There are still many unanswered questions that need to be addressed in order to obtain a rich understanding of the nature of creativity.

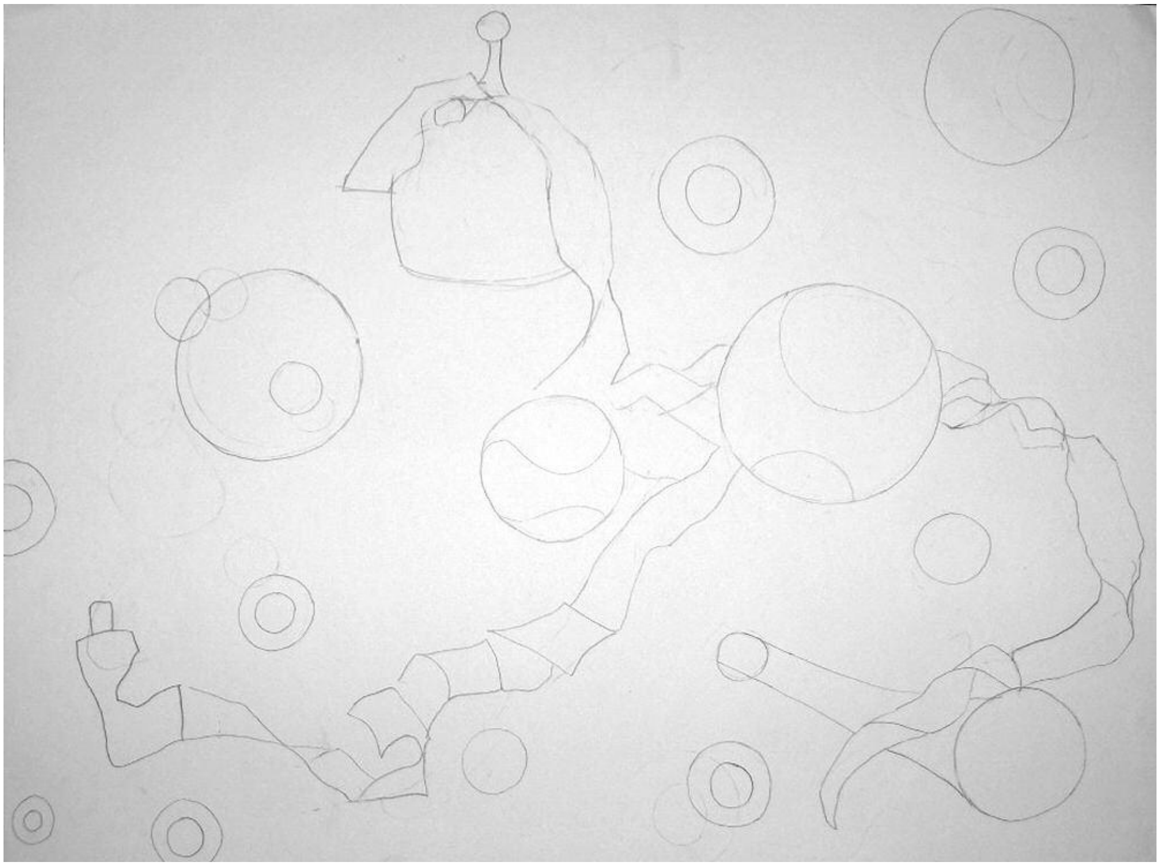
Appendix A: Assortment of Objects

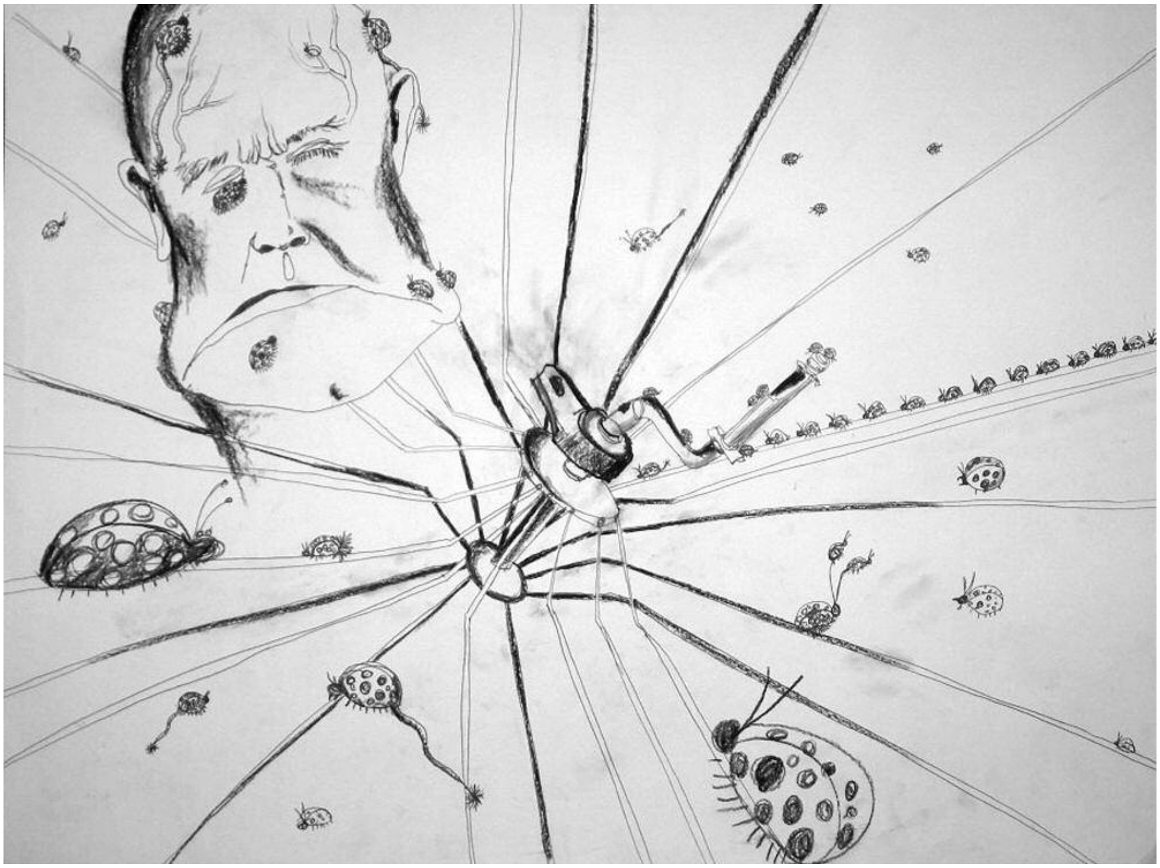
Appendix B: Examples of High-Rated Drawings (all done by Artists)

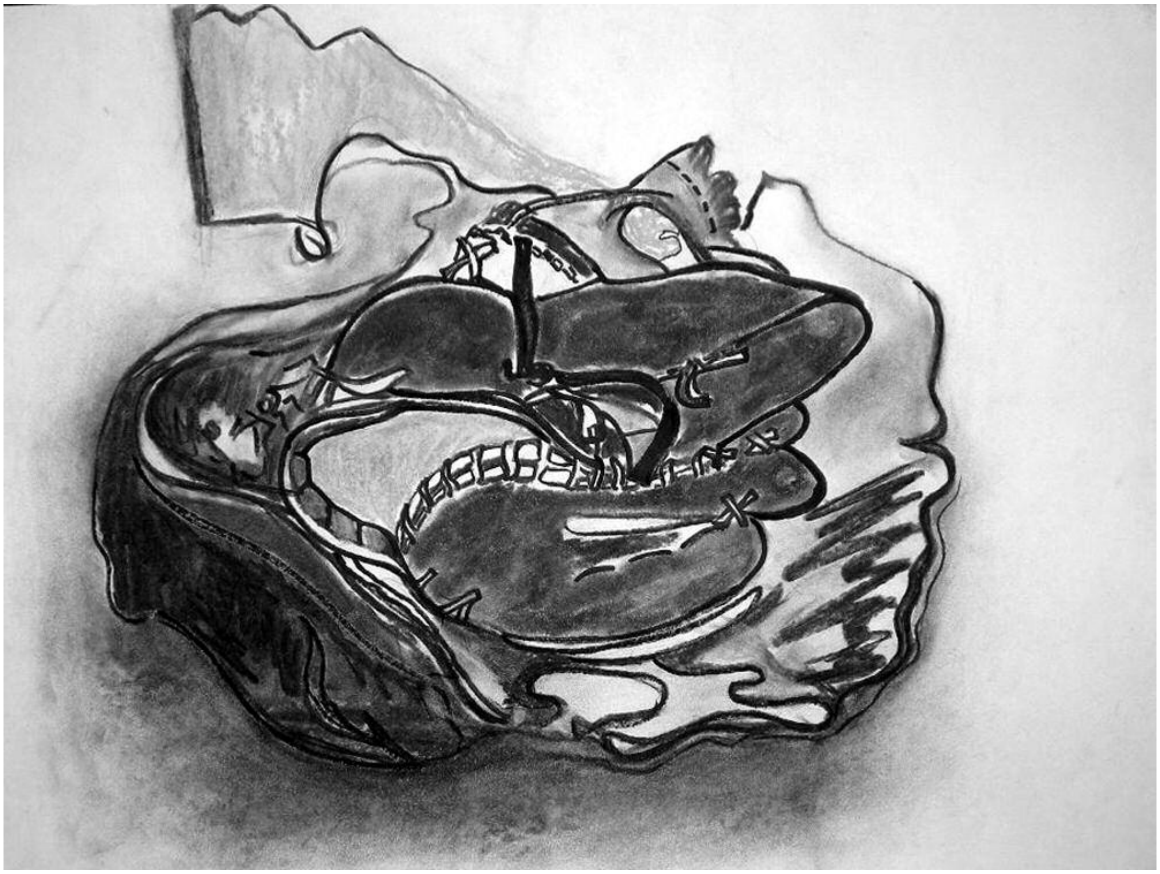


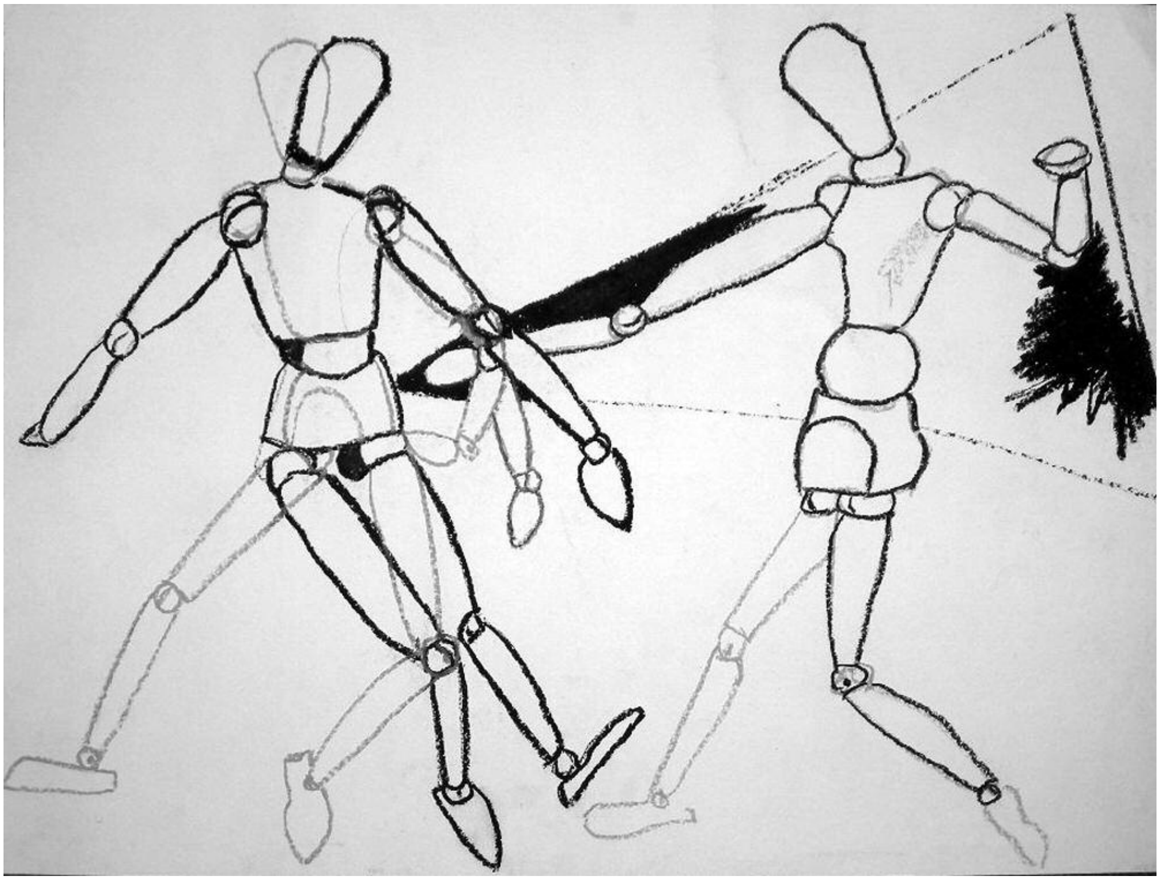


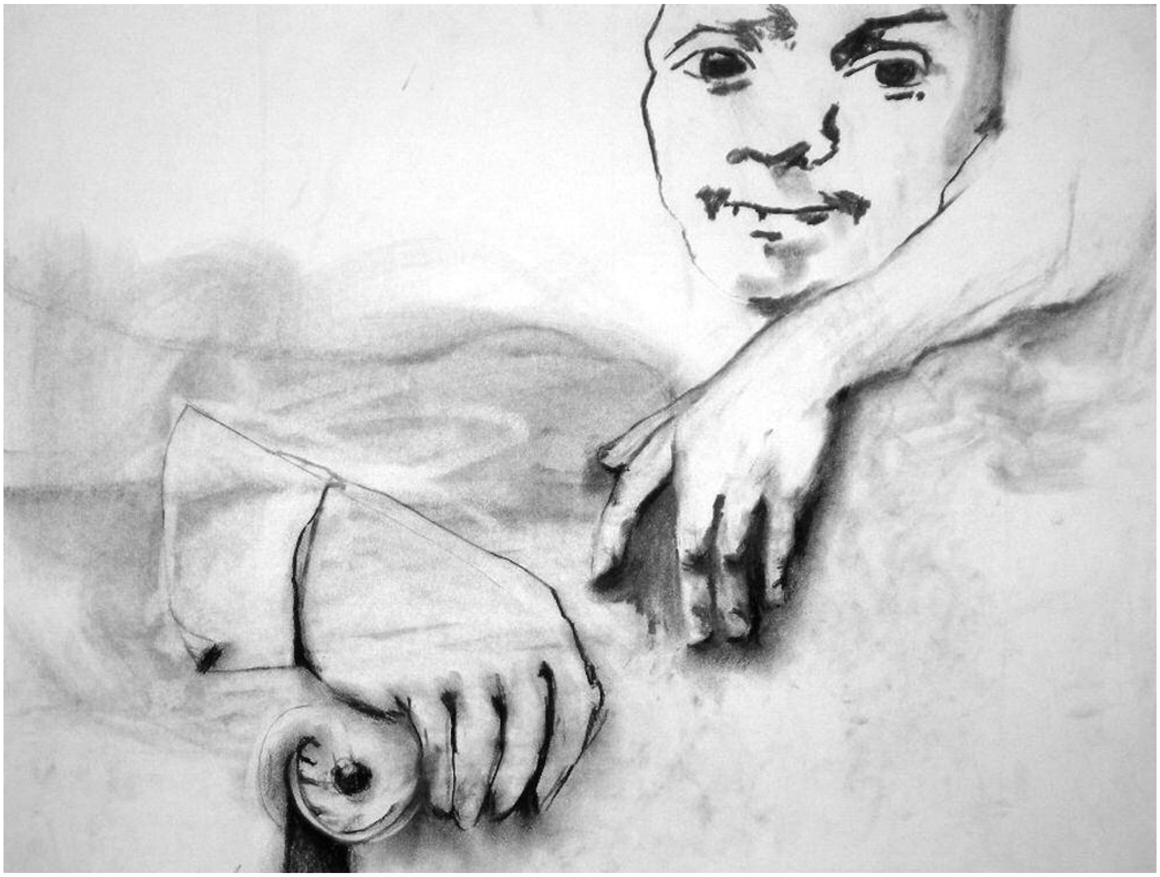


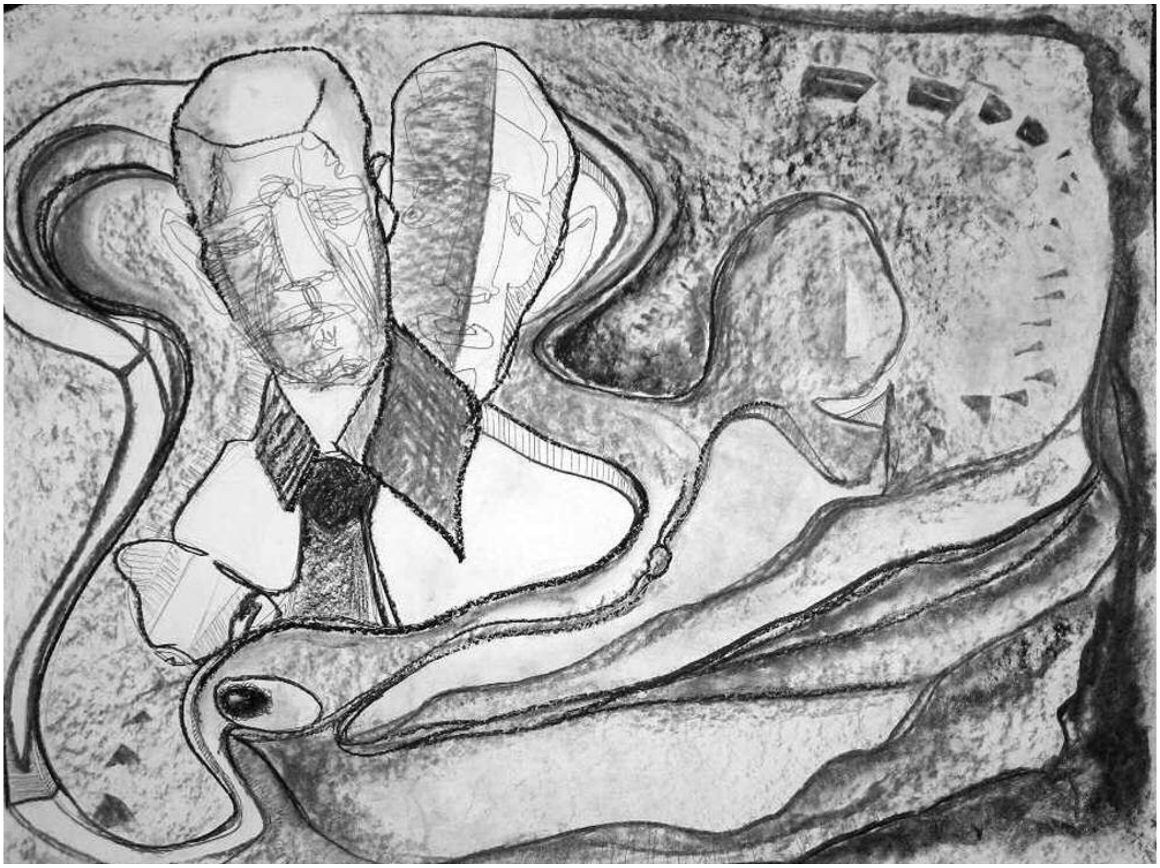


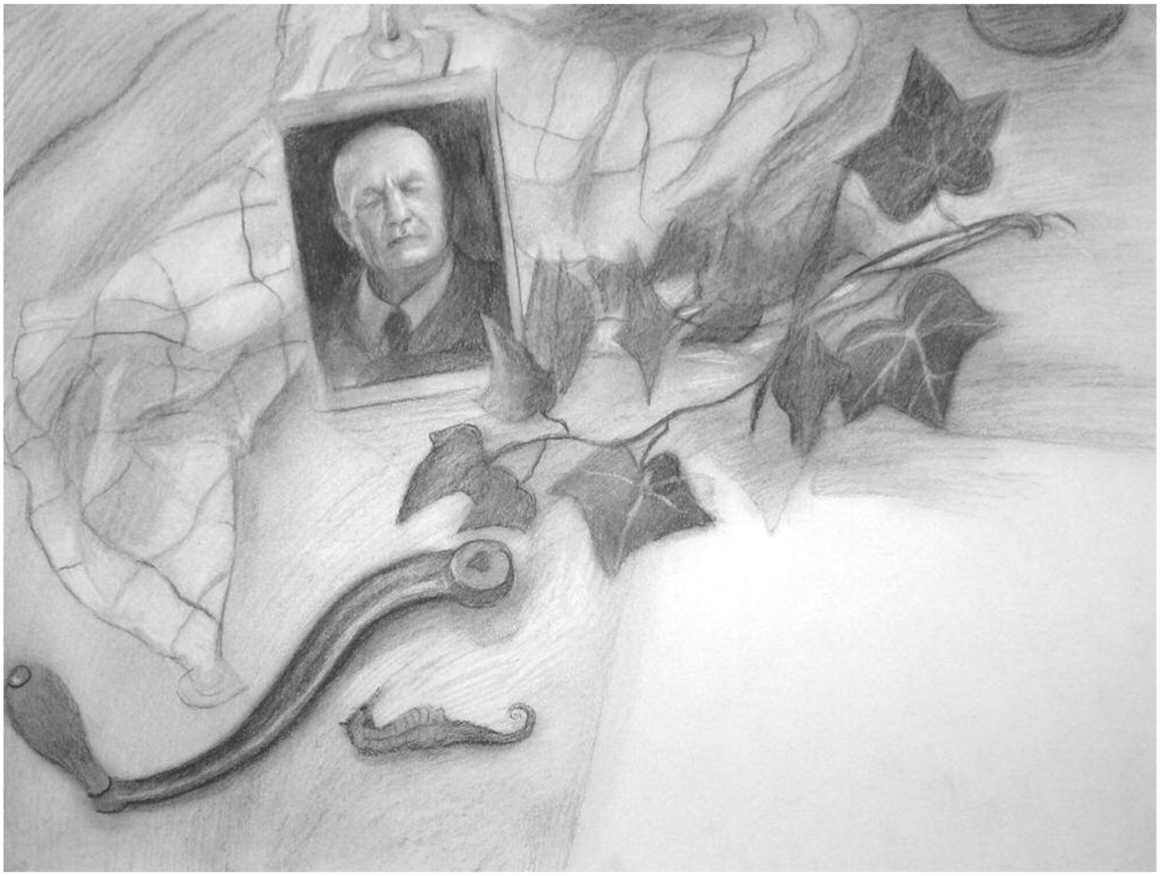


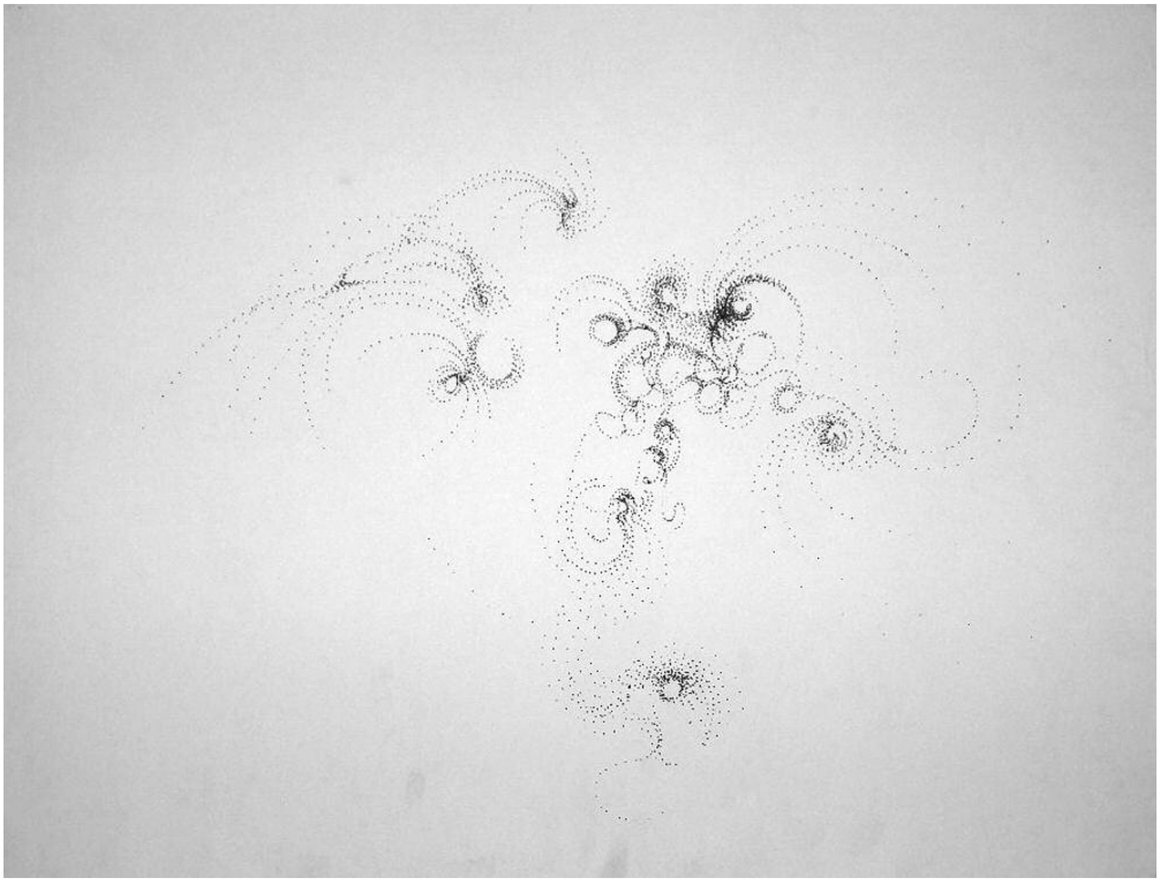


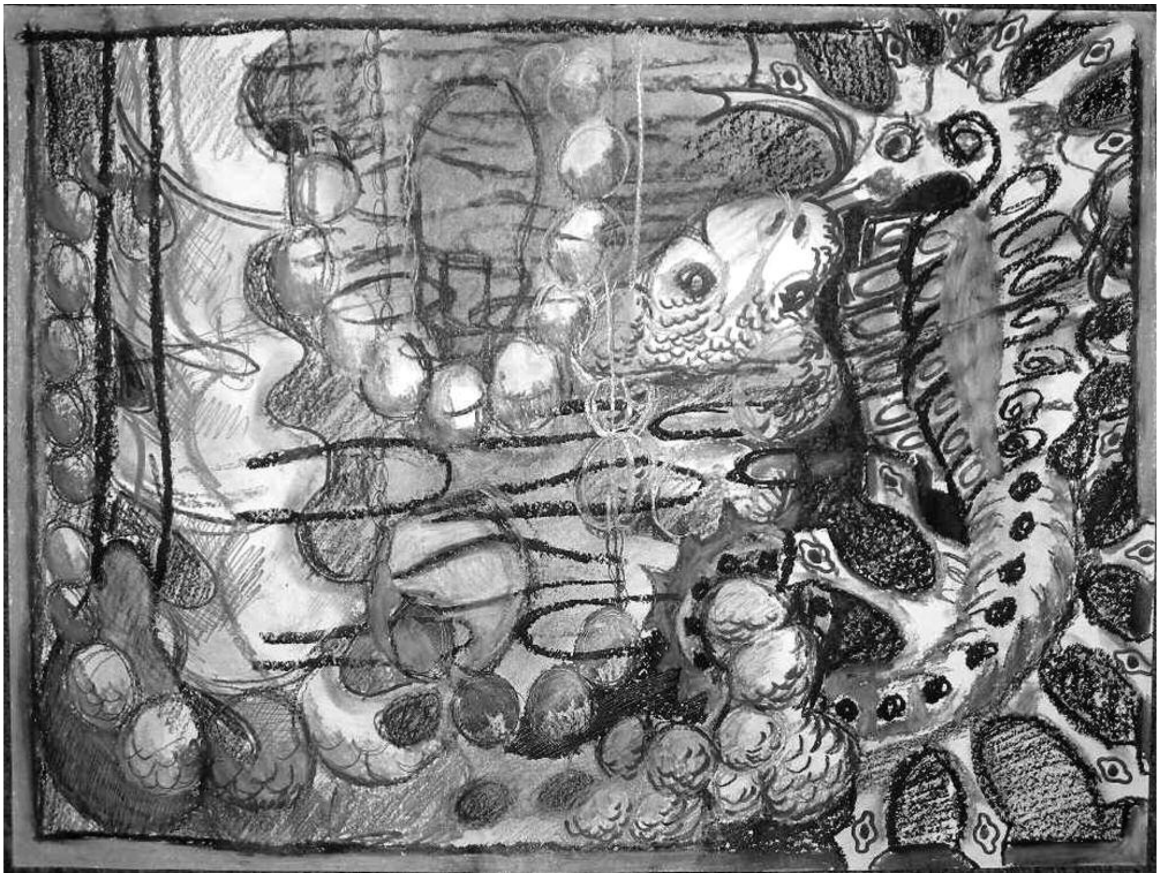


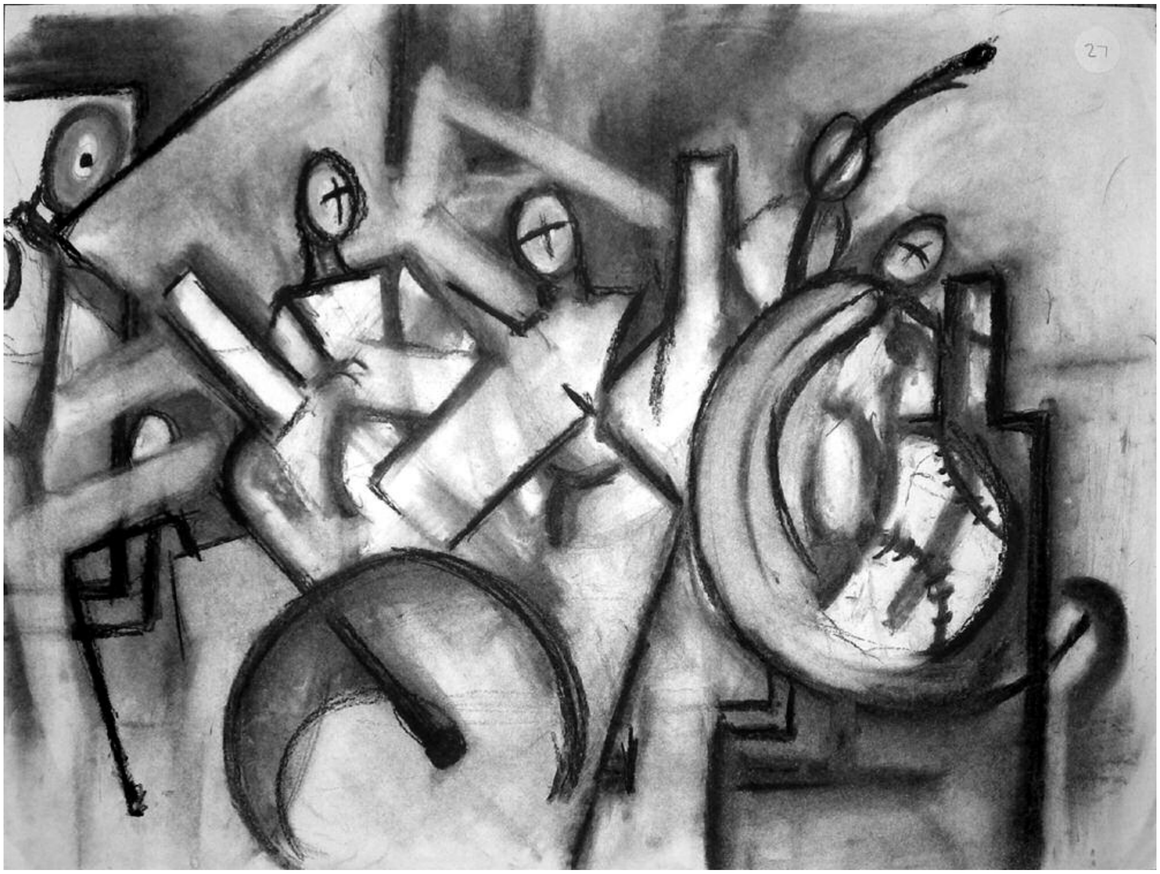








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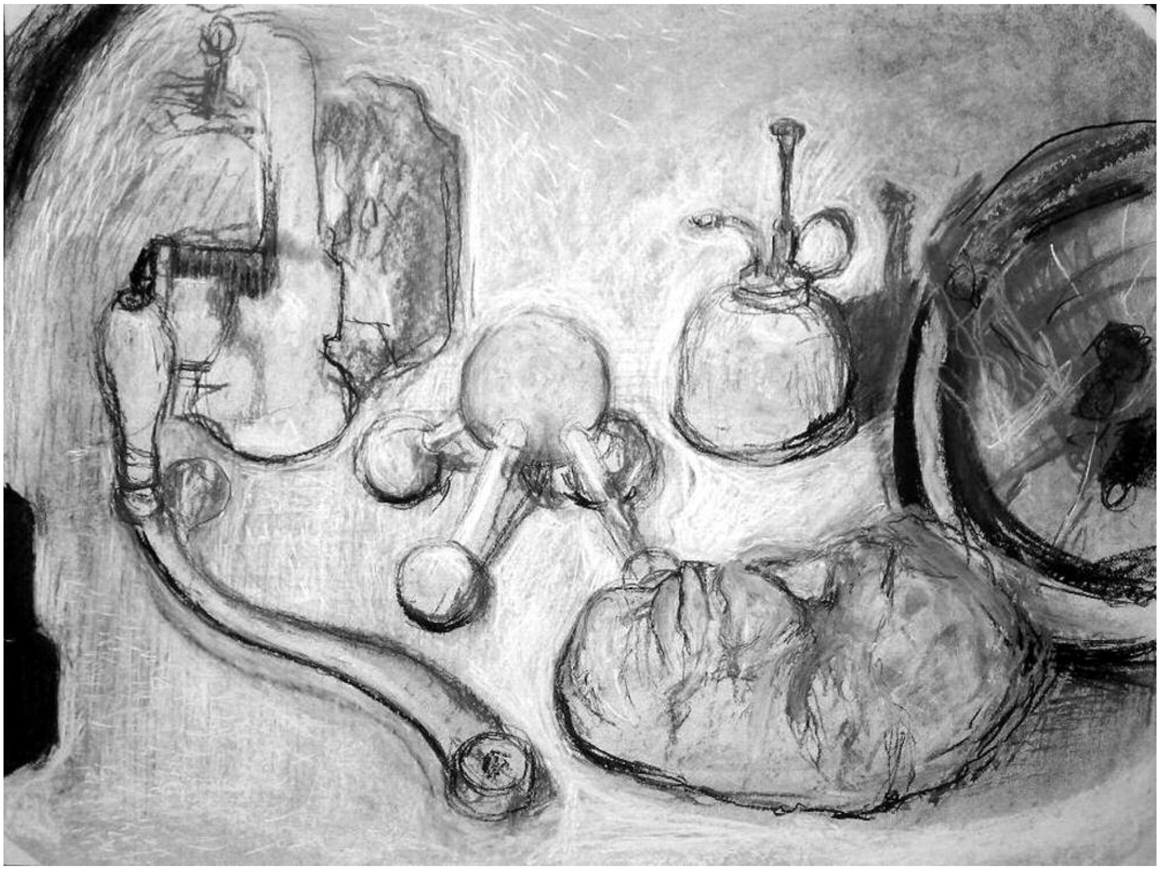
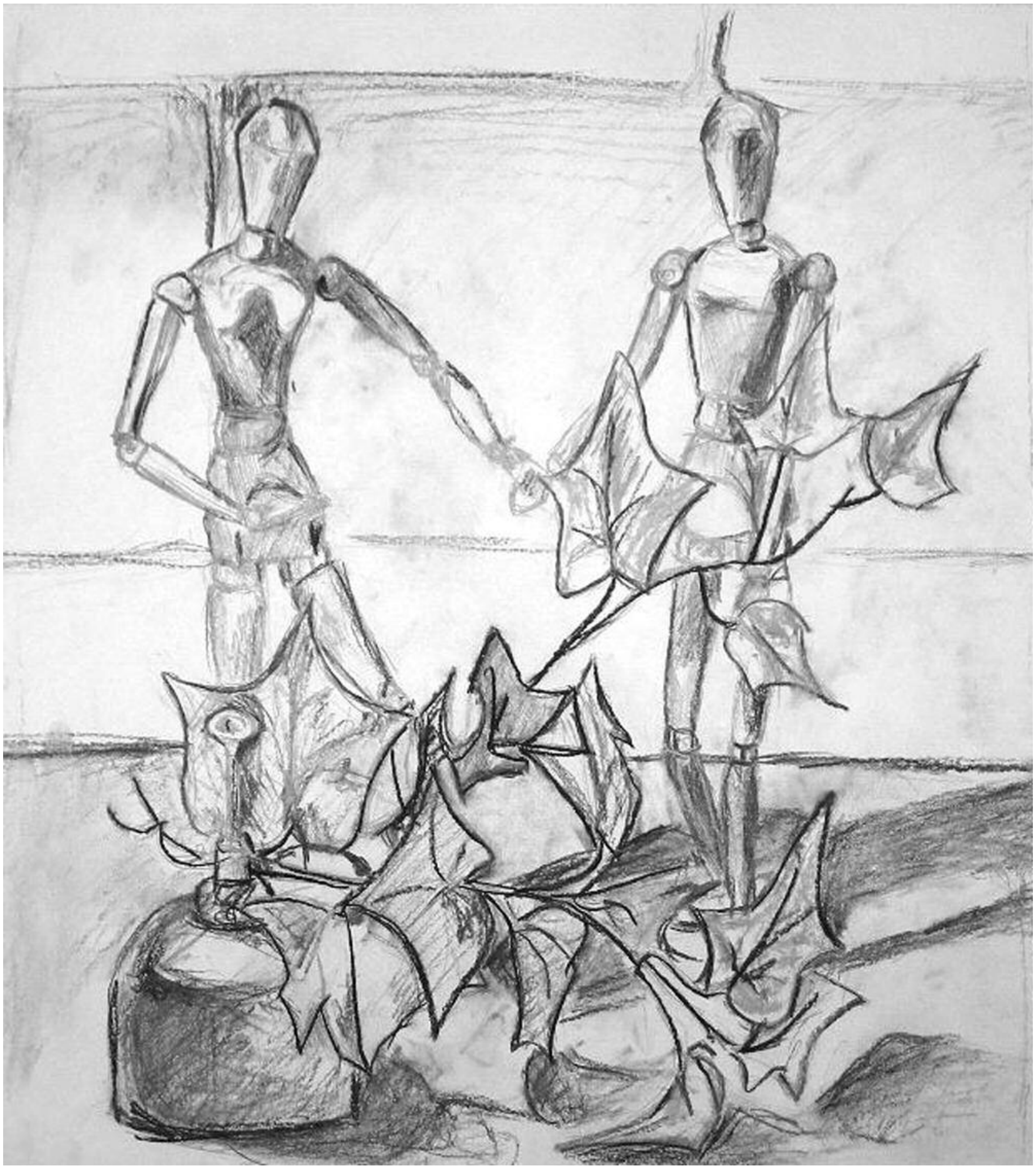
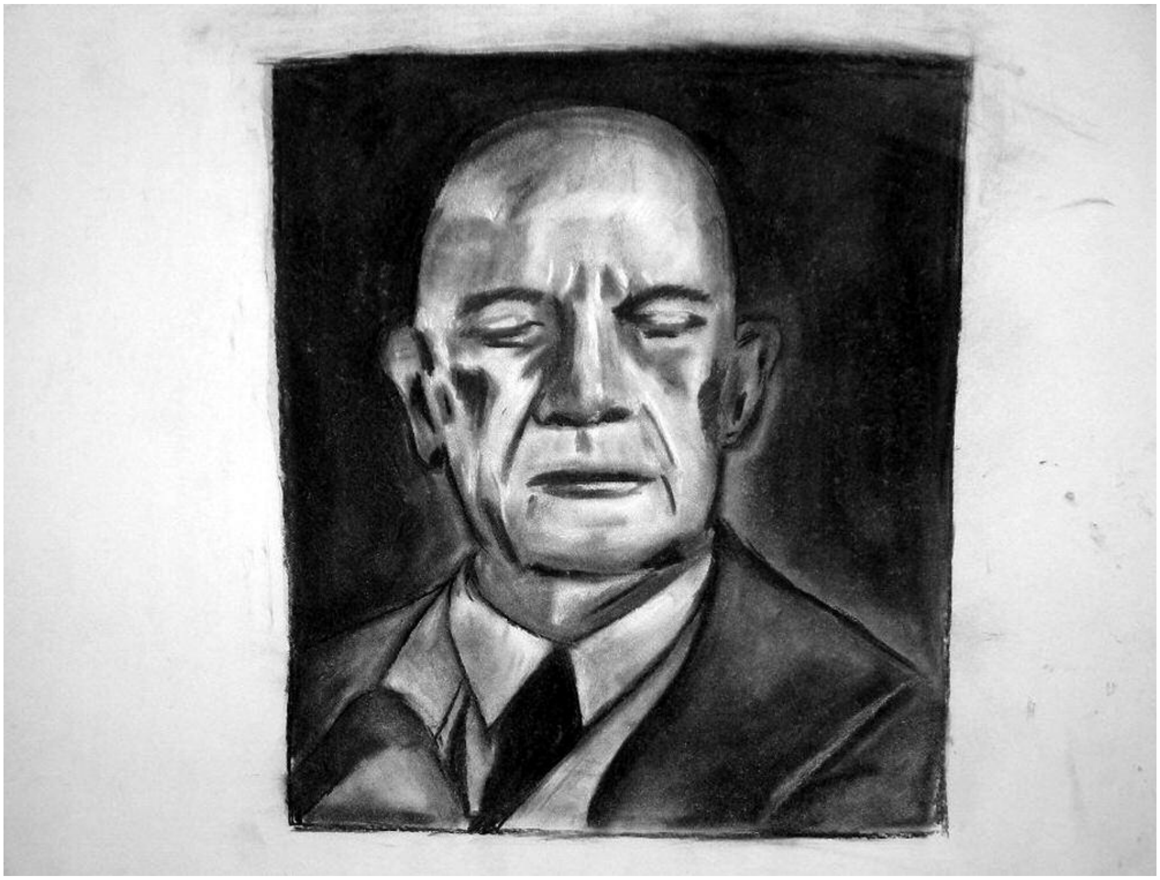
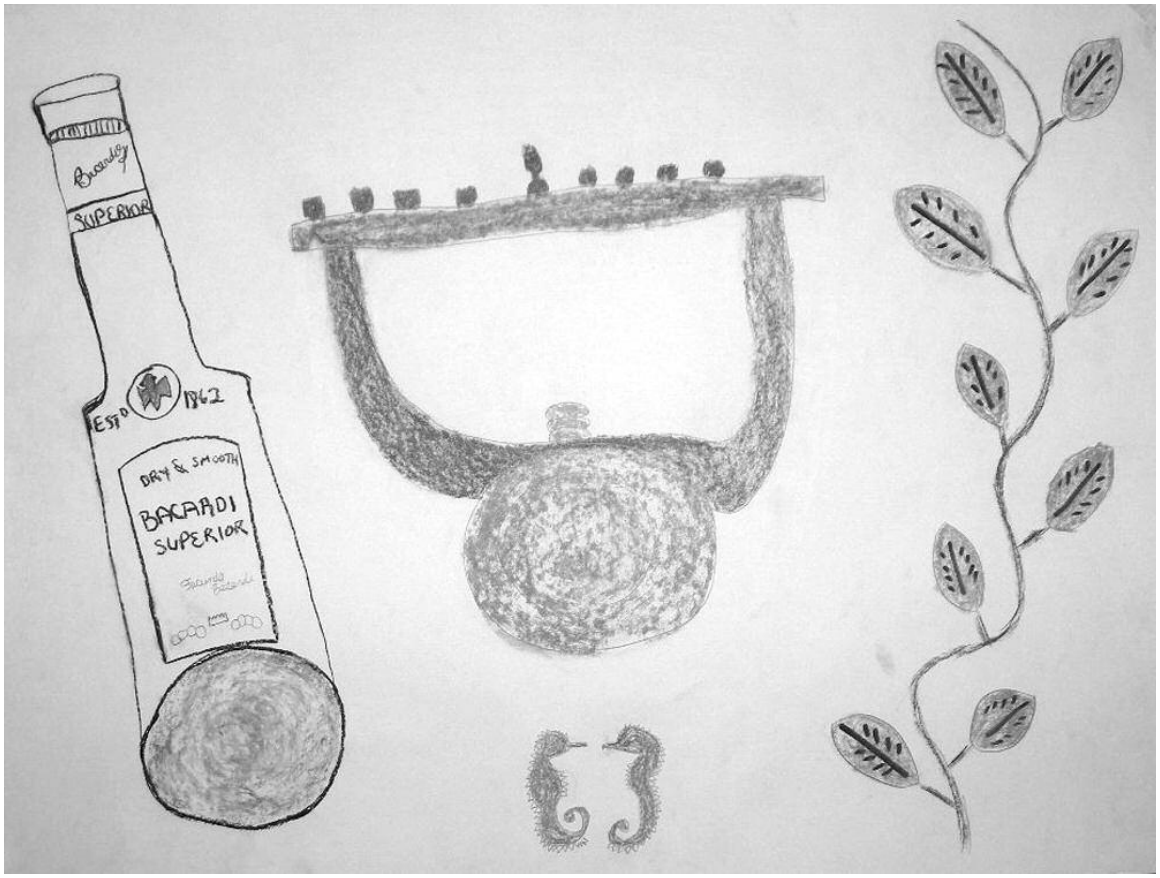
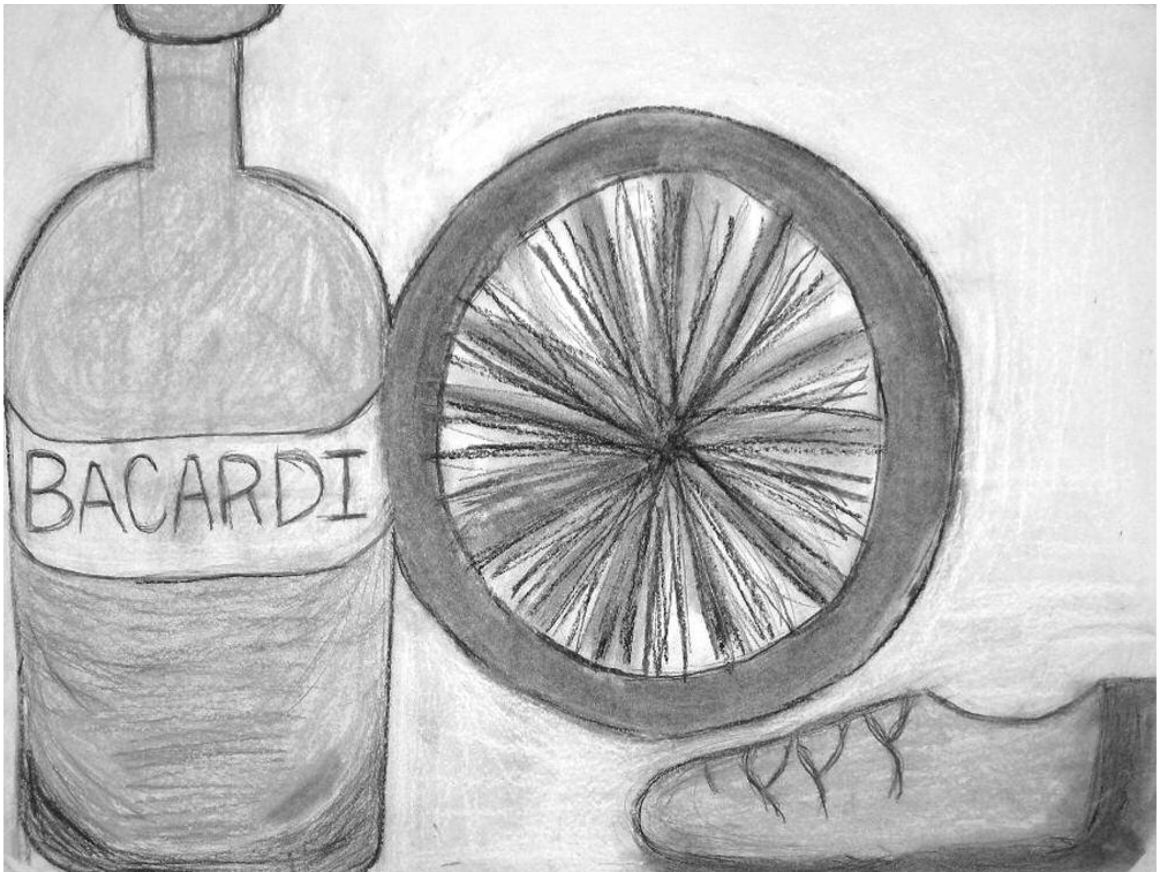


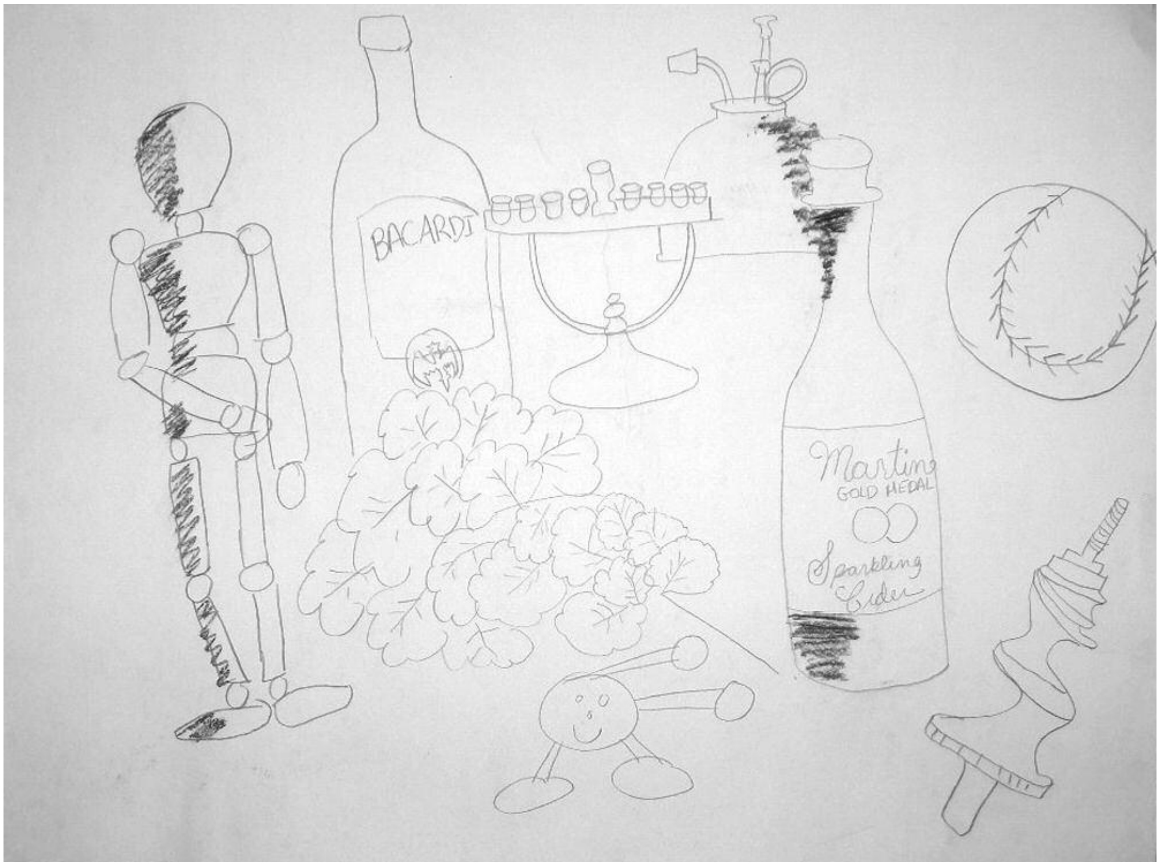


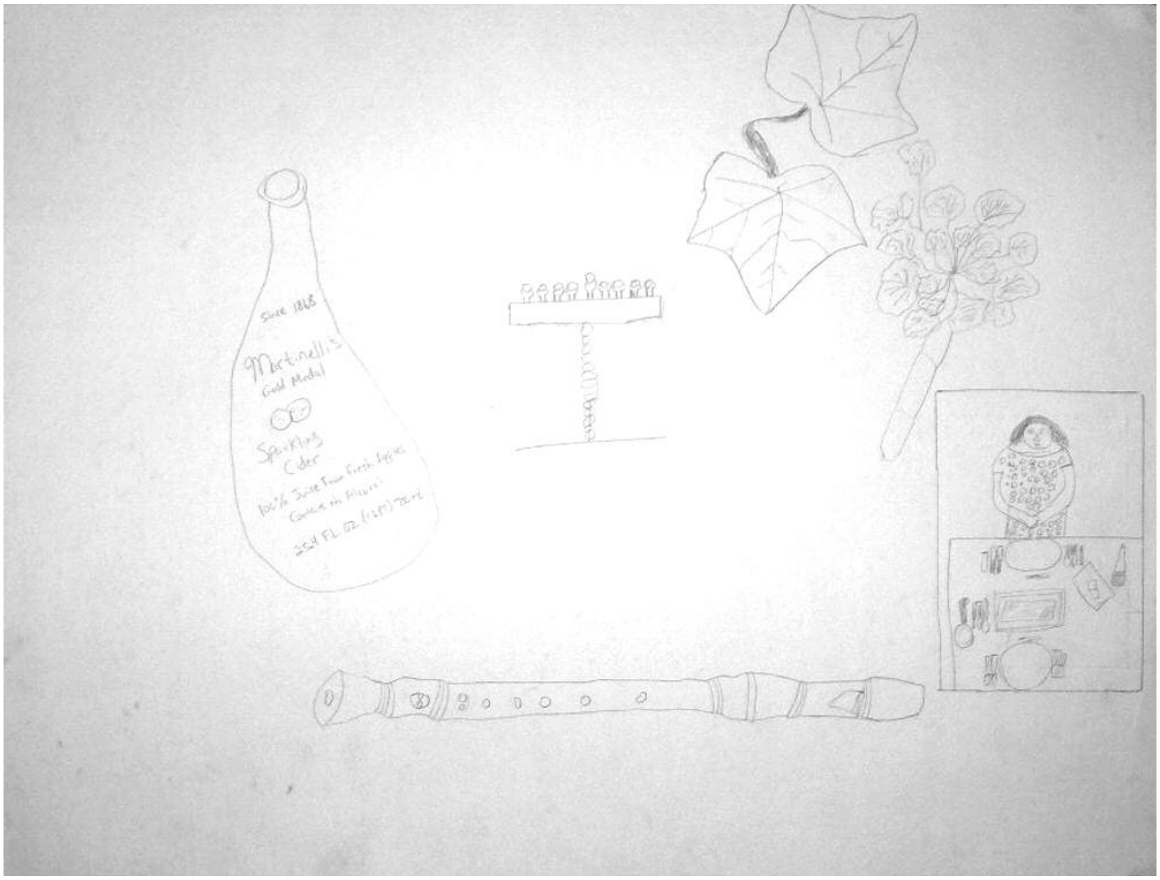


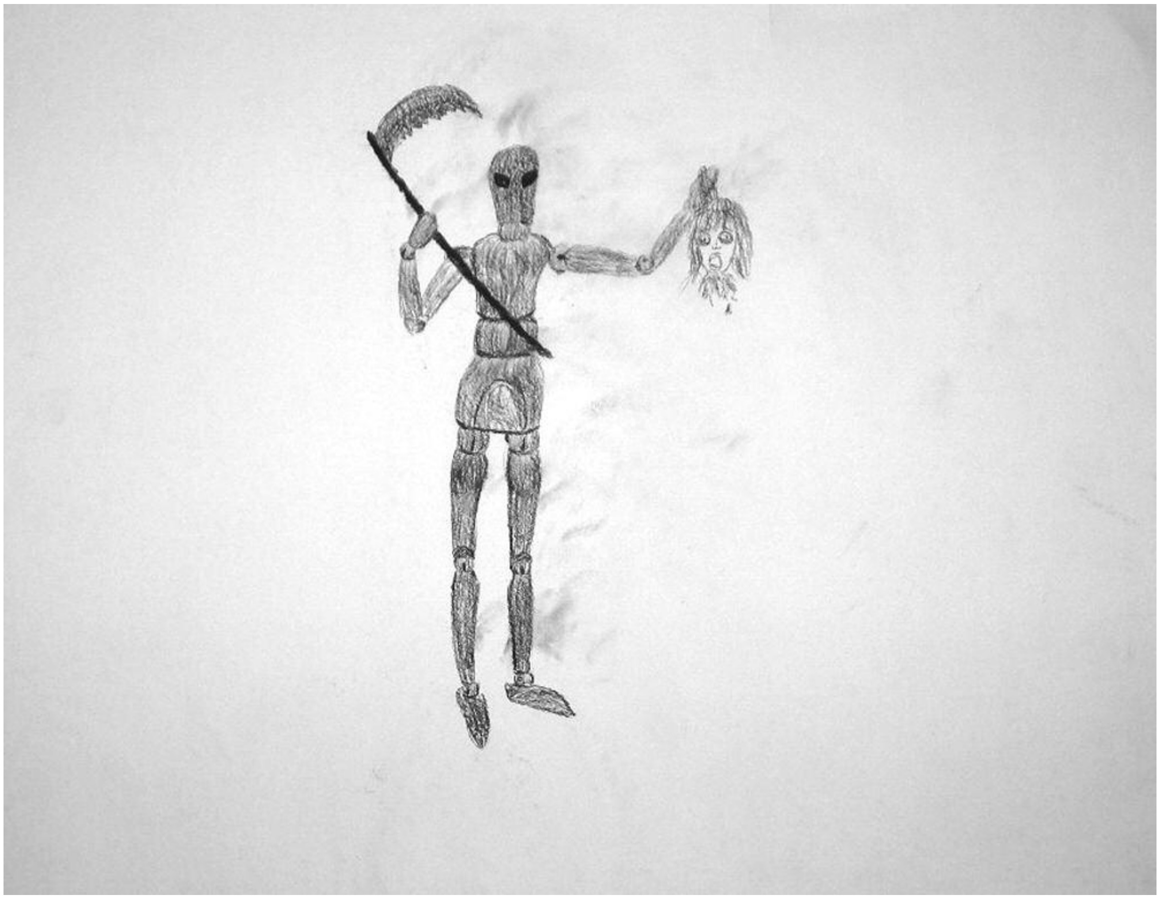
Appendix C: Examples of Low-Rated Drawings (all done by Non-artists)

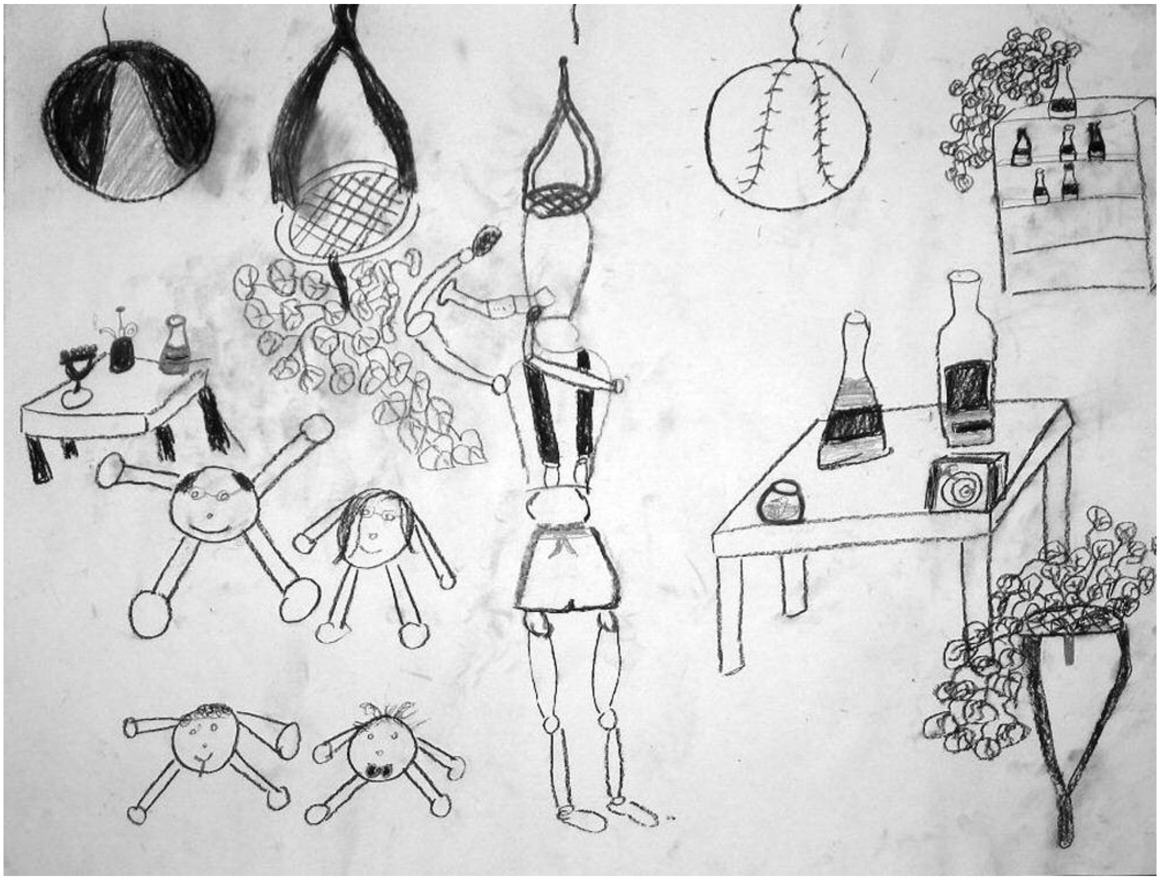

SUPERIOR
ESTD 1862
DRY & SMOOTH
BACARDI
SUPERIOR

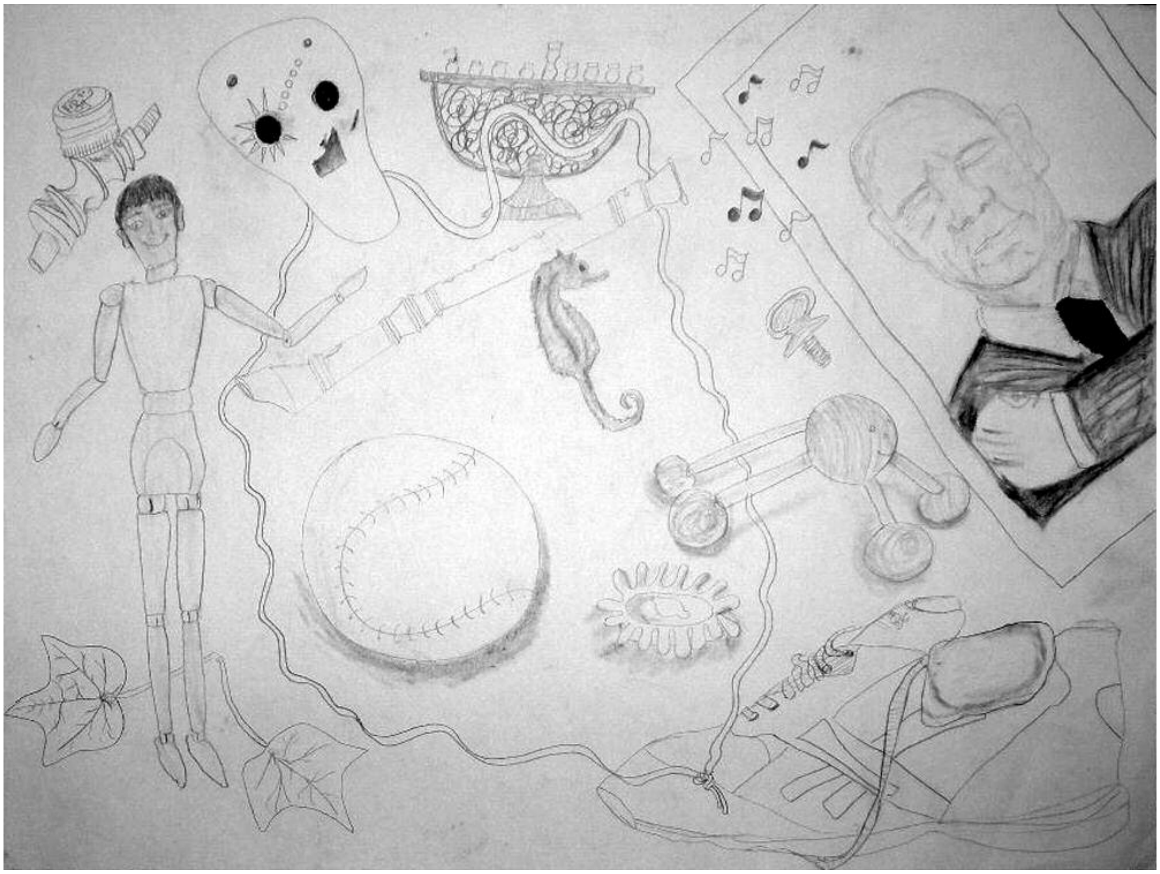

BACARDI

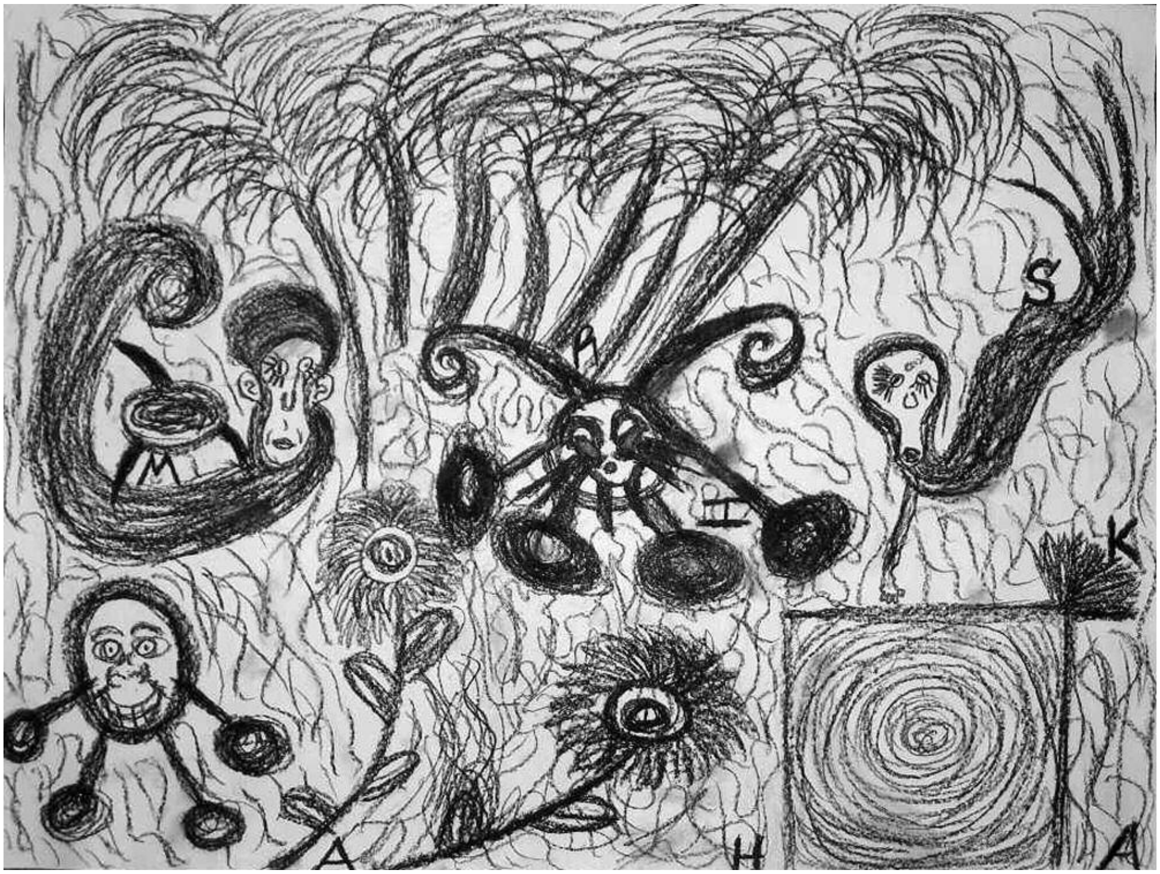

BACARDI
Martine
GOLD MEDAL
Sparkling
Cider


Since 1868
Martinelli's
Gold Medal
Sparkling
Cider








M
S
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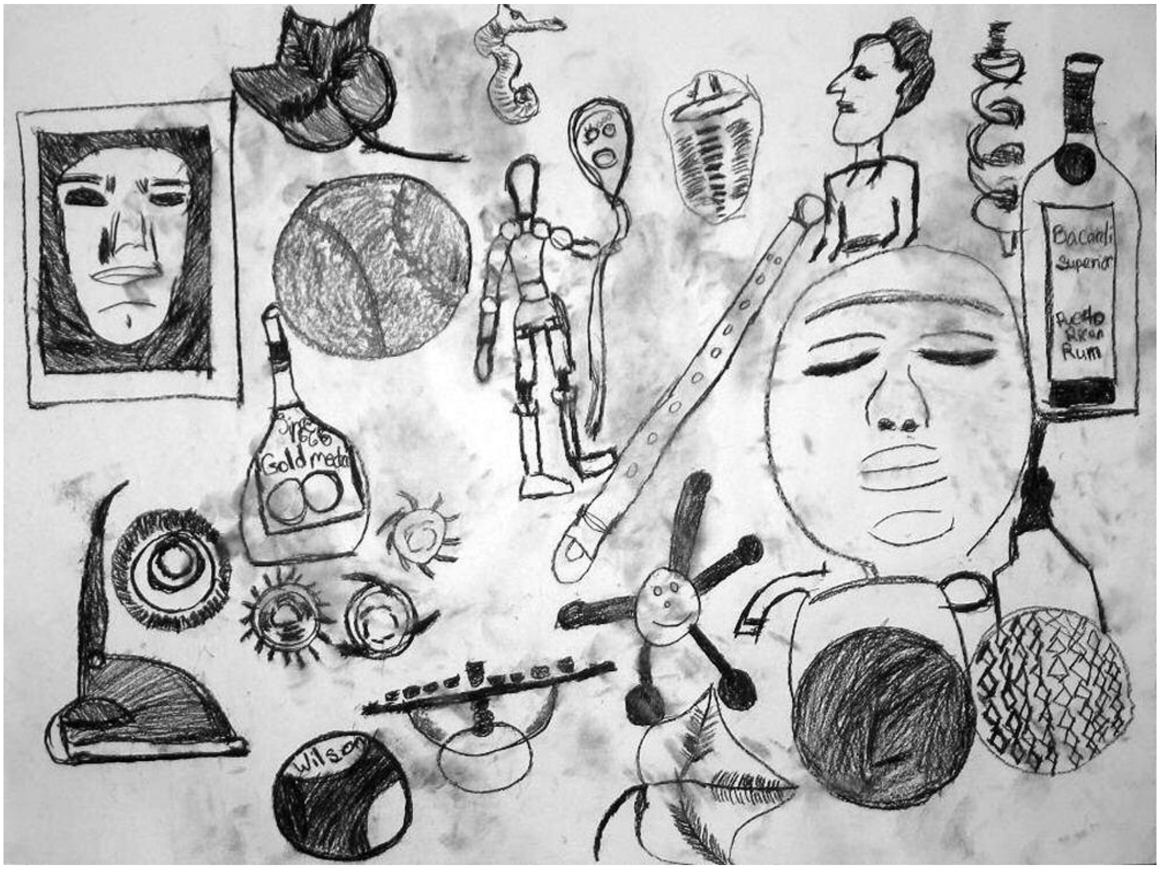
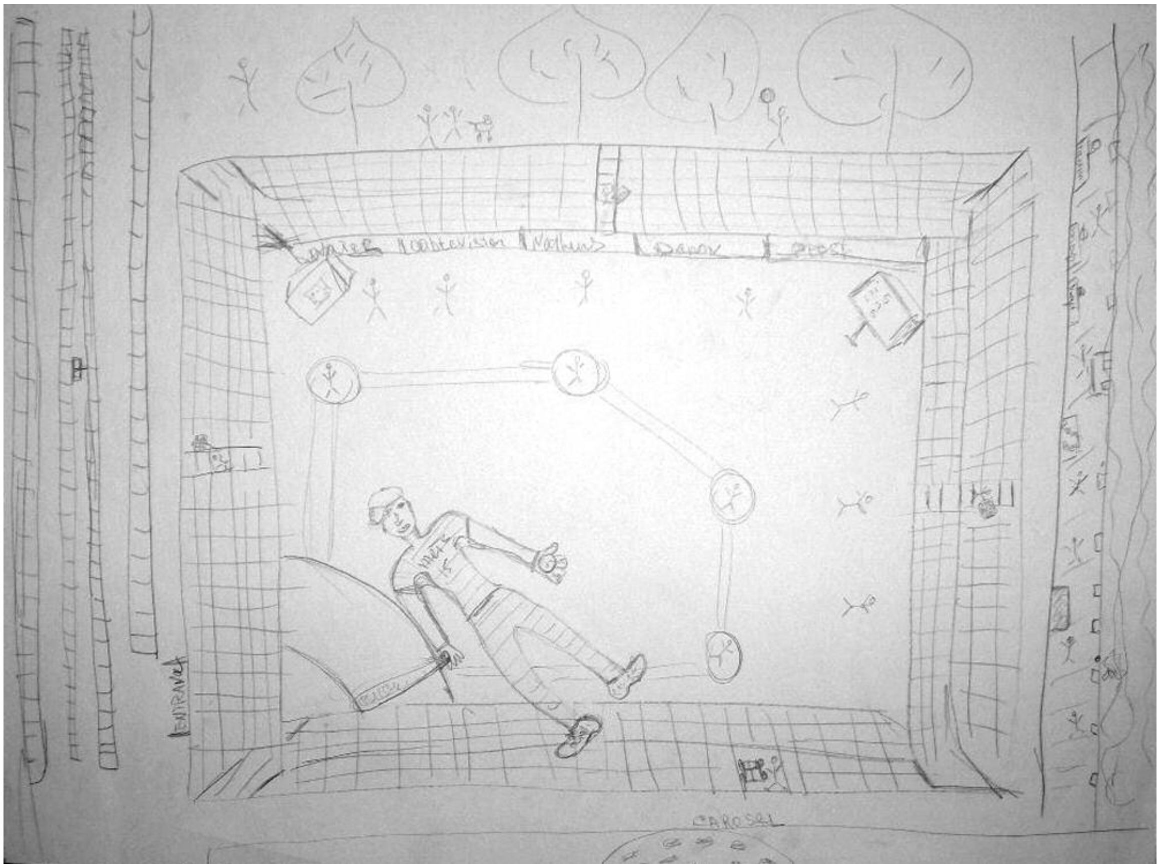
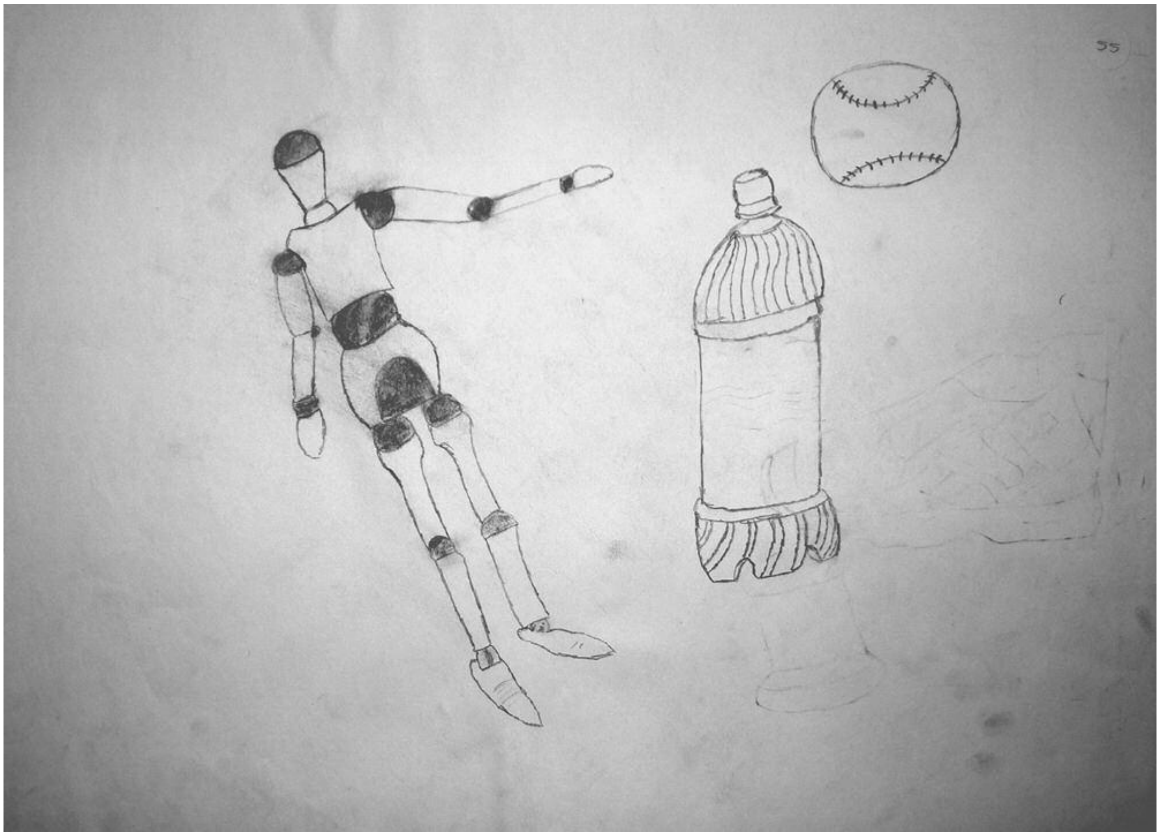
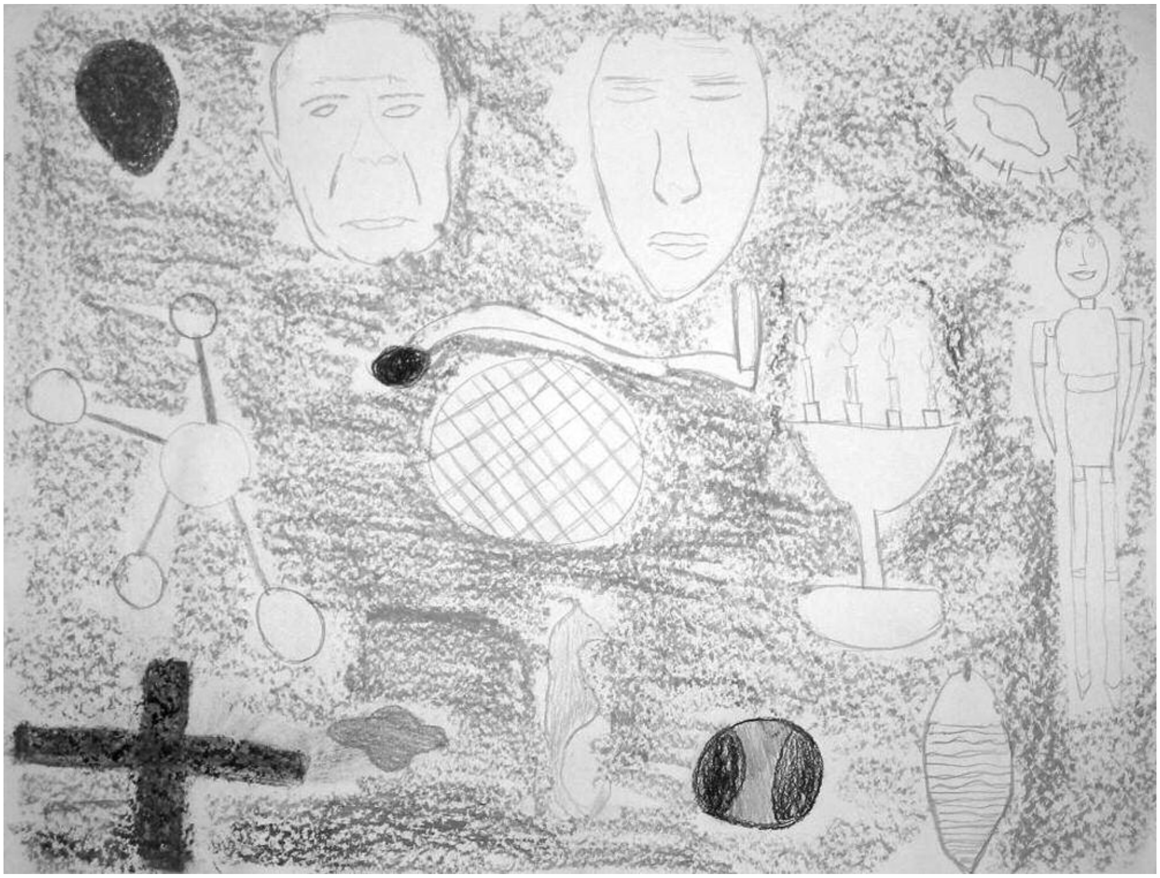
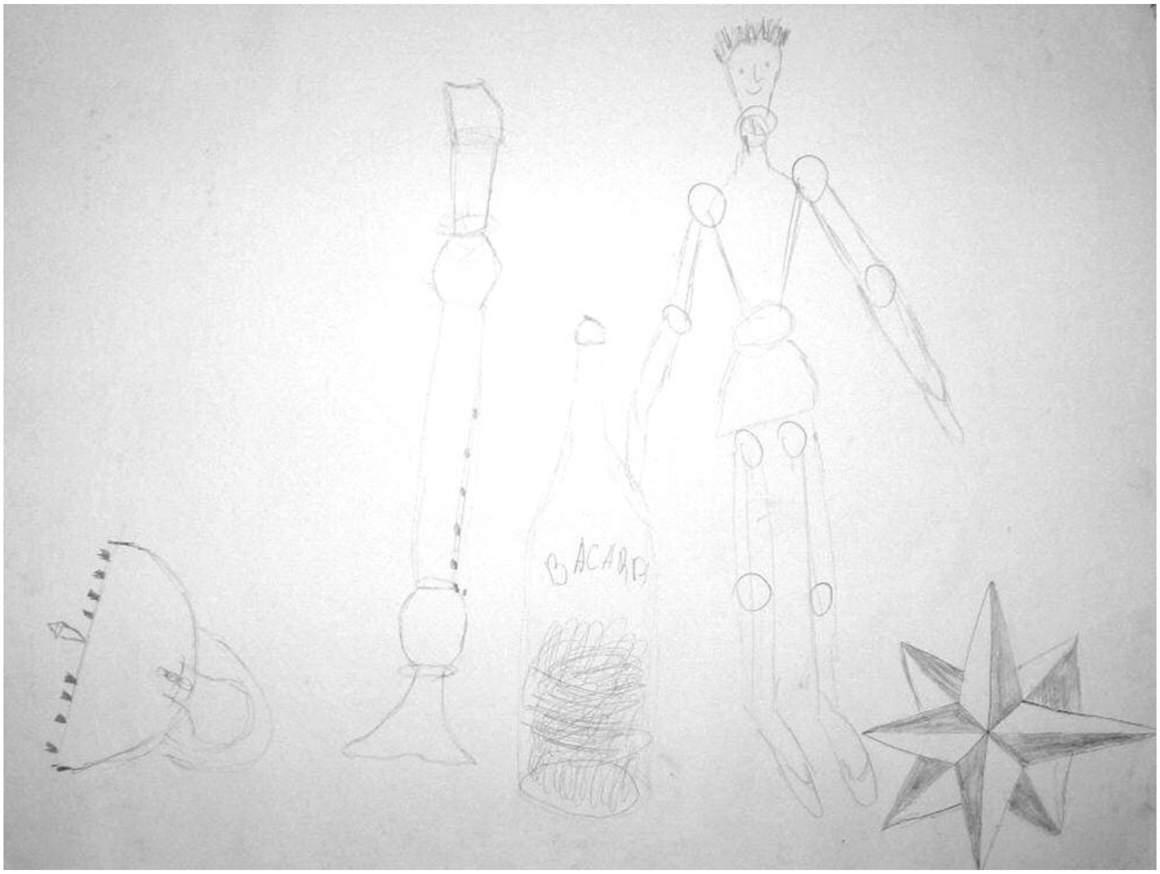
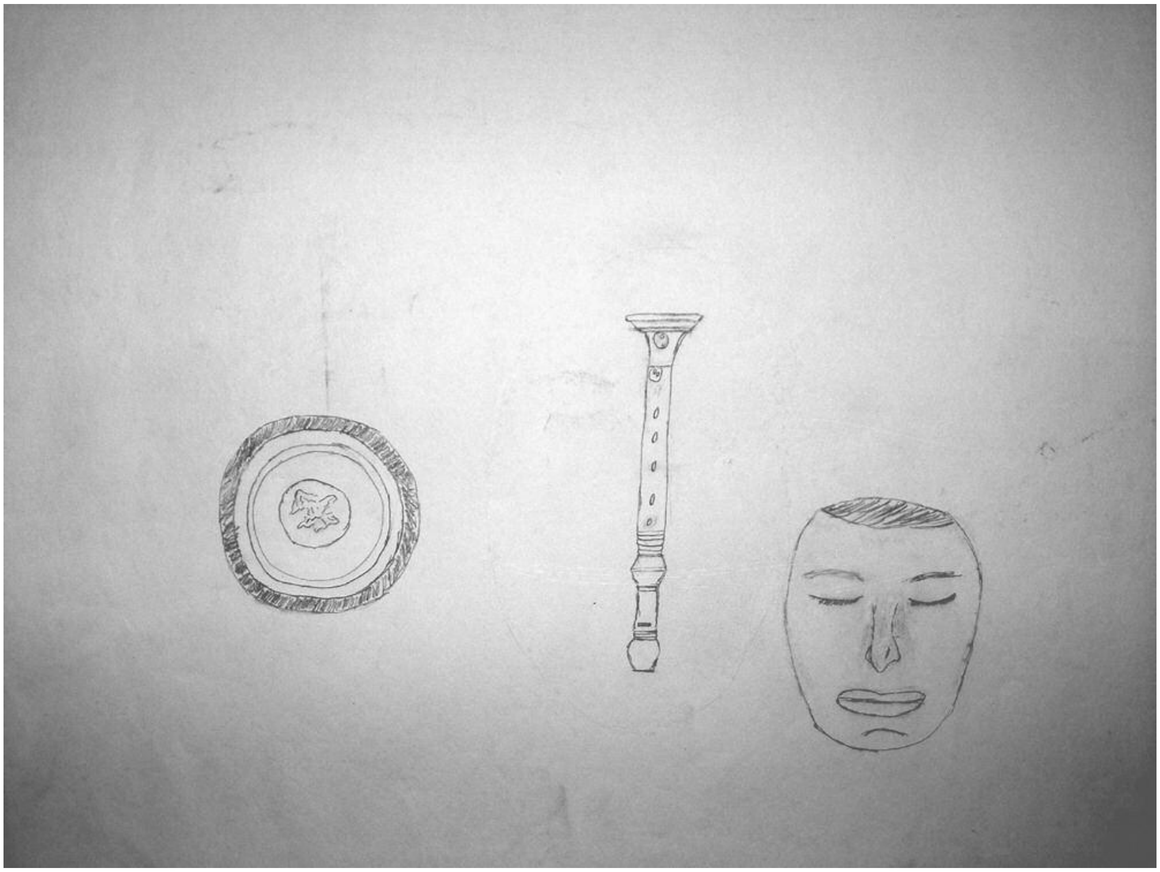

Bacardi
Superior
Rum
Gold medal
Wilson

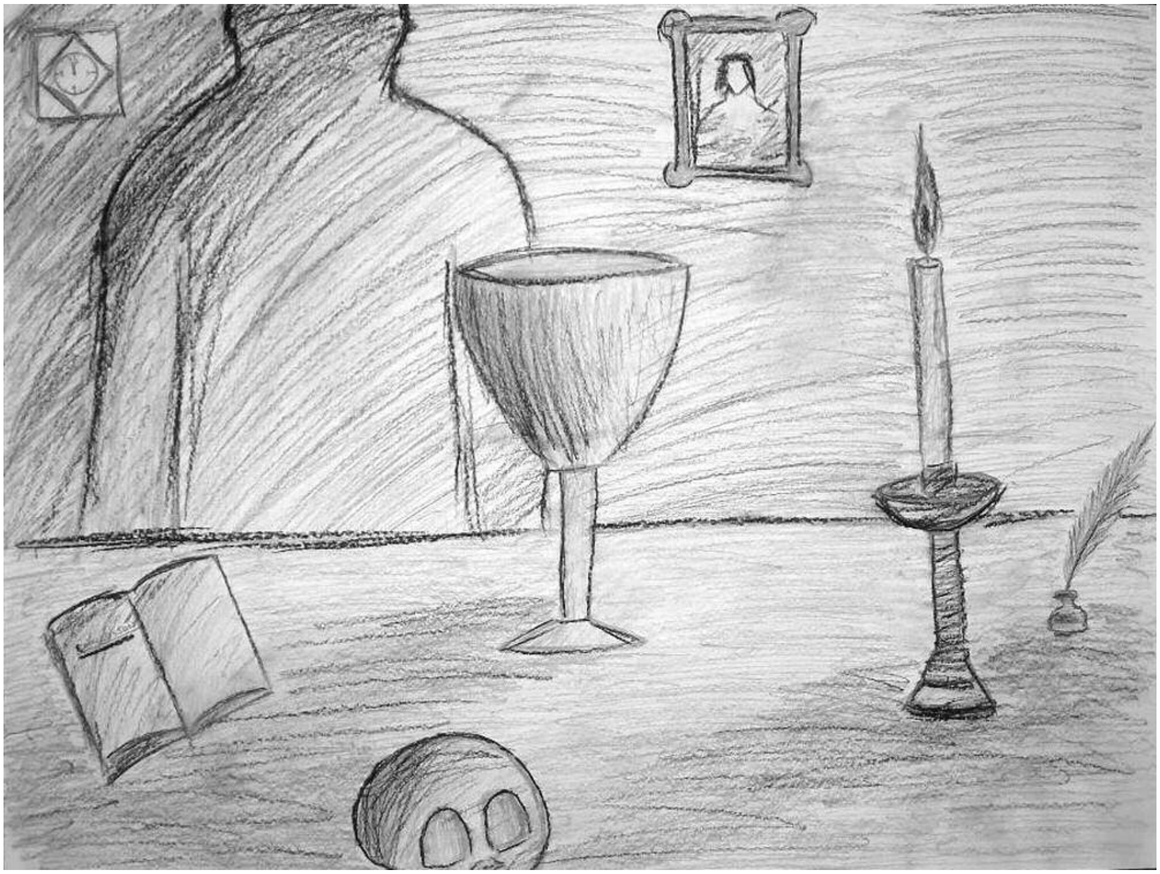

WATER
ENTRANCE
CAROSEL

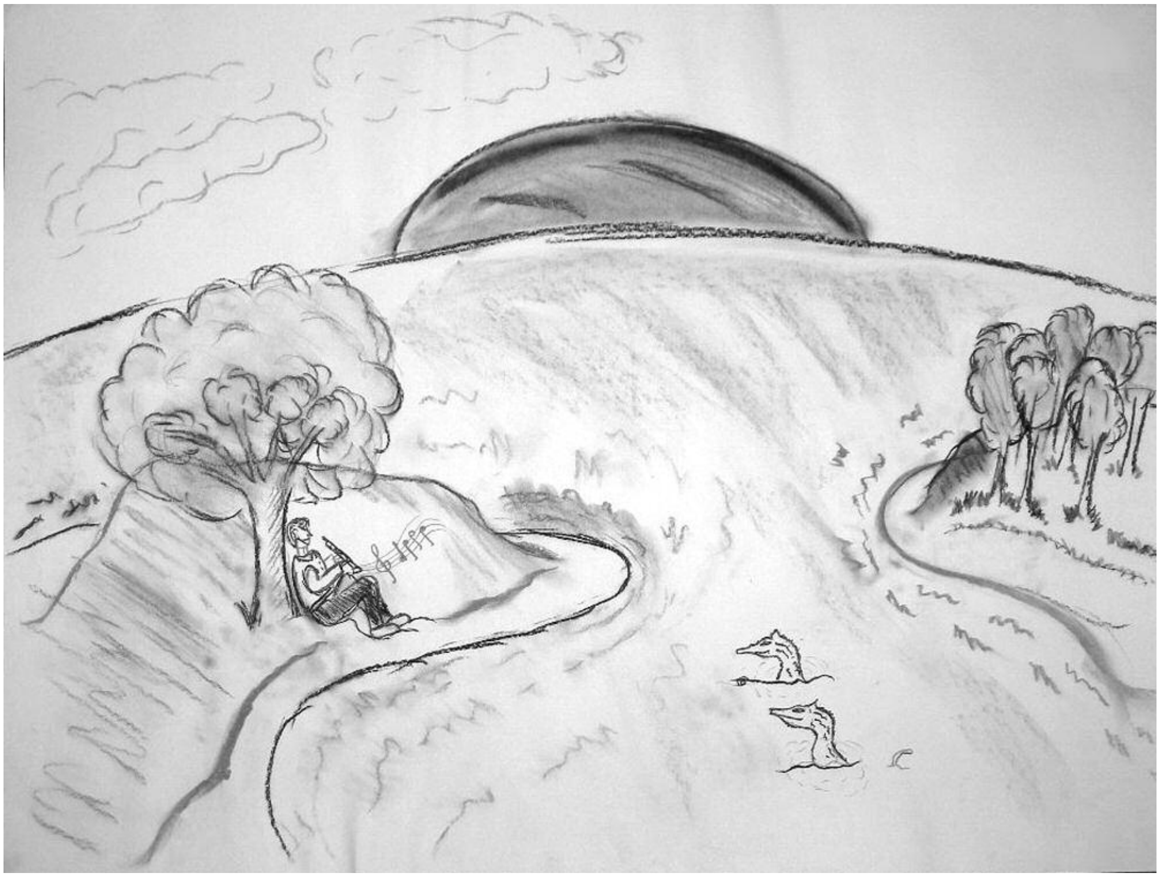


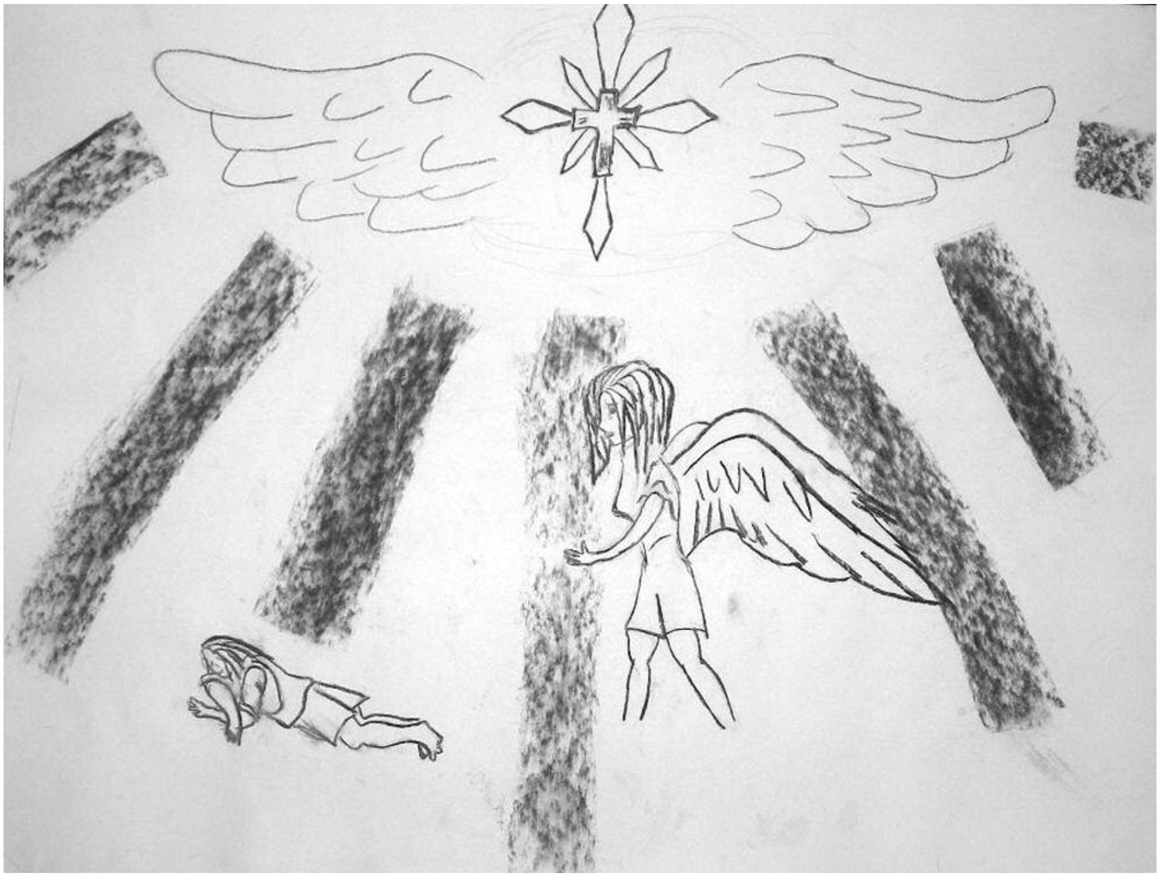


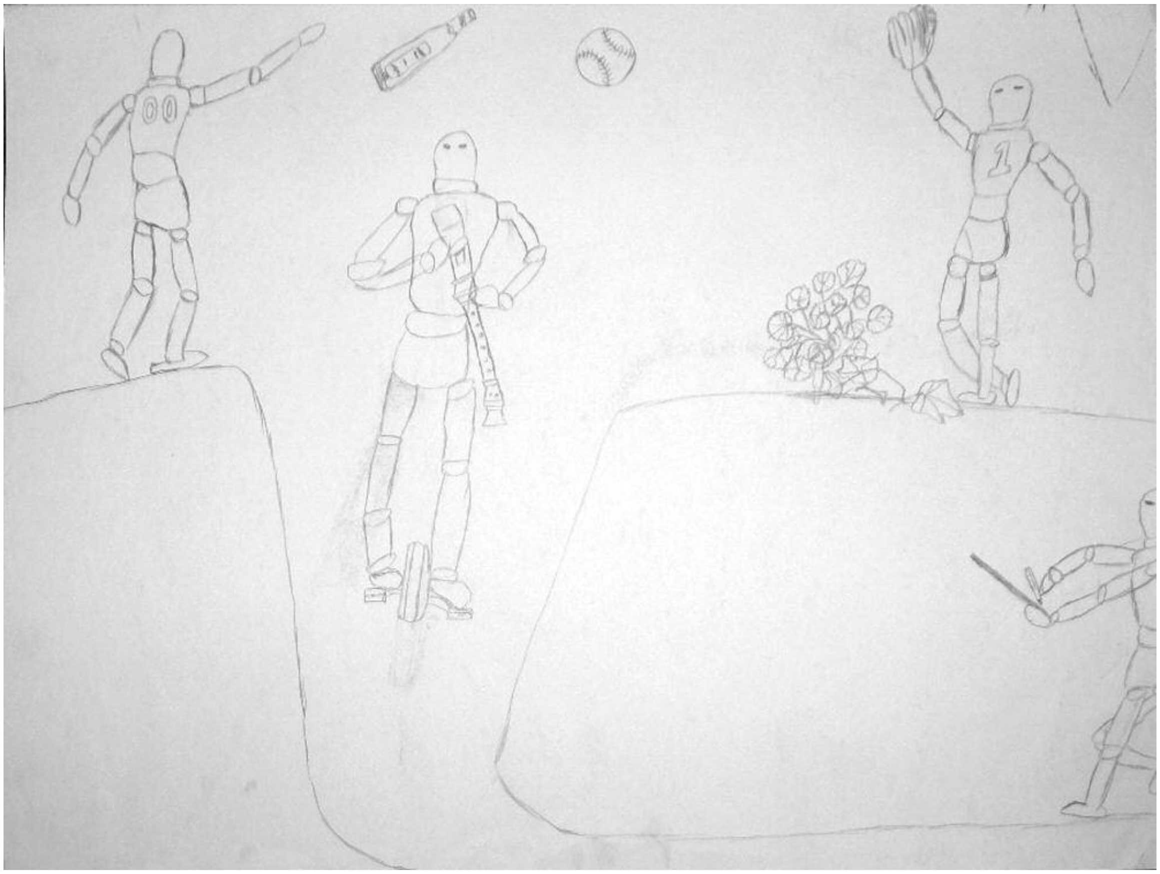












Appendix D: Drawing Evaluation Form

Age: ______________ Gender: ______________

Instructions: Please rate each drawing by circling the number that you feel best describes each drawing for each of the three questions. There are no correct or incorrect answers.

	Overall Quality Low High	Originality Low High	Technical Skill Low High
Drawing #1	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #2	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #3	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #4	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #5	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #7	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #8	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #9	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #10	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #11	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #12	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #13	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #14	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #15	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #16	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #17	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #18	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #19	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #20	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #21	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #22	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #23	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #24	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #25	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #26	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #27	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #28	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #29	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #30	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #31	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #32	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #33	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #34	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #35	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #36	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

Instructions: Please rate each drawing by circling the number that you feel best describes each drawing for each of the three questions. There are no correct or incorrect answers.

	Overall Quality Low High	Originality Low High	Technical Skill Low High
Drawing #37	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #38	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #39	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #40	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #41	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #42	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #43	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #44	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #45	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #46	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #47	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #48	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #49	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #50	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #51	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #52	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #53	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #54	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #55	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #56	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #57	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #58	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #59	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #60	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #61	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #62	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #63	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #64	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #65	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #66	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #67	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #68	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #69	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #70	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Drawing #71	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

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