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Adam J. Freedman
Macalester College, freedman.adamj@gmail.com

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Adam J. Freedman

Macalester College

Advisor: Professor R. Brooke Lea, Psychology

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Abstract

I investigated the importance of cognitive exposure and social interaction for group-to-individual transfer for low-and high-demonstrability tasks. I tested the hypothesis that transfer occurs for high-demonstrability tasks with or without social interaction, but transfer for low-demonstrability tasks only occurs if subjects engage in social interaction. During the transfer phase, subjects either worked in a small group, which permitted social interaction, or viewed a video of a yolked group, which only permitted the transfer of cognitive processes. Analysis of subjects' pre-post performance difference indicated that transfer is constant regardless of the level of demonstrability. However, overall transfer for the high demonstrability task exceeds transfer of the low demonstrability task.

Keywords: group-to-individual transfer, demonstrability

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Most everyone has worked in a group, whether it was in an educational, work or athletic setting. Both group work and individual work have benefits for individual development and individual and group productive abilities. Initial psychological research regarding the benefits of groups evaluated the additional productive capacity of groups over the sum of the production of the individual group members working alone. These studies illustrated a super-additive effect for several types of group work, in which the whole was greater than the sum of its parts, and were used to justify more group work in industrial and corporate settings (Page, 2007; Surowiecki, 2005).

After the documentation of the super-additive benefits of group-work on collective outcomes in empirical research (for a complete review, see Hill, 1982), studies turned to other beneficial applications of groups. In one development, studies aimed to determine if group work aided members' post-group comprehension and recall of the work material, titled "group-to-individual" transfer. Previous research in this field has been applied successfully in business and educational settings to better understand how individual group-members perform after engaging in group work and to maximize these performance gains.

1. Group-to-Individual Transfer

Several studies have provided support for group-to-individual transfer using different types of tasks and varying group sizes (Kirschner, Paas & Kirschner, 2009; Laughlin, Carey & Kerr, 2008; Stasson, Kameda, Parks, Zimmerman & Davis, 1991; for a complete review, see Laughlin, 2011). The base design of each of these studies compares the performance of an individual who works alone without any group experience (control condition) to an individual who works alone after working with a group (experimental condition). All of these studies find that both the groups and the individuals who have worked in groups outperform the individuals in the control condition who have had no group experience.

For transfer to occur, a task must be selected that permits the transfer of problem-solving techniques to individuals in an interactive group setting. Such tasks must require similar problem-solving techniques in each experimental phase. For example, if an individual were to learn to simplify fractions in a group setting, it is likely that his post-group performance on fraction simplification problems would improve because he would retain the techniques necessary to solve similar problems. However, his performance on an unrelated mathematical task, such as geometry, would likely remain constant because he did not learn this alternative skill. These sorts of tasks allow individual group-members to learn the skill necessary for solving the problem while working with the group and to retain it in subsequent trials (Laughlin, 2011). To meet this criterion, researchers tested both specific and general group-to-individual transfer. In specific group-to-individual transfer, subjects are presented with identical questions in each trial, permitting them to learn not only the skills necessary to solve the problems, but also the correct answers (e.g., Laughlin & Ellis, 1986; Laughlin & Adamopoulos, 1980). However, studies of specific group-to-individual transfer have been criticized for not evaluating individual group members' acquisition of problem-solving techniques, but instead measuring group members' ability to recall the solutions achieved by the group (Olivera & Straus, 2004). Alternatively, in cases of general group-to-individual transfer, subjects are presented with similar but not identical problems in each experimental phase, which require the application of the learned skills from previous experimental phases to solve the current problem. General group-to-individual transfer permits the researcher to dissociate memory of the learned skills with memory of the correct answer and exclusively test for transfer (e.g., Olivera & Straus, 2004).

One question that has arisen in the group-to-individual transfer literature is what processes within a group promote transfer to individuals who have worked in a group context (e.g., does social interaction between group members facilitate transfer?). Olivera and Straus (2004) evaluated the importance of both group members' social interaction with other group members and exposure to other group members' cognitive processes on group-to-individual transfer for verbal "eureka" problems, and found that exposure to a variety of cognitive processes, but not social interaction, was necessary to achieve transfer. However, Olivera and Straus propose that their results may not be generalizable to other types of tasks. The current study aimed to a) extend the research conducted by Olivera and Straus by evaluating the relative contribution of social versus cognitive processes during group-to-individual transfer and b) use tasks that vary with respect to how easily group members with the correct solution can communicate and demonstrate the general method of solving the task to other group members. The literature calls this variable demonstrability.

2. Cognitive and Social Components of Transfer

One issue that has arisen in the group-to-individual transfer literature is the types of processes through which problem-solving skills are transferred from the group context to each individual after group work. Olivera and Straus (2004) compared the relative importance of social and cognitive elements of group-to-individual transfer. In their analysis, Olivera and Straus draw their definitions of cognitive and social elements of transfer from the cooperative learning literature, which addresses the most effective formation and organization of groups in educational settings (Slavin, 1992; O'Donnell & Kelly, 1994). Olivera and Straus divide the social factors of transfer into components of group motivation and social cohesion. Group motivation refers to the individual incentives to work with and learn from the group, which is motivated by the potential collective benefits that can be achieved when the group works together. Social cohesion refers to the additional individual group member learning that is motivated by group members identifying and empathizing with one another. In contrast, they define the cognitive components of transfer as the development of each group member's cognitive processes while being exposed to others' cognitive processes during group interaction. Cognitive processes are further divided into two categories, development and elaboration. Developmental processes include the expansion of an individual group member's cognitive maps of problem solving techniques through the exposure to others' perspectives and approaches. Alternatively, elaborative processes focus on individual group members developing and changing their existing cognitive structures through social interaction such as asking questions and explaining their reasoning to other group members (Olivera & Straus, 2004).

Olivera and Straus (2004) experimentally tested the relative importance of these cognitive and social components of transfer using a highly demonstrable verbal "eureka" task. In their experiment, they included four experimental conditions: individual (control), group, video and feedback. All subjects completed three experimental phases of the verbal task, however the second phase of the experiment (the "transfer" phase) varied across the four conditions. In the individual condition, subjects completed three phases of the verbal task independently to determine the baseline performance of any individual with no exposure to the cognitive or social elements of group-to-individual transfer. In the group condition, subjects completed the second experimental phase in groups of three to permit both the cognitive and social elements of group-to-individual transfer. In the video condition, the experimenters permitted the cognitive elements of transfer while excluding the social elements of transfer by having subjects work along with a video of participants in the group condition completing the second experimental phase. In the feedback condition, subjects also worked independently, similar to the individual condition. However during the intervention phase, they received the responses of a group in the group condition to control for a possible effect arising from the exposure of subjects in the group and video conditions to more correct answers in the second phase.

To test for transfer, Olivera and Straus (2004) compared each of the participants' performance during the first and third stages. They found that, overall, participants' performance in the group and video conditions improved more than participants' performance in the individual and feedback control conditions. Additionally, they found that subjects in the group and video conditions had equivalent improvements in performance from the initial phase to the final phase. This result strongly indicates that for highly demonstrable verbal tasks the cognitive components of group-to-individual transfer addressed by Olivera and Straus are sufficient to achieve transfer, and that the social components of transfer are apparently secondary. They also found that individuals in the individual and feedback conditions exhibited equivalent learning across the three trials, which indicates that the mere exposure to more correct responses does not improve individual performance, strengthening the results of improved performance of subjects in the group and video conditions.

In the present research, I deviated from the definitions of social and cognitive elements of transfer used by Olivera and Straus (2004). Specifically, Olivera and Straus described the cognitive elements of group-to-individual transfer as the elaboration of participants' problem solving methods while working with the group and watching the video. However, in the context of their and my experimental design, the elaborative element of cognitive transfer is theoretically more of a social aspect of group-to-individual transfer, as subjects in the video condition do not have the same opportunity to elaborate and reconcile their problem solving techniques. Instead, they only have the opportunity to passively observe the group members interact. This distinction helps to theoretically and empirically disentangle the component processes of group-to-individual transfer in the group and video conditions of Olivera and Straus's experiment. Consequently, it helps us better interpret the relevant importance of the cognitive and social components of transfer for the two types of tasks included in this experiment.

3. Demonstrability

Another issue addressed in the group problem solving and group-to-individual transfer literature is the implications of the type of task the group is required to complete on group performance and group-to-individual transfer. One dimension on which the tasks vary is their degree of demonstrability. Laughlin and Ellis (1986) propose four dimensions to measure the degree of demonstrability of a task. First, group members must agree upon a verbal or mathematical system to solve the problem. Second, group members must have enough information to solve the problem. Third, group members who are not individually able to initially solve the problem must have sufficient knowledge of the problem to recognize and accept a correct solution if it is presented by one of their group members. Finally, members with the correct solution must be able and willing to communicate and demonstrate the method of achieving the solution to the problem to other group members.

To evaluate the demonstrability of a task, Laughlin and Ellis (1986) compare tasks based on the social combination processes necessary for the group to achieve a correct solution. Social combination processes are the procedures groups follow when integrating the knowledge and opinions of individual group members to form a collective group opinion. Laughlin and Ellis define each social combination process by the necessary number of group members who know and understand the correct response and are able to justify and explain their decision to others in their group prior to entering group deliberations to ensure the group selects the correct response. They consider five social combination processes for different types of tasks: majority, simple majority, equiprobability, truth-supported wins, and truth wins.

For the purposes of this study, I only considered the final two processes. Tasks have a truth wins social combination process when only one group member must know the correct response to ensure that the group selects the correct answer. Truth wins is the most accurate social combination process for math and other "Eureka" problems (Laughlin & Ellis, 1986), in which there is a universal path to solution that is accepted by all group members and yields an undeniable solution. In contrast, tasks that require at least two group members who know the correct response before joining the group deliberation support a truth-supported wins paradigm. Truth-supported wins is the most accurate social combination process for tasks involving English vocabulary (Part 1 of the Terman Concept Mastery Task; Laughlin, Kerr, Davis, Halff & Marciniak, 1975) and analogies (Laughlin & Adamopoulous, 1980). Laughlin and Ellis (1986) postulate that tasks that have a truth-supported wins social combination process are less demonstrable than those that have a truth wins process, as tasks of the former designation require a second correct group member to convince other group members of the correct solution due to the less explicit path to solution. During the additional elaboration and explanation of the correct answer on these types of tasks, group members who did not initially have the correct answer have an opportunity to propose their solution and justification for their answer when interacting with the group, and receive feedback enabling them to understand the correct answer. Alternatively, due to the agreement on a highly defined method to reach a solution for high demonstrability tasks, the elaboration of group members with an incorrect answer is not necessary for transfer and is not likely to occur.

In this experiment, I replicated the study executed by Olivera and Straus (2004), however I varied demonstrability by using two sets of tasks, mathematics problems that have a high degree of demonstrability and verbal analogies that have a low degree of demonstrability. I aimed to determine if Olivera and Straus's results do in fact apply to all types of tasks as they claim, or if the relative importance of the cognitive and social elements of transfer differ across tasks of different degrees of demonstrability.

I predicted that there would be an interaction between the relative importance of social and cognitive transfer and low and high demonstrability tasks, such that low demonstrability tasks require more social interaction than high demonstrability tasks to achieve transfer. I anticipated this interaction would occur due to the greater elaboration of group members' problem-solving methods that is more helpful during group deliberations for a low-demonstrability task than a high-demonstrability task to ensure the group selects the correct answer. Consequently, it follows that subjects' performance in the video condition will not improve on the low-demonstrability task as much as on the high-demonstrability task because these subjects will not have the opportunity to engage in active deliberations as in the group condition, but instead will only be able witness the exchange of cognitive processes.

Method

Subjects

The subjects were 78 students at Macalester College who participated to fulfill a class requirement or volunteered to complete the study in return for a nominal amount of candy. Due to the verbal nature of the activity, only native English speakers were invited to participate.

Design

The experiment used a 2 X 3 mixed design. The level of demonstrability of the experimental tasks (high vs. low) was a within-subjects variable, and transfer condition (individual-individual-individual (III), individual-group-individual (IGI), or individual-video-individual (IVI)) was a between-subjects variable. In both levels of demonstrability (high and low), subjects solved 10 unique problems three times, in one of the transfer conditions, III, IGI, or IVI (see Table 1). To summarize, each subject completed 60 problems (10 problems per phase X 3 phases X 2 levels of demonstrability). I excluded the feedback condition proposed by Olivera and Straus to control for an effect caused by subjects' exposure to more correct responses, as Olivera and Straus found no difference between this condition and the individual condition.

Materials

Two types of tasks were used in the experiment. In the high-demonstrability level, subjects completed three phases of 10 mathematical questions (adapted from Laughlin and Ellis, 1985; see Appendices A and B). In the low-demonstrability level, subjects completed three phases of 10 analogies (Burt & Bader, 1982; see Appendices B and C). The mathematical questions and analogies used in the experiment were selected to permit general group-to-individual transfer between the three test phases in both levels of demonstrability (high and low). For example, in the high-demonstrability level, each of the mathematical questions relied on a specific skill, such as probability computation or fraction simplification. The specific skills required to solve each mathematical problem were common across each phase such that a participant could learn the skill and apply it to a similar task in the next phase (for the categories of these questions, see Appendix B). Similarly, in the low-demonstrability level, each of the analogies required the subject to identify a type of relationship between the words, such as noting that the words were antonyms or components of a cause and effect relationship (for the categories of these questions, see Appendix D). These relationships were constant across phases to allow the individual to learn the relationships.

Videos of individuals in the group phase of the group condition were recorded and displayed to participants on a 21.5" Apple iMac computer in the video condition during the video phase. After the group in the video selected a response, text appeared at the bottom of the video for five seconds with the question number, letter response and actual response (e.g., 5. A: Dog). The group and video conditions were yoked to control for inter-group differences. Consequently, subjects in the video condition were equally likely to watch a video of a group that had extensive or minimal discussion, and many or few correct responses on the task. Although using one video would have been significantly less resource intensive, it would have limited the natural differences in group performance and elaboration witnessed by subjects in the video condition. Videos of the groups were recorded using a high-definition digital video-recorder that was positioned directly above the table the participants were working at and focused on the hands and worksheets of the participants, similar to Olivera and Straus's (2004) methods of protecting subjects' anonymity. Subjects were provided with thick-point markers to use when being recorded to enable the viewer of the video to read their scratch work.

Procedure

Subjects were scheduled using an online program and through communication with the experimenter. They were permitted to sign up in groups of up to three subjects. Depending on the number of subjects available for each time slot, they were assigned to one of the three experimental conditions (e.g., if one or two subjects were available, they either completed the individual or video condition; if three subjects were available, they completed the group condition).

Subject(s) were then taken to separate room(s) by the researcher. When the subject(s) arrived at their respective room, they were asked to complete a consent form. The researcher then presented the subjects with a set of written instructions informing them that they would be completing 6 phases of problem sets, which would either consist of three phases of 10 math exercises followed by three phases of 10 verbal analogies or vice versa (depending on counterbalancing decided prior to subjects' arrival). The instructions also included condition-specific instructions. For copies of the instructions, please see Appendix E. Each subject was given a pencil and a worksheet with a set of 10 problems. Subjects were allowed to complete scratch-work on each worksheet. After the completion of each phase, the worksheet was collected and the worksheet for the next trial was administered. At the top of the high-demonstrability worksheets, subjects were reminded that the tasks may appear similar but are different to prevent them from copying their previous answers (see Appendix B).

Participants working alone were given 10 minutes to complete each phase of the high-demonstrability level and 10 minutes to complete each phase of the low-demonstrability level (pretesting indicated that 10 minutes were sufficient for subjects to complete the high-demonstrability task and 10 minutes were sufficient for subjects to complete the low-demonstrability task). In the individual condition, subjects were informed they would be working alone on all six tasks.

Subjects in the group condition were informed that for each level of demonstrability (high and low), they would work alone in the first phase, work in a group of three in the second phase, and work alone again in the third phase. In the group phases of the group condition, participants were told they had 10 minutes to complete each phase of the high-demonstrability level and 10 minutes to complete each phase of the low-demonstrability level (Pretesting indicated that 10 minutes were sufficient for groups to discuss the high-demonstrability task and 10 minutes were sufficient for groups to discuss the low-demonstrability task).

Subjects in the video condition were informed that for both levels of demonstrability (high and low), they would work alone in the first phase, work along with a video of a group in the second phase, and work alone in the third phase. In the video phase of the video condition, participants were informed they had as much time as the group in the video used to watch the video and select their responses. They were instructed to work along with the group in the video, but that they did not have to choose the same responses as the group in the video.

When the experiment was run for the first time, subjects were only scheduled for the group condition. This was necessary to produce an initial video of the group phase for the video condition of the yoked design. Consequently, in the last administration of the experiment, subjects were only scheduled for the video and individual conditions.

Results

The data consisted of subjects' nominal performance on the three administrations of both the low demonstrability and high demonstrability tasks. Means and standard deviations of performance across phase, condition and level of demonstrability are presented in Table 2. The data from three subjects completing the group condition were excluded because their performance in the high demonstrability intervention phase was more than two standard deviations below the mean performance of other groups. These data were omitted because they would have adversely impacted the potential transfer for the subject in the video condition that would have been assigned to watch the video of that group.

I. Preliminary Analyses

Initial analyses were required to ensure that the data are fit for exploring transfer. First and foremost, it was imperative that each of the tasks was of equal difficulty. A one-way ANOVA showed no differences across the first administration of each of the high demonstrability tests, (*M*s = 6.23 vs. 6.80 vs. 6.68 correct responses), $F(2, 72) < 1$, or for the first administration of each of the low demonstrability tests, (*M*s = 7.07 vs. 6.90 vs. 6.80 correct responses), $F(2, 72) < 1$. Additionally, it was necessary to ensure that random assignment was sufficient to control for participants' initial performance across their respective experimental conditions (individual, group, video). A one-way ANOVA showed no differences of subjects' initial performance across conditions for the high demonstrability task, (*M*s = 7.47 vs. 6.29 vs. 7.53 correct responses, respectively), $F(2, 72) = 1.21$, $p = .303$. An additional one-way ANOVA showed no differences of subjects' initial performance across conditions for the low demonstrability task, (*M*s = 6.87 vs. 6.78 vs. 7.53 correct responses, respectively), $F(2,72) = 1.26$, $p = .290$. These analyses met the necessary conditions to further evaluate the data.

II. Did Groups Outperform Individuals During the Intervention Phase?

An additional prerequisite of transfer is that individuals that work in groups outperform individuals that work individually during the intervention phase. The mean scores of each condition across both levels of demonstrability during the intervention phase are presented in Figure 1. Based on this figure, it is clear that subjects in the video and group conditions both outperformed those in the individual condition during the intervention phase of both tasks, however it is unclear whether or not there is a difference in performance between the subjects in the group and video conditions.

I conducted a 1-way ANOVA of condition (individual, group, video) on performance during the intervention phase to confirm that this condition was met. To complete this analysis I formed nominal groups of three subjects in the individual (n = 5) and video conditions (n = 5) to compare to the group scores from the group condition (n = 15). I then compared the means of each of these groups across each of the three conditions. There was a significant effect of condition for the high demonstrability task, $F(2, 24) = 9.18$, $p = .001$. Fisher's LSD revealed significant differences between the individual and group conditions (*M*s = 7.80 vs. 9.53 correct responses, respectively), $p < .001$, and individual and video conditions (*M*s = 7.80 vs. 9.07 correct responses, respectively), $p = .018$, but no significant difference between the group and video conditions, (*M*s = 9.53 vs. 9.07 correct responses, respectively), $p = .261$. These results indicate that for the high demonstrability task, subjects in the group and video conditions outperformed subjects in the individual condition during the intervention phase, however the performance of subjects in the group and video condition did not differ during the transfer phase.

An additional one-way ANOVA also revealed a significant main effect of condition for the low demonstrability task, $F(2, 24) = 4.109$, $p = .03$. These results indicate that for the low demonstrability task, performance during the intervention phase differed significantly across conditions. Fisher's LSD revealed significant differences between the individual and group conditions (*M*s = 6.80 vs. 8.13 correct responses, respectively), $p = .013$, and individual and video conditions (*M*s = 6.80 vs. 8.27 correct responses, respectively), $p = .024$, but no significant difference between the group and video conditions, (*M*s = 8.13 vs. 8.27 correct responses, respectively), $p = .790$. These results indicate that for the low demonstrability task, subjects in the group and video conditions outperformed subjects in the individual condition during the intervention phase, however the performance of subjects in the group and video condition did not differ.

III. Did Transfer Occur?

After confirming the data were appropriate for testing for transfer, we were able to begin examining whether or not transfer occurred. Figures 2 and 3 illustrate the mean performance of subjects in each condition across each of the three phases for the high and low demonstrability tasks, respectively (please note, although Figures 2 through 9 depict performance across phases as a continuous variable, the data collected are not actually continuous; a line graph was used to present the data as effectively and clearly as possible).

Figures 4 and 5 depict subjects' performance improvements in each condition from phase one to phase three for the high and low demonstrability tasks, respectively. Based on Figures 4 and 5, it is very clear that subjects' performance in the group and video conditions on the high demonstrability task improved substantially from phase one to phase three, clearly showing the transfer of skills acquired in the intervention phase. Additionally, it appears that subjects' performance in the group condition on the low demonstrability task increased less dramatically from phase one to phase three. However, it is clear that subjects' negligible performance gains on the low demonstrability task in the video condition and high demonstrability task in the individual condition are weak. It is also apparent that subjects' performance decreased from phase one to three in the low demonstrability task of the individual condition.

To test for transfer, I conducted a two-way ANOVA of condition on subjects' pretest versus posttest performance for both the high and low levels of demonstrability. The ANOVA for high demonstrability revealed a significant main effect of improvement from phase one to phase three, $F(1, 72) = 35.42$, $p < .001$, a significant interaction between improvement and condition, $F(2, 72) = 6.39$, $p = .003$, but a non-significant main effect for condition, $F(2, 72) < 1$. The significant interaction between subjects' improvement from phase one to phase three was followed by paired t-tests of subjects' improvements from phase one to phase three. Paired t-tests for subjects in the group and video conditions revealed a significant difference in performance from phase one to phase three, $t(44) = 7.054$, $p < .001$ and $t(14) = 4.379$, $p = .001$, respectively. However, the paired t-test for subjects in the individual condition revealed no significant difference in performance from phase one to phase three, $t(14) < 1$.

I conducted an additional two-way ANOVA to test for transfer in the low demonstrability condition. The ANOVA for low demonstrability revealed no significant main effect of improvement from phase one to phase three, $F(1, 72) < 1$, a non-significant interaction between improvement and condition, $F(2, 72) = 1.13$, $p = .328$, and no significant main effect of condition, $F(2, 72) = 2.112$, $p = .128$.

IV. Does Transfer Vary Across Degree of Demonstrability?

Finally, although no transfer occurred for the low demonstrability task, it is still possible that a three-way interaction occurred across demonstrability, condition and performance improvements from phase one to phase three. Figure 6 combines the information presented in Figures 4 and 5, including subjects' performance improvements across conditions and degrees of demonstrability. If subjects' performance improvements varied significantly between low demonstrability for the group and video condition, the interaction may detect that.

To test this hypothesis, I conducted a three-way ANOVA across condition, degree of demonstrability and pretest-posttest differences to test for a three-way interaction between the given variables. The ANOVA revealed a non-significant interaction between performance improvement, demonstrability and condition, $F(2, 72) = 1.29$, $p = .281$, providing no support for the hypothesized difference. However, the results revealed a main effect for pretest-posttest improvement, $F(1, 72) = 16.76$, $p < .001$, indicating that on the whole, subjects' performance improved from the first to third phase of problems across conditions and degrees of demonstrability.

The interaction between performance improvement and demonstrability was also significant, $F(1, 72) = 17.12$, $p < .001$, indicating that subjects' performance improvement was significantly greater for the high demonstrability task than the low demonstrability task. Figures 7 through 9 graphically depict this effect, illustrating performance improvement for the high and low demonstrability tasks for the individual, group, and video condition, respectively. The main effect for demonstrability, $F(1, 72) = 1.08$, $p = .303$, and interaction between demonstrability and condition, $F(2, 72) < 1$, were both non-significant.

The three-way interaction was further analyzed using two additional 2-way ANOVAs for the group and video conditions to determine if subjects' performance improvement differed between the two levels of demonstrability across the two experimental conditions. The ANOVA for the video condition revealed an interaction between performance improvement and demonstrability, $F(1, 14) = 11.485$, $p = .004$. This result indicates that, as expected, subjects' performance in the video improved more on the high demonstrability than low demonstrability task. The ANOVA for the group condition also revealed an interaction between performance improvement and demonstrability, $F(1, 44) = 17.668$, $p < .001$. This result was unexpected as the theories presented in this paper predicted that subjects in the group condition would learn equally well from the high and low demonstrability tasks. The two interactions observed in these two ANOVAs provide some explanation of why the three-way interaction was insignificant and the interaction between demonstrability and subjects' performance improvement was significant in the previous 3 x 2 ANOVA.

Discussion

As predicted, the results of the experiment support group-to-individual transfer for a high demonstrability task for both individuals exposed to others' cognitive processes and social interaction as well as individuals only exposed to the cognitive components of the group interaction. However, in contrast to the proposed hypothesis regarding transfer for the low demonstrability task, group-to-individual transfer for the low demonstrability task did not occur for the individuals in either the group or video conditions. Originally, I had predicted that although subjects in both the video and group conditions would experience the same degree of transfer for the high demonstrability task, subjects in the group condition would experience superior transfer to those in the video condition for the low demonstrability task due to the opportunity to elaborate their problem solving techniques while interacting with their group.

These results suggest that transfer may be constant across all learning conditions, whether they permit or limit exposure to cognitive and social processes. However, the degree of transfer differs across different tasks. Specifically, the results of the current experiment suggest that individuals are better able to achieve transfer for high demonstrability tasks than low demonstrability tasks, regardless of their transfer condition. These results support and strengthen Olivera and Straus's (2004) results, which indicate that only the cognitive components of group work are necessary to achieve group-to-individual transfer. Additionally, they corroborate Olivera and Straus's finding that there is no support for the importance of the social components of group work for achieving group-to-individual transfer.

Olivera and Straus recognize that the equivalent performance across conditions may be due to individuals in the video condition experiencing secondary social components of transfer, based on Bandura's (1986) theory of observational learning. The current finding provides additional support for Olivera and Straus's findings, suggesting that transfer is not as much a function of the individual's exposure to different processes during transfer, but is instead a function of the type of the task the individual is working on.

A potential explanation for the unexpected poor performance of subjects in the group condition on the low demonstrability task may be the number of individuals in the groups and the group environment. Although previous research indicates that three group members is sufficient for successfully achieving a correct response on a low demonstrability verbal task, such as analogies, group members may have not participated to the extent of their abilities for numerous reasons. One potential reason for group members' inferior performance on the low demonstrability task could be the presence of a video camera in the room. Although Olivera and Straus (2004) determined that the video camera did not impact their results by comparing the results of videotaped and non-videotaped groups, their results are not germane to low demonstrability tasks, which theoretically require the participation and elaboration of additional group members, compared to high demonstrability tasks, to achieve group-to-individual transfer. Although this effect may have also impacted the results of the high demonstrability task, the effect size is likely larger for the low demonstrability task because the low demonstrability task requires additional participation and greater elaboration from group members, which is more likely to be impeded by the presence of a camera.

Additionally, although effort was made to ensure that all the analogies were equally difficult, it is possible that a significant effect in the low-demonstrability condition was masked by varying degrees of task difficulty across the three sets of analogies. The processes of ensuring that all the analogies were of equal difficulty would have been incredibly resource intensive and beyond the scope of this project, such as undergoing analysis of word frequency. For the sake of this experiment, I decided that pretests were sufficient to gauge the relative difficulty of the selected analogies. This was not a concern for the high demonstrability tasks, as it was much easier to control for the difficulty of the tasks due to the similarity of the problems.

These results provide provocative implications for the structure and use of group work in organizations and educational settings. The result with the greatest potential significance is that transfer of high demonstrability tasks exceeds transfer of low demonstrability tasks. Although groups are frequently used in organizations to achieve maximal productive output by achieving a super-additive outcome, this result suggests that the benefit of groups may only be realized for certain types of tasks. However, it is reasonable to assume that in different contexts, for example, in which the group may function more freely with greater interaction and discourse, the benefits of group-to-individual transfer may be realized for additional types of tasks.

Additionally, it is quite interesting that working in groups does not improve transfer for either low or high demonstrability tasks over passively viewing group interaction. This result implies that in cases in which it is too expensive or resource intensive to form a group for learning purposes, group members are just as well off viewing a video of a group working as they are participating in the group.

Unfortunately, there are several limitations to the current study. One of the main weaknesses is that the results are not generalizable to organizational and educational contexts for a variety of reasons. First, the groups used in the study were formed randomly and the members had little to no expectations of working together again in the future. Group work in real-world contexts generally involves individuals who work together on a frequent basis and consequently know each other well and know how to optimize group productivity and efficiency. Additionally, individuals in real-world contexts generally are motivated by other factors, such as furthering their relationships with group members or achieving long-term efficiency, that are likely not the goals of subjects in the current study (Edmondson, 1999).

The results also have limited generalizability due to the type of tasks used in the experiment. Although it is useful to consider simple forms of low-and high-demonstrability tasks, work completed in organizational settings is generally quite different and more complex, likely leading to different outcomes. Both of these shortcomings can be addressed by doing more research inside of organizations and in educational settings.

It is also important to note various problems that arise when groups of individuals work together. One such problem is groupthink, in which group members choose one or more incorrect answers due to insufficient discussion of alternative answers. Groupthink usually occurs in groups composed of members with similar backgrounds or groups with strong interpersonal dynamics that limit discussion. When groupthink occurs, it threatens group-to-individual transfer because individual group members do not have the opportunity to elaborate their understanding of the material and may mistakenly accept an incorrect answer to a problem. Additionally, subjects may accept their group's response during the intervention phase without fully understanding how their peers reached their answers. Instead of agreeing on an incorrect solution, such as in groupthink, this issue arises when the group chooses the correct answer but not all group members understand why the answer is correct. This problem is likely evidenced in the current experiment by the decrease in performance of subjects in the group and video conditions from the intervention phase to the posttest phase of the experiment. It is reasonable to speculate that this increased performance during the intervention phase occurred because group members who did not adequately transfer the skill were able to copy the response of a group member or the group they were viewing in the video without understanding the concept.

Another valuable vein of research to pursue would evaluate the quality, style and duration of discourse used in group settings for different types of tasks that would optimize group performance and group-to-individual transfer. Although it is reasonable to surmise that organizations can promote transfer by encouraging elaborative discourse during problem solving tasks, such that individuals share their methods to solution instead of only sharing their solutions, one cannot make definitive conclusions based on the data presented in this study. It would be beneficial for future research to include quantitative and qualitative measures of discourse quality and depth, potentially by measuring the duration of group interactions or considering the number of concepts discussed.

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Table 1

Schematic of the Experiment's Design

Low-Demonstrability Condition

	Order of Phases		
Transfer Condition	Phase 1	Phase 2	Phase 3
Individual	Individual	Individual	Individual
Group	Individual	Group	Individual
Video	Individual	Video	Individual

High-Demonstrability Condition

	Order of Phases		
Transfer Condition	Phase 1	Phase 2	Phase 3
Individual	Individual	Individual	Individual
Group	Individual	Group	Individual
Video	Individual	Video	Individual

Note: Participants were randomly assigned to one of the three-transfer conditions (individual (control), group or video). All subjects completed both levels of demonstrability (high and low); the presentation order of the two levels of demonstrability were chosen in a counterbalanced fashion.

Table 2

Subjects' Mean Performance and Standard Deviations of Performance During Phases 1-3 for High and Low Demonstrability Tasks Across Conditions.

	Condition											
	Individual				Group				Video			
Level of Demonstrability	High		Low		High		Low		High		Low	
Phase	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	7.467	2.386	6.867	1.506	6.289	2.528	6.778	1.691	6.400	2.849	7.533	1.457
2	7.800	2.007	6.800	1.424	9.533	0.625	8.133	0.968	9.067	1.335	8.267	1.486
3	7.667	2.350	6.533	1.187	8.378	1.628	7.289	1.714	8.333	1.877	7.733	1.387

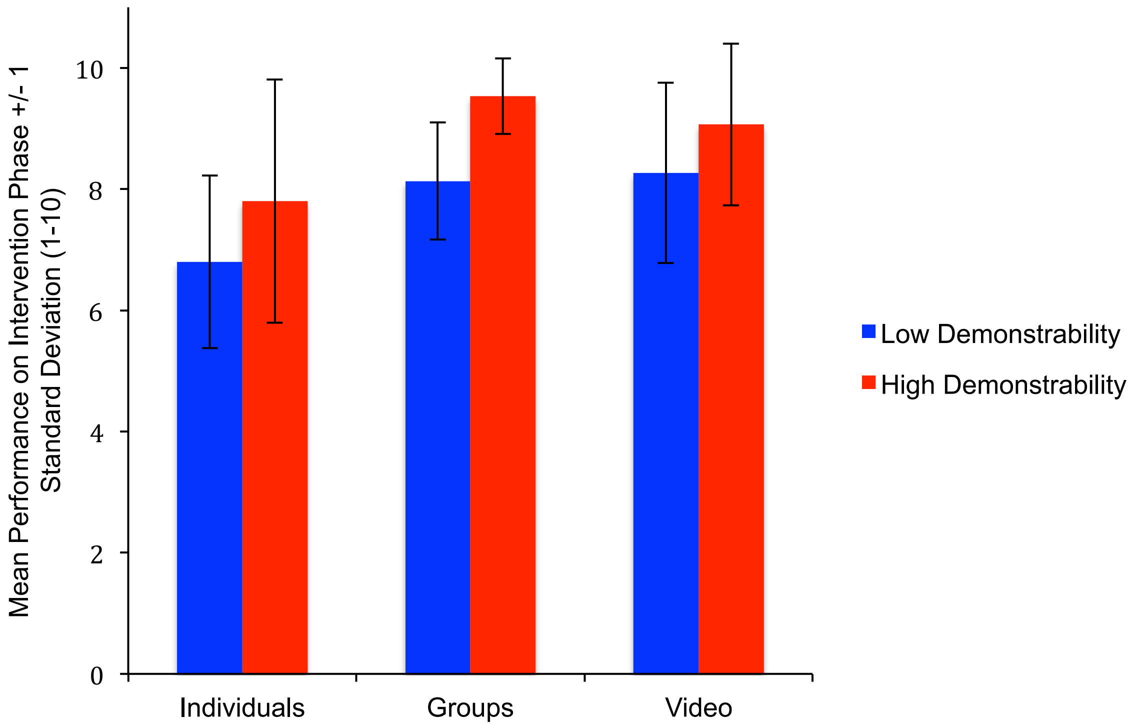

Figure 1. Subjects' mean performance +/- one standard deviation (error bars) during the intervention phase of each condition and level of demonstrability. One-way ANOVAs revealed a main effect of condition for both the high and low demonstrability tasks, $p = .001$ and .03, respectively. Post-hoc Fisher's LSD tests of the high demonstrability task revealed significant differences between the individual and group conditions, $p < .001$, and the individual and video conditions, $p = .018$, but an insignificant difference between the group and video conditions, $p = .261$. Post-hoc Fisher's LSD tests of the low demonstrability task revealed significant differences between the individual and group conditions, $p = .013$, and the individual and video conditions, $p = .024$, but an insignificant difference between the group and video conditions, $p = .790$.

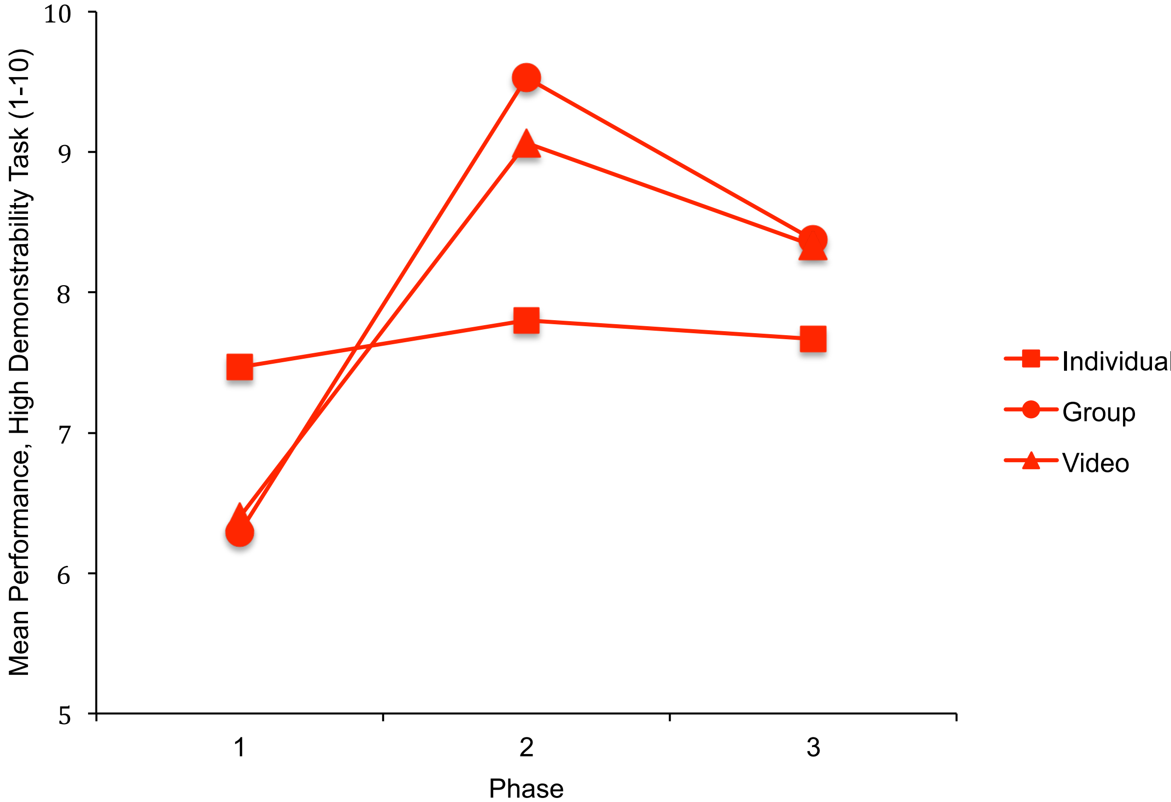

Figure 2. Subjects' mean performance across phases in each condition for high demonstrability task. Please note: for all remaining Figures, the individual condition is represented using a square marker, the group condition is represented using a circle marker, and the video condition is represented using a triangle marker. The high demonstrability task is marked using a red solid line and the low demonstrability condition is marked using a blue dotted line. If a line is not condition specific, no markers are used. Although a line graph is used in the Figures, the data do not include enough information to provide evidence of a linear relationship between phases.

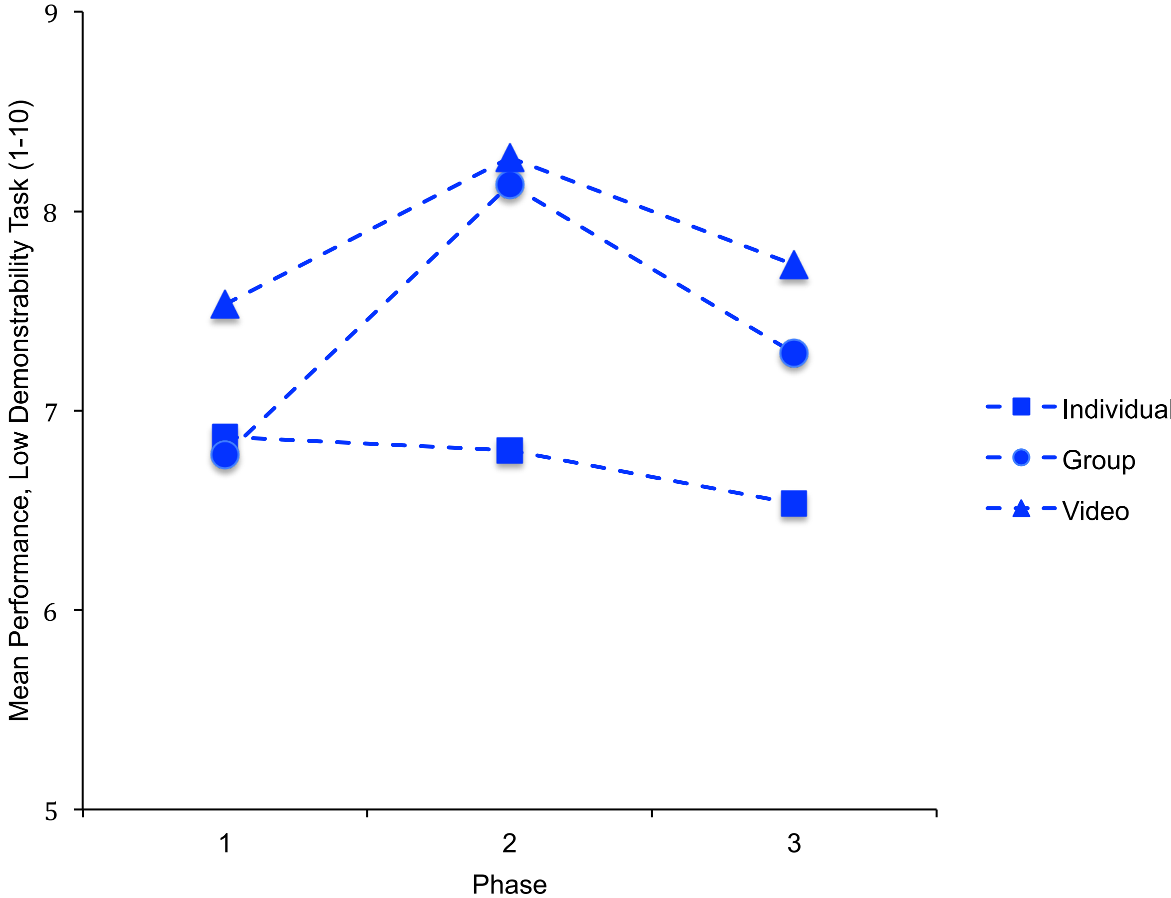

Figure 3. Subjects' mean performance across phases in each condition for low demonstrability task.

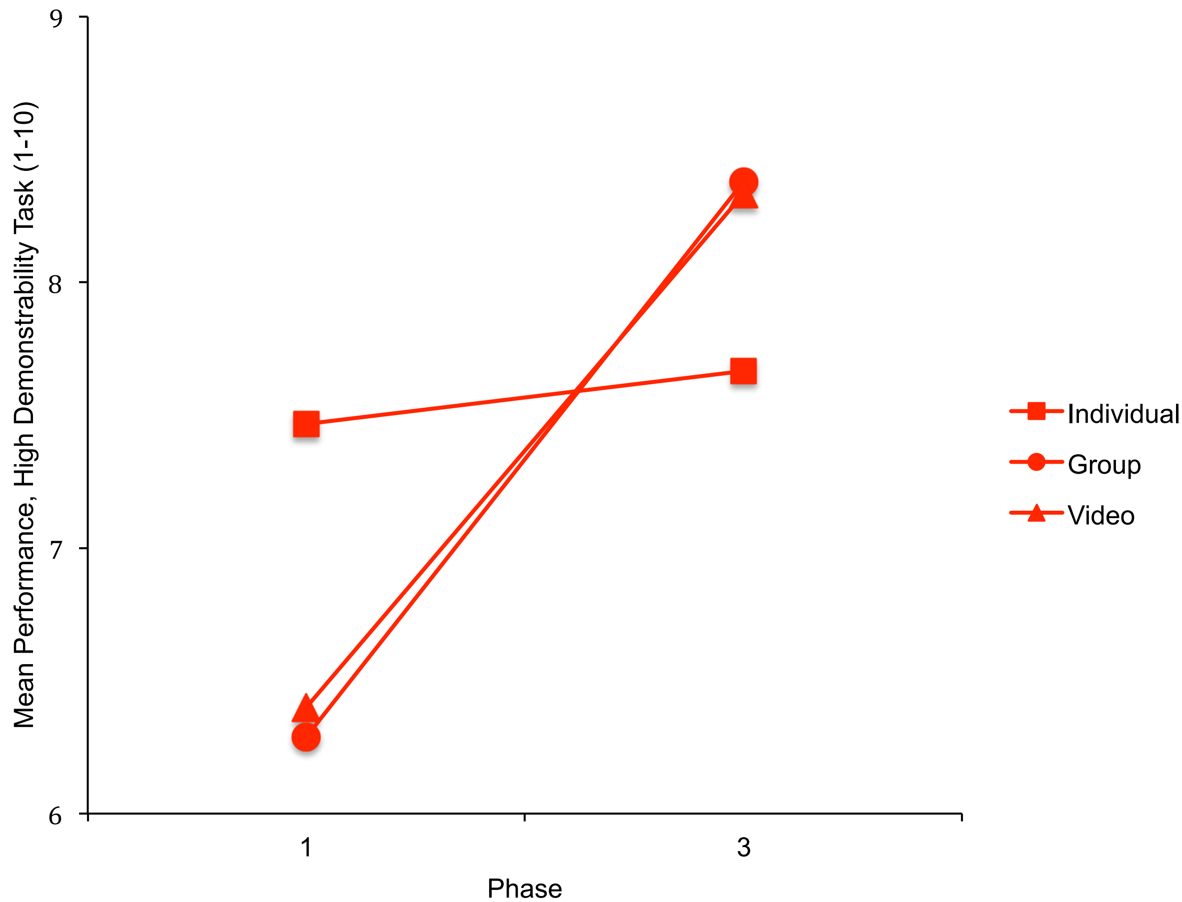

Figure 4. Subjects' mean performance improvement across phases 1 to 3 in each condition for high demonstrability task. Overall, subjects' performance improved significantly from phase 1 to phase 3, $p < .001$. Additionally, the interaction between condition and improvement was significant, $p = .003$. Post-hoc paired t-tests of subjects' improvement from phase one to phase three revealed a significant improvement of subjects in the group and video conditions, $p < .001$ and $p = .001$, respectively, but no significant improvement for subjects in the individual condition, $p = .510$.

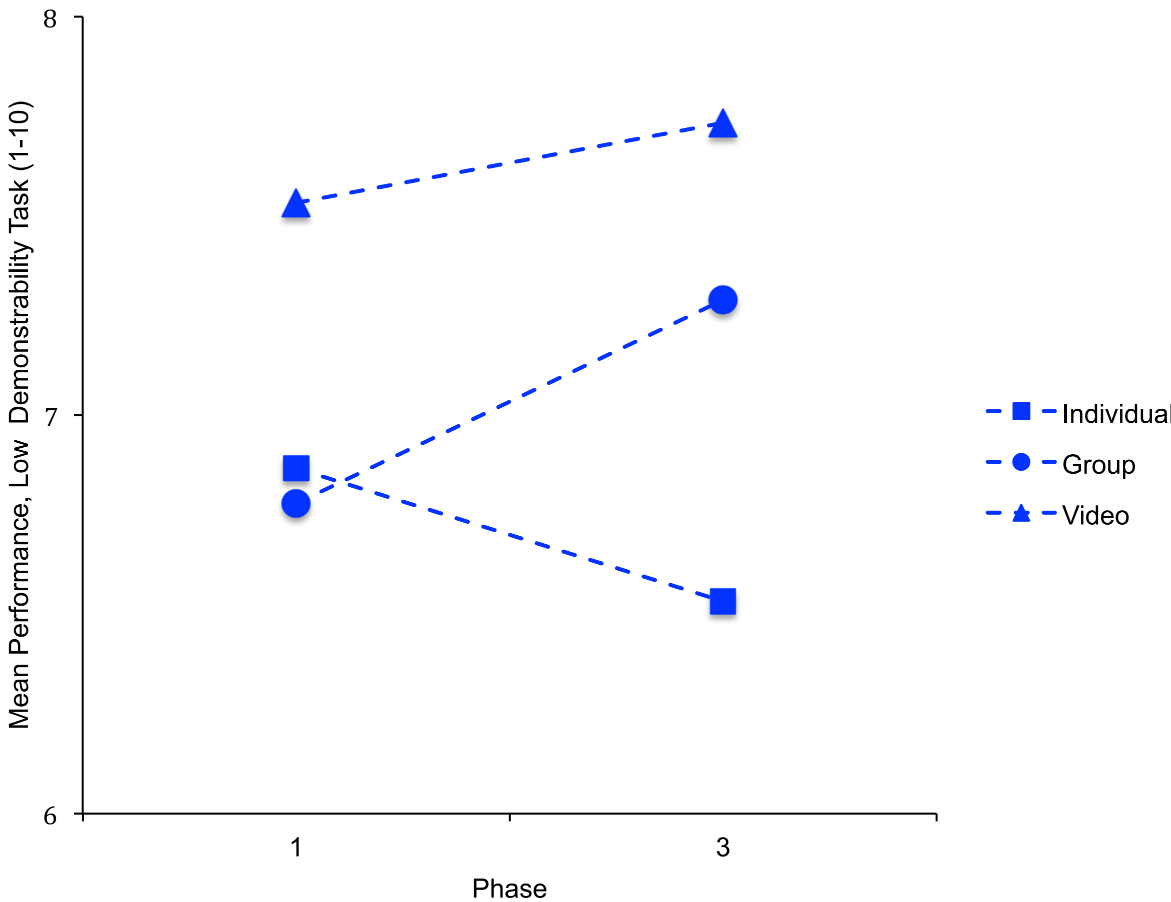

Figure 5. Subjects' mean performance improvement across phases 1 to 3 in each condition for low demonstrability task. An ANOVA revealed no significant improvement across the conditions, no interaction between conditions and improvement or main effect for condition.

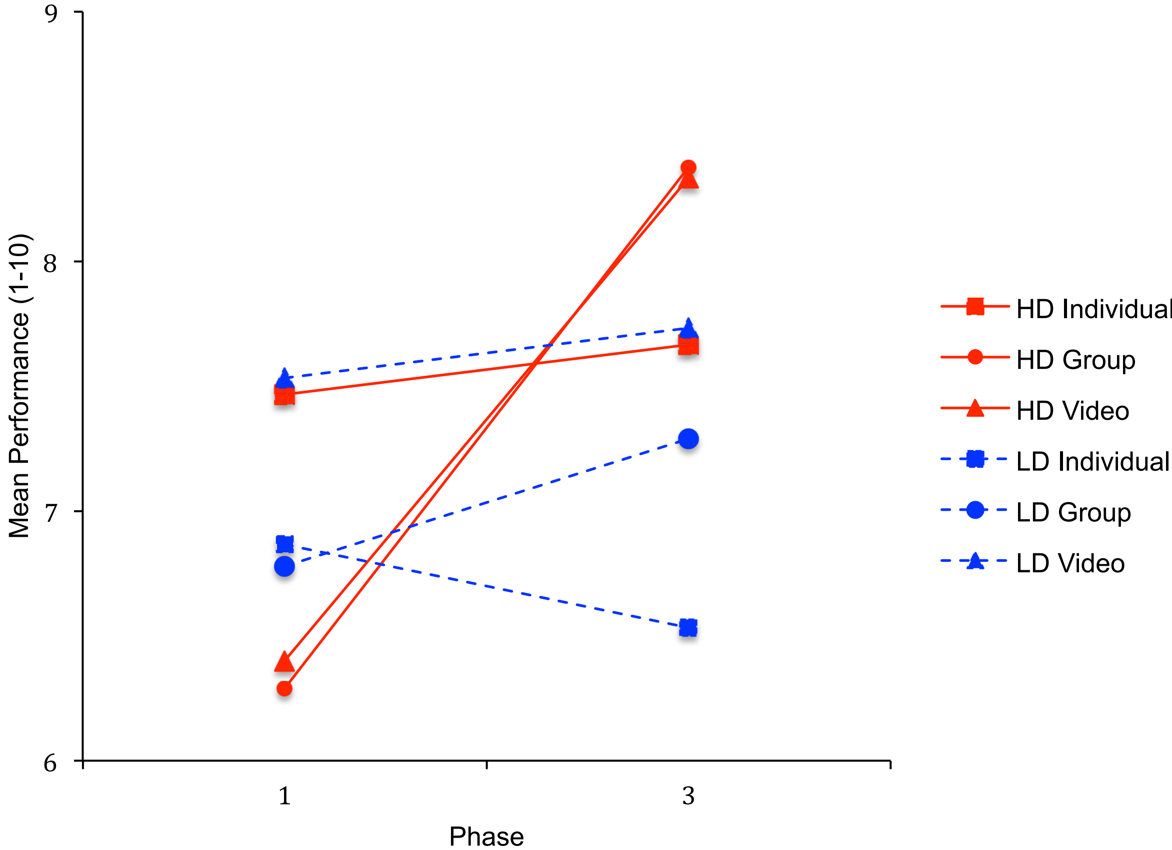

Figure 6. Subjects' mean performance improvement across phases 1 to 3 in each condition for both levels of demonstrability. The three-way interaction between performance improvement, demonstrability and condition was not significant. However, subjects' performance increased significantly from the first to third phase, $p < .001$. Additionally, subjects' performance improvement across conditions when completing the high demonstrability task significantly exceeded their performance improvement for the low demonstrability task, $p < .001$. Figures 7-9 graphically depict subjects' performance improvement by condition across the high and low demonstrability tasks.

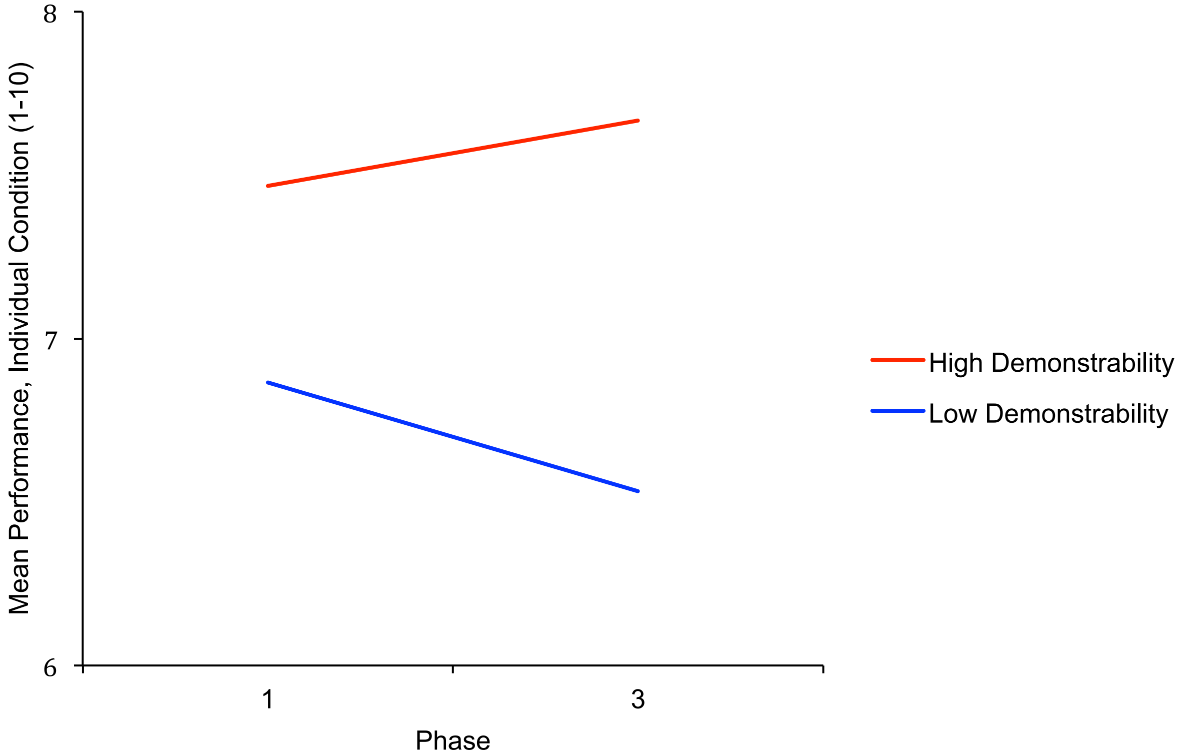

Figure 7. Subjects' mean performance improvement across phases 1 to 3 in individual condition for both levels of demonstrability.

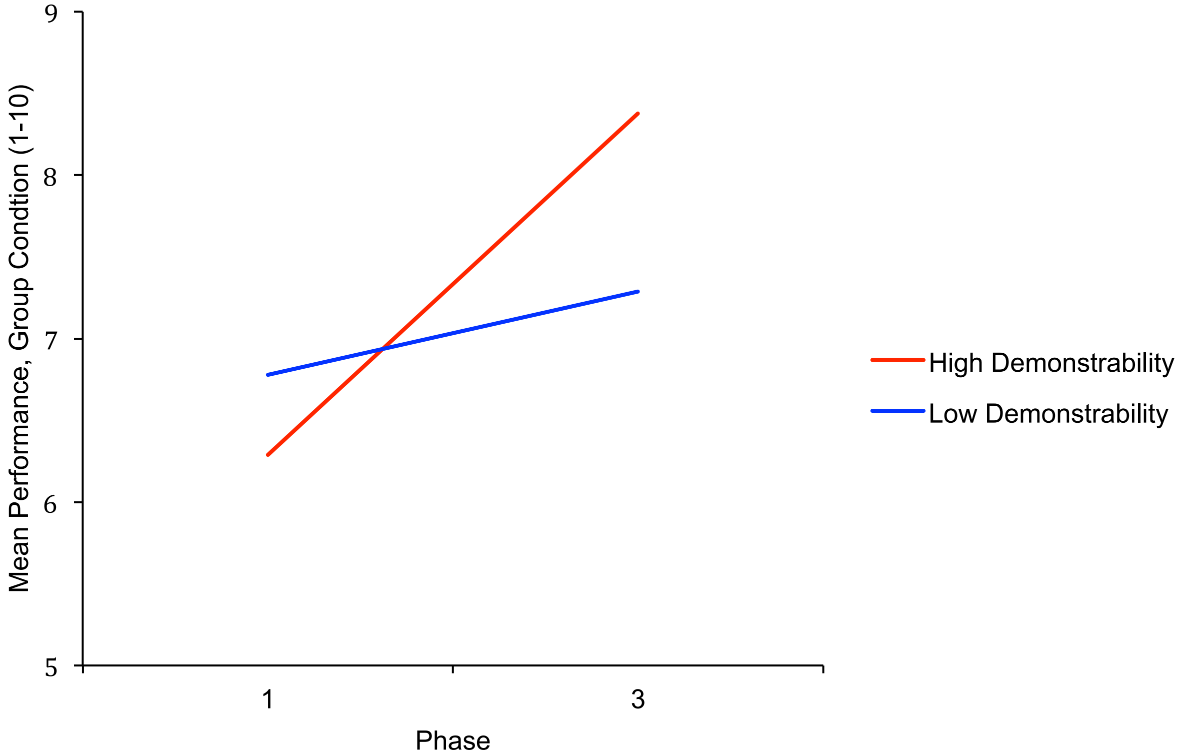

Figure 8. Subjects' mean performance improvement across phases 1 to 3 in group condition for both levels of demonstrability.

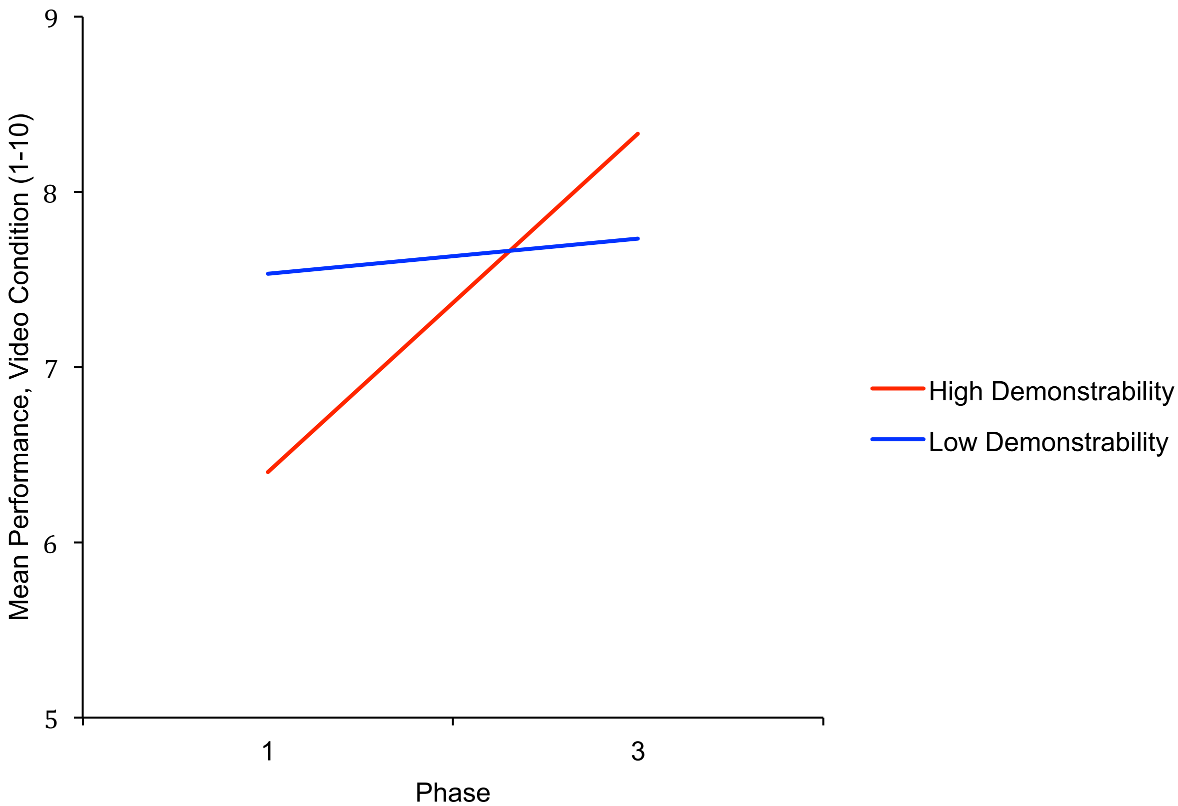

Figure 9. Subjects' mean performance improvement across phases 1 to 3 in video condition for both levels of demonstrability.

Appendix A

Categories of Math Problems by Question

Types of Math Problems (Directly Relate to the Question Number in Each Phase):

1. Applied Value Calculation
2. Functions of Complex Variables
3. Probability Without Replacement
4. Area Trigonometry
5. Fraction Simplification
6. Angular Trigonometry
7. Probability with Replacement
8. Compounding
9. Solving Systems of Equations
10. Differentiation

Appendix B

Math Problems Used During Phases of High-Demonstrability Condition

<u>First Phase of the High-Demonstrability Condition</u>

1. A house cost Ms. Jones \$*C* in 1965. Three years later she sold the house for 25% more than she paid for it. She has to pay a tax of 50% of the gain (The gain is the selling price minus the cost). How much tax must Ms. Jones pay?

A. 1/24 *C* **B. *C*/8** C. *C*/4 D. *C*/2 E. .6*C*

2. Given that *A* and *B* are real numbers, let $f(A, B)$ = AB and let $g(A) = A^2 + 2$. Then $f[3, g(3)]$ equals:

A. 3*A* X 2 B. (3*A* X 2) + 6 C. 27 D. 29 **E. 33**

3. A drawer contains 6 red socks and 4 blue socks. What is the probability that if 2 socks are picked (without looking) from the drawer, both socks will be red?

A. 2/15 B. 4/15 **C. 1/3** D. 2/5 E. 3/5 (6/10*5/9)

4. If the radius of a circle is increased by 10%, then the area of the circle is increased by:

A. .1% B. 10% **C. 21%** D. 100% E. 11%

5. [(1)/(1/3)]/[(1/3)] equals:

A. 1 B. $1/3^2$ C. 1/3 D. 3 **E. 3^2**

6. ABC is a triangle. Angle A equals 16X, Angle B equals 12X, and Angle C equals 8X. How many degrees is Angle A?

A. 90 **B. 80** C. 70 D. 160 E. 180

7. What is the probability of rolling 2 fives in a row with one six-sided die?

A. 1/6 B. 2/6 C. 16/36 D. 2/36 **E. 1/36**

8. Jonathon loans Matthew \$10, with an interest rate of 10% compounded daily. 1 day after the loan, Matthew Owes Jonathon:

A. \$13.10 **B. \$11.00** C. \$11.10 D. \$12.10 E. \$12.00

9. If X + 3Y = 6 and X / Y = 3, then X is equal to:

A. 0 B. 1 C. 3/2 D. 2 **E. 3**

10. $f(x) = ½(x)^2 + 4(y)^3$; $f'(x) =$:

A. 2(x) + 3 B. $x + 12(y)^2$ C. $2(x)^2 + 14(y)$ D. $2(x)^3 + 12(y)^2$ **E. x**

Second Phase of the High-Demonstrabilty Condition

Note: These questions may appear very similar to the previous questions, however they are different.

1. A house cost Ms. Jones $\$C$ in 1965. Three years later she sold the house for 10% more than she paid for it. She has to pay a tax of 50% of the gain (The gain is the selling price minus the cost). How much tax must Ms. Jones pay?

A. 1/20 *C* B. *C*/8 C. *C*/16 D. *C*/21 E. .6*C*

2. Given that *A* and *B* are real numbers, let $f(A, B)$ = AB and let $g(A) = A^2 + 5$. Then $f[4, g(4)]$ equals:

A. 3*A* X 2 B. (3*A* X 2) + 6 C. 58 **D. 84** E. 33

3. A drawer contains 3 red socks and 7 blue socks. What is the probability that if 2 socks are picked (without looking) from the drawer, both socks will be red?

A. 2/15 **B. 1/15** C. 1/3 D. 2/5 E. 3/5

4. If the radius of a circle is increased by 20%, then the area of the circle is increased by:

A. 35% **B. 44%** C. 21% D. 100% E. 11%

5. [(1/3)]/[(1/3)] equals:

A. 1 B. $1/3^2$ C. 1/3 D. 3 E. 3^2

6. ABC is a triangle. Angle A equals X, Angle B equals 3X, and Angle C equals 2X. How many degrees is Angle A?

A. 90 B. 48 **C. 30** D. 52 E. 180

7. What is the probability of rolling 2 fours in a row with a 4-sided die?

A. 2/8 B. 2/4 C. 16/48 **D. 1/16** E. 5/16

8. Jonathon loans Matthew $10, with an interest rate of 10% compounded daily. 2 Days after the loan, Matthew Owes Jonathon:

A. $13.10 B. $11.15 C. $11.10 **D. $12.10** E. $12.00

9. If X + 2Y = 8 and X / Y = 4, then Y is equal to:

A. 0 B. 1 **C. 8/6** D. 5/12 E. 2

10. $f(x,y) = 3(x)^2 + 2(x)^3$; $f'(x) =$:

A. $2(x) + 3$ B. $x + 12(x)^2$ C. $2(x)^2 + 14(x)$ **D. $6(x) + 6(x)^2$** E. $3(x) + 12(x)^2$

Third Phase of the High-Demonstrability Condition

Note: These questions may appear very similar to the previous questions, however they are different.

1. A house cost Ms. Jones \$*C* in 1965. Three years later she sold the house for 50% more than she paid for it. She has to pay a tax of 25% of the gain (The gain is the selling price minus the cost). How much tax must Ms. Jones pay?

A. 1/20 *C* **B. *C*/8** C. *C*/4 D. *C*/21 E. .6*C*

2. Given that *A* and *B* are real numbers, let *f(A, B)* = AB and let $g(A) = A^2 + 2$. Then *f*[*2, g(3)*] equals:

A. 22 B. (3*A* X 2) + 6 C. 3*A* X 2 D. 84 E. 33

3. A drawer contains 3 red socks and 2 blue socks. What is the probability that if 2 socks are picked (without looking) from the drawer, both socks will be red?

A. 2/15 B. 4/15 C. 1/3 D. 2/5 **E. 3/10**

4. If the radius of a circle is increased by 50%, then the area of the circle is increased by:

A. 50% B. 75% C. 100% D. 90 % **E. 125%**

5. [(1/3)]/[(3/1)] equals:

A. 1 B. $1/3^3$ **C. 1/9** D. 3 E. 3^2

6. ABC is a triangle. Angle A equals 3X, Angle B equals 2X, and Angle C equals 4X. How many degrees is Angle A?

A. 90 B. 15 C. 30 **D. 60** E. 180

7. What is the probability of rolling 2 threes in a row with a 5-sided die?

A. 2/8 B. 2/4 C. 16/48 **D. 1/25** E. 1/16

8. Jonathon loans Matthew \$10, with an interest rate of 50% compounded daily. 2 Days after the loan, Matthew Owes Jonathon:

A. \$21.50 B. \$21.25 C. \$20.50 **D. \$22.50** E. \$23.00

9. If X + 2Y = 6 and X / Y = 4, then X is equal to:

A. 0 B. 1 C. 3 D. 2 **E. 4**

10. $f(x,y) = 2(x) + 2(x)^3$; $f'(x) =$

A. **$2 + 6(x)^2$** B. $x + 12(x)^2$ C. $2(x)^2 + 14(x)$ D. $6(x) + 2(x)^3$ E. $3(x) + 12(x)^2$

Appendix C

Categories of Analogies by Question

Types of Analogies (Directly Relate to the Question Number in Each Phase):

1. Antonyms
2. Cause and Effect
3. Part to Whole
4. Purpose
5. Action to Object
6. Sequence
7. Degree
8. Characteristic
9. Association
10. Part to Part

Appendix D

Analogies Used During Phases of Low-Demonstrability Condition

First Phase of the Low-Demonstrability Condition

1. Sunder : Consolidate :: Tangible :

A. Abstract B. Tasty C. Possible D. Tangled

2. Curiosity : Enlightenment :: Veracity :

A. Credulousness B. Credibility C. Validity D. Cognizance

3. Steer : Ranch :: Meat :

A. Carpenter **B. Market** C. Roast D. Cowboy

4. Liquid : Siphon :: Smoke :

A. Tobacco B. Fire C. Flame **D. Flue**

5. Scrub : Floor :: Scour :

A. Sweep **B. Pan** C. Kitchen D. Cleanse

6. Acorn : Oak :: Infant :

A. Individual B. Baby **C. Adult** D. Male

7. Possible : Probable :: Hope :

A. Expect B. Deceive C. Resent D. Prove

8. Hero : Valor :: Heretic :

A. Dissent B. Bravado C. Reverence D. Discretion

9. Solution : Mystery :: Learning :

A. Study B. Comics C. College D. School

10. Maturity : Adolescence :: Childhood :

A. Manhood **B. Infancy** C. School D. Immaturity

Second Phase of the Low-Demonstrability Condition

1. Accord : Breach :: Connection :

A. Tie **B. Dissociation** C. Association D. Distrust

2. Seed : Plant :: Egg :

A. Yolk B. Crack **C. Bird** D. Shell

3. Ingredient : Recipe :: Yellow :

A. Yolk **B. Green** C. Liver D. Age

4. Photograph : Souvenir :: Movie :

A. Theater B. Star **C. Entertainment** D. Actors

5. Evade : Pursuer :: Dodge :

A. Ball B. Car C. Escape **D. Blow**

6. Intern : Physician :: Apprentice :

A. Doctor B. Lawyer C. Journeyman **D. Craftsman**

7. Gun : Club :: House :

A. Prehistoric **B. Cave** C. Cannon D. Rampage

8. Depression : Despair :: Cheer :

A. Victory **B. Hope** C. Gloom D. Celebration

9. Pennant : Team :: Oscar :

A. Teacher B. Player **C. Actor** D. Surgeon

10. Carrot : Lettuce :: Potato :

A. Grape **B. Cabbage** C. Radish D. Onion

Third Phase of the Low-Demonstrability Condition

1. Magnanimity : Parsimony :: Tolerance :

A. Advocation B. Totality C. Urgency **D. Bigotry**

2. Moon : Light :: Eclipse :

A. Violence **B. Darkness** C. Cruelty D. Whistling

3. Petal : Flower :: Fur :

A. Coat **B. Rabbit** C. Warm D. Women

4. Press : Print :: Eraser :

A. Efface B. Board C. Chalk D. Rubber

5. Whet : Appetite :: Hone :

A. Hunger **B. Knife** C. Meal D. Fork

6. Second : Fourth :: B :

A. A **B. D** C. a D. c

7. Suggest : Recommend :: Estimate :

A. Guess B. Value **C. Calculate** D. Worth

8. Resilient: Ball :: Resonant :

A. Loud B. Resounding C. Response **D. Echo**

9. Tears : Sorrow :: Laughter :

A. Joy B. Smile C. Girls D. Grain

10. Moon : Earth :: Earth :

A. Mars B. Moon C. Sky **D. Sun**

Appendix E

Individual, Group, and Video Condition Instructions

Every subject received the same baseline set of instructions given to subject in the individual condition. Subjects in the group and video conditions received supplementary instructions specific to their condition. All subjects also received an example math problem and analogy, which are included at the end of this appendix.

Individual Instructions

Overview:

Over the next 60-75 minutes, you will complete 6 separate problem sets. The first 3 problem sets will consist of 10 math problems each, and the second 3 problem sets will consist of 10 verbal analogies each.

General Instructions:

-For each problem set, you will have 10 minutes to complete the problems. The researcher will monitor your time on each of the problem sets. You are not required to use all 10 minutes.

-If you complete a problem set in less than 10 minutes, please inform the researcher.

-After the first 3 problem sets, there will be a scheduled break for you to walk around, go to the bathroom, etc. If you would like an additional break, please let your researcher know between problem sets.

-These questions are designed to be challenging. If you cannot complete one of the questions and cannot make an educated guess about the correct answer, just leave the question blank; please do not guess.

-You can use the blank space on the sheet for calculations, but not a calculator.

-The questions in the 3 math problem sets are very similar to each other (but not identical).

Group Instructions

Overview:

Over the next 60-75 minutes, you will complete 6 separate problem sets. The first 3 problem sets will consist of 10 math problems each, and the second 3 problem sets will consist of 10 verbal analogies each.

General Instructions:

-For each problem set, you will have 10 minutes to complete the problems. The researcher will monitor your time on each of the problem sets. You are not required to use all 10 minutes.

-If you complete a problem set in less than 10 minutes, please inform the researcher.

-After the first 3 problem sets, there will be a scheduled break for you to walk around, go to the bathroom, etc. If you would like an additional break, please let your researcher know between problem sets.

-These questions are designed to be challenging. If you cannot complete one of the questions and cannot make an educated guess about the correct answer, just leave the question blank; please do not guess.

-You can use the blank space on the sheet for calculations, but not a calculator.

-The questions in the 3 math problem sets are very similar to each other (but not identical).

Group Instructions:

-During the second problem set of both math problems and verbal analogies, you will work with two other participants to complete the problem set. When working in this small group, please only work on one problem at a time and reach consensus about the answer before moving onto the next problem. Please speak clearly.

-You will be permitted 10 minutes when working with the group.

Video Instructions

Overview:

Over the next 60-75 minutes, you will complete 6 separate problem sets. The first 3 problem sets will consist of 10 math problems each, and the second 3 problem sets will consist of 10 verbal analogies each.

General Instructions:

-For each problem set, you will have 10 minutes to complete the problems. The researcher will monitor your time on each of the problem sets. You are not required to use all 10 minutes.

-If you complete a problem set in less than 10 minutes, please inform the researcher.

-After the first 3 problem sets, there will be a scheduled break for you to walk around, go to the bathroom, etc. If you would like an additional break, please let your researcher know between problem sets.

-These questions are designed to be challenging. If you cannot complete one of the questions and cannot make an educated guess about the correct answer, just leave the question blank; please do not guess.

-You can use the blank space on the sheet for calculations, but not a calculator.

-The questions in the 3 math problem sets are very similar to each other (but not identical).

Video Instructions:

-During the second problem set of both math problems and verbal analogies, you will be shown a video of a group of 3 individuals completing the same problem set you are trying to solve. You will be asked to work along with the group in the video, however you will be permitted to choose different answers than they select if you believe they are incorrect.

-When viewing the video, you will not be permitted to pause or rewind the video.

Examples

Math:

1. Given that 2x+2=4, solve for x:

Solution:

First, isolate the x on one side of the equation by subtracting 2 from 4:

$$2x=2$$

Next, divide both sides by 2 to solve for x:

$$x=1$$

Then, circle the correct solution (A), to indicate your response.

A. X = 1 B. X =2 C. X = 3 D. X = 4

Verbal Analogies:

2. Run : Stride :: Swim :

Solution:

For all verbal analogies, one must determine the semantic relationship between the first two words (in this example, run and stride). In this case, one must realize that a stride is the physical basis of running, therefore one would look for the physical basis for "swim" to complete the analogy. The correct choice is (B), **Stroke**. Circle the correct solution (B), to indicate your response.

A. Leap **B. Stroke** C. Study D. Deviate