Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Experimental Social Psychology 42 (2006) 244–251
Journal of Experimental Social Psychology
www.elsevier.com/locate/jesp

# Productivity is not enough: A comparison of interactive and nominal brainstorming groups on idea generation and selection ☆

Eric F. Rietzschel [a,*], Bernard A. Nijstad [a], Wolfgang Stroebe [b]

[a] *Department of Work and Organizational Psychology, University of Amsterdam, Roetersstraat 15, 1018 WB, Amsterdam, The Netherlands*
[b] *Department of Psychology, Utrecht University, The Netherlands*

Received 27 October 2003; revised 13 January 2005
Available online 13 June 2005
Communicated by Stasser

**Abstract**

The conclusion that nominal brainstorming groups outperform interactive brainstorming groups has been exclusively based on studies of idea generation. This study tested whether the productivity advantage of nominal groups would also result in better idea selection. Nominal and interactive groups performed a task that involved idea generation and selection. Idea generation and selection were strictly separated for half the groups, but were combined for the other half. Nominal groups generated more ideas than interactive groups, and the ideas generated by nominal groups were more original and less feasible than the ideas generated by interactive groups. However, there were no differences among conditions in quality of the selected ideas. Further, idea selection was not significantly better than chance. This suggests that high productivity in brainstorming is not sufficient to lead to better solutions.


*Keywords:* Group brainstorming; Group creativity; Idea generation; Idea selection; Nominal groups; Productivity; Idea quality

## Introduction

Ever since the publication of Osborn's (1953) influential book *Applied Imagination*, many organizations consider group brainstorming as a particularly effective technique for generating large numbers of creative ideas. This popularity persists despite repeated findings that brainstorming groups generate fewer ideas, and fewer good ideas, than individual brainstormers whose ideas are pooled (so-called nominal groups; e.g., Diehl & Stroebe, 1987; Taylor, Berry, & Block, 1958). In fact, most people continue to believe that group brainstorming yields more ideas than individual brainstorming. This false belief has been dubbed "the illusion of group effectivity" (Paulus, Dzindolet, Poletes, & Camacho, 1993; Stroebe, Diehl, & Abakoumkin, 1992).

As a result of this discrepancy between research findings and everyday beliefs, brainstorming research has focused almost exclusively on productivity (i.e., number of ideas generated) as a dependent variable (Sutton & Hargadon, 1996), studying possible explanations for the productivity loss in interactive brainstorming groups (e.g., Diehl & Stroebe, 1991; Paulus & Dzindolet, 1993) and ways to minimize productivity loss (e.g., Gallupe, Bastianutti, & Cooper, 1991). Considering that the brainstorming procedure was designed with the specific goal of boosting productivity, this makes sense. However, when brainstorming is regarded as an innovation tool, this focus is too narrow. After all, producing

☆ This research was supported by a grant (NWO Grant 410-21-010) from the Netherlands Organization for Scientific Research. We thank Marieke Holterman, Rosa Noordam, and Charlotte Pasteuning for collecting part of the data. We also thank Katherine Stroebe for her assistance in coding the data and Bianca Beersma, Carsten de Dreu, Astrid Homan, Lotte Scholten, and two anonymous reviewers for their helpful comments on an earlier version of this manuscript. Parts of this paper were presented at the 11th European Congress on Work and Organizational Psychology in Lisbon, Portugal, May 2003.
* Corresponding author.
*E-mail address:* e.f.rietzschel@uva.nl (E.F. Rietzschel).

0022-1031/$ - see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.jesp.2005.04.005

large numbers of ideas is never the ultimate goal of a brainstorming session. Instead, what brainstormers are after is a limited number of good ideas to select for further development and, eventually, implementation (Nijstad & De Dreu, 2002). Thus, for creativity to become innovation, divergent idea generation must be followed by convergent idea selection. Given the neglect of idea selection as a research topic, we agree with Sutton and Hargadon (1996) that "it is premature to conclude that face-to-face brainstorming groups are ineffective" (p. 688). It should first be assessed whether the higher productivity of nominal groups also leads to a higher quality of selected ideas. The primary aim of our study is to answer this question through a comparison of interactive and nominal groups on a task that involves both idea generation and idea selection.

Even though idea generation and idea selection are both essential parts of the innovation process, combining them effectively is considered an onerous task. Brainstorming conventions dictate that idea selection should be separated from idea generation as strictly as possible. An important 'active ingredient' (Smith, 1998) in the brainstorming procedure is the deferment of judgment: people are thought to generate more ideas when they feel free of evaluation and criticism (e.g., Amabile, 1979; Hennessey, 1989), so separation of idea generation and selection is essential. Although the brainstorming literature provides some support for this assumption (e.g., Camacho & Paulus, 1995; Diehl & Stroebe, 1987), it remains an open question whether this task separation has any effects on the quality of selected ideas. Thus, our second aim is to study whether the recommended separation between idea generation and selection improves the quality of selected ideas. In this study, we manipulate this task separation by presenting idea generation and idea selection either as two separate tasks, or as one task consisting of two activities (idea generation and selection).

### *Idea selection in interactive and nominal groups*

The outcome of idea selection is dependent on two factors: the quality of the available ideas, and the quality of the selection process. Our manipulation of group interaction could have opposing effects on these factors. With regard to idea generation, the superiority of nominal groups is clear. In line with Osborn's (1953) proposal that quantity breeds quality, research has shown a strong correlation between the total number of ideas generated and the number of good ideas available therein (Diehl & Stroebe, 1987). Nominal groups generate more ideas than interactive groups, and hence have more good ideas to choose from.

With regard to the selection process, however, it is less obvious what to expect. On the one hand, various sorts of process loss can lead to suboptimal idea selection in interactive groups. For example, decision making groups often fail to discuss all relevant information and to consider all available alternatives (see Stasser, 1999). Of course, effective selection largely rests on a thorough consideration of available options. If interactive groups do not consider the options at their disposal, they cannot be expected to compensate for their lower productivity. One plausible prediction, therefore, is that the quality of selected ideas will be higher for nominal groups than for interactive groups.

On the other hand, several studies have demonstrated that groups can outperform individuals, particularly on intellective tasks. For example, Laughlin and colleagues (Laughlin, Bonner, & Altermatt, 1998; Laughlin & Shippy, 1983; Laughlin, VanderStoep, & Hollingshead, 1991) found that groups performed better than individuals on a task in which participants had to decide between hypotheses to account for certain patterns. Although idea selection is not an intellective, but a judgmental task, group discussion clearly can improve the selection process. Thus, one could also predict that interactive groups will overcome their lower productivity, and will select ideas that are at least as good as those selected by nominal groups.

### *Separation of idea generation and selection*

We expect that presenting idea generation and idea selection as one task will make the evaluative aspect inherent in idea selection more salient during idea generation, and that this will inhibit productivity. This effect should be especially strong in interactive groups, for two reasons: First, only in interactive groups can members be evaluated by others; thus, we expect any manipulation that increases evaluation apprehension to have a stronger effect for interactive than for nominal groups. Second, interactive groups suffer from production blocking: Members of interactive groups have to take turns expressing their ideas, and this interferes with group members' idea generation and expression (Diehl & Stroebe, 1991). We expect that removing the task separation will exacerbate this production blocking, because group members will devote more time to explaining their ideas, which means that other group members will have to wait longer before they can express their ideas.

The presence or absence of a strict task separation could influence idea selection in two ways. If the separation of idea generation and selection enhances productivity, more ideas are available for selection; this in turn could lead to the selection of better ideas as compared to the situation in which generation and selection are not strictly separated. However, because removing the task separation should cause brainstormers to devote more time to idea evaluation, even while still generating ideas, it could also improve the selection process. Therefore, it is possible that even though productivity will be negatively affected by removing the traditional task separation, the quality of the selected ideas will not be negatively affected.

## Method

### *Participants*

In total, 138 students of the University of Amsterdam participated in the experiment (102 females and 36 males, mean age = 21.4 years). Participants received course credit or 10 Euros (about 13 US Dollars). All participants were assigned to three-person groups that were homogeneous with regard to gender, yielding 12 male groups and 34 female groups. Four groups were excluded from the analyses, because not all of the group members followed task instructions.

### *Independent variables*

The study used a 2 (Type of Group: interactive versus nominal) × 2 (Task Separation: two tasks versus one task) factorial design. Participants were assigned randomly to conditions.

### *Procedure*

First, all participants read a general introduction in which it was explained that they would participate in a study regarding creativity and innovation, and that they would generate and select ideas. During idea generation and selection, members of interactive groups worked together in one room; members of nominal groups worked alone in separate rooms. All sessions were videotaped, in order to measure brainstorming times.[1]

The experimental task consisted of two parts: idea generation and idea selection. In the first part, participants were asked to generate ideas about ways to improve education at the Department of Psychology. The four brainstorming rules were provided: (1) generate as many ideas as possible, (2) freewheeling is encouraged, (3) criticism and evaluation are not allowed, and (4) combine and improve ideas. Participants wrote down their ideas on A4-sized sheets of paper, which were divided into sections to facilitate the counting of ideas. In interactive groups, all ideas were verbalized and then written down by one of the group members. In the idea selection part of the task, participants selected and rank ordered the four best ideas; these were then to be written down on a designated A4-sized sheet of colored paper.

Participants in the two-task condition first performed the idea generation task; after 30 min, or when participants indicated that they had finished generating ideas, the experimenter handed out the instructions and materials for the selection task. For this task, a maximum of 30 min was available as well.

In the one-task condition, participants received the instructions for idea generation and idea selection simultaneously. The content of these instructions was the same as in the two-task condition (including the four brainstorming rules), but they were presented together, as one set of instructions. Thus, the difference between the two conditions was that idea generation and selection were either framed as two separate tasks, or as one task consisting of two activities. We did not give participants in the one-task condition the instruction to stop brainstorming after 30 min, because this would interfere with our manipulation. Consequently, whereas participants in the two-task condition had 30 min for idea generation and 30 min for idea selection, participants in the one-task condition simply had 60 min for the whole task. Note that participants in the one-task condition did not receive any instructions with regard to task separation; thus, they were free to switch between idea generation and selection, or to separate the tasks.

In all conditions, idea selection was followed by a questionnaire that participants completed individually. Participants were then debriefed and paid.

### *Measures and dependent variables*

#### *Productivity*

As usual, productivity was defined as the number of non-redundant ideas per group. For nominal groups, the ideas produced by three individuals were added together. Redundant ideas, defined as identical ideas within one group's production, were counted only once.

#### *Idea quality*

A trained rater who was blind to conditions coded all unique ideas for originality and feasibility. For both dimensions, a 5-point scale was used (1 = *not original* [*feasible*], 5 = *highly original* [*feasible*]). Examples of a highly original and a highly unoriginal idea, respectively, are: "Use hypnosis to increase students' concentration," and "Teach courses in smaller groups." Examples of a feasible and an unfeasible idea, respectively, are: "Maintain a stricter policy against cell phones during exams," and "Make all course books available in digital form." The first author scored 10% of the ideas to determine interrater reliability. With raters considered to be in agreement whenever ratings differed by no more than one point (Diehl & Stroebe, 1987), agreement existed in 97.7% of the cases for originality, and in 97.2% of the cases for feasibility. We also computed intraclass correlations, using a two-way random model and consistency

[1] In the two-task condition, brainstorming time was defined as the period between the moment the experimenter left the room and the moment the group or individual stopped brainstorming. In the one-task condition, this boundary could not be drawn so easily. We therefore defined brainstorming time as the period between the moment the experimenter left the room and the moment when the group or individual visibly switched to idea selection by reaching for the selection sheet and leafing through the ideas.

Table 1
Means and standard deviations for productivity and the quality of the generated and selected ideas

| Measure | 1 Task | | 2 Tasks | |
|---|---|---|---|---|
| | Nominal group | Interactive group | Nominal group | Interactive group |
| Number of ideas | 67.7 (13.38) | 25.9 (6.79) | 46.4 (15.54) | 28.75 (12.75) |
| Number of ideas per minute[a] | 2.20 (0.45) | 0.78 (0.21) | 1.79 (0.50) | 1.34 (0.72) |
| Mean originality of generated ideas[b] | 1.61 (0.12) | 1.44 (0.22) | 1.51 (0.28) | 1.37 (0.25) |
| Mean feasibility of generated ideas[b] | 3.71 (0.21) | 3.98 (0.44) | 3.67 (0.19) | 3.90 (0.31) |
| Mean originality of selected ideas[b] | 1.47 (0.23) | 1.67 (0.59) | 1.53 (0.48) | 1.44 (0.29) |
| Mean feasibility of selected ideas[b] | 3.77 (0.39) | 3.90 (0.42) | 3.93 (0.44) | 3.67 (0.62) |

*Note.* $N = 42$ groups. Standard deviations are in parentheses.
[a] $N = 40$ groups.
[b] Maximum value = 5.

definition (McGraw & Wong, 1996; Shrout & Fleiss, 1979); these were .77 for originality and .73 for feasibility. These values are "good" to "excellent" according to criteria specified by Cicchetti and Sparrow (1981). Hence, we used the scores of the first judge in our analyses.

We computed the mean originality and the mean feasibility of the generated ideas and the selected ideas. Interactive groups selected the four best ideas as a group; in nominal groups, each group member selected his/her four best ideas as an individual, yielding twelve selected ideas per nominal group. Having participants use a rank ordering procedure in the selection task allowed us to compute quality scores for the *three favorite ideas* in each interactive and nominal group, that is, the three ideas that received the highest ranking within each group. For the interactive groups, we computed the mean originality and feasibility scores of the selected ideas with rankings 1, 2, and 3; for the nominal groups, we computed the mean originality and feasibility of the three selected ideas with ranking 1. We also computed alternative measures for the quality of the selected ideas, such as the mean originality and feasibility of *all* selected ideas, but these measures showed the same results in the analyses and are not reported here.

*Satisfaction*

In the questionnaire, we asked participants how satisfied they felt about their productivity, the quality of their ideas, the quality of the selection process and the quality of the selected ideas. Responses to all these items were given on a 9-point scale (1 = *not at all satisfied*, 9 = *very satisfied*).

## Results

*Productivity*

Table 1 presents the means and standard deviations for productivity and the quality of generated and selected ideas. A 2 (Type of Group) × 2 (Task Separation) ANOVA on productivity yielded a main effect for type of group ($F(1,38) = 58.53$, $p < .001$, $\eta^2 = .61$): Nominal groups generated more ideas ($M = 57.05$, $SD = 17.85$) than interactive groups ($M = 27.45$, $SD = 10.35$). A main effect of task separation ($F(1,38) = 5.64$, $p = .023$, $\eta^2 = .13$) was qualified by a Type of Group × Task Separation interaction ($F(1,38) = 9.66$, $p = .004$, $\eta^2 = .20$). Simple effects analysis revealed that one-task nominal groups generated more ideas than two-task nominal groups ($F(1,38) = 14.40$, $p = .001$); this difference was not significant for the interactive groups ($p > .5$).

To test whether the high productivity of one-task nominal groups was caused by the longer time available for brainstorming in the one-task condition (theoretically, one-task groups could spend 59 min brainstorming and 1 min selecting ideas,[2]) we divided the number of ideas generated in each group by the number of minutes spent brainstorming by that group (measured from the video recording of each session; for two groups, no video recordings were available, due to equipment failure). An ANOVA yielded a main effect for type of group ($F(1,36) = 31.21$, $p < .001$, $\eta^2 = .46$): nominal groups generated more ideas per minute ($M = 1.98$, $SD = 0.51$) than interactive groups ($M = 1.10$, $SD = 0.62$). The interaction Type of Group × Task Separation was significant ($F(1,36) = 8.35$, $p = .006$, $\eta^2 = .19$); simple effects analysis showed that, as predicted, the one-task interactive groups generated fewer ideas per minute than two-task interactive groups ($F(1,36) = 5.68$, $p = .023$). One-task nominal groups, however, generated slightly more ideas per minute than two-task nominal groups (although this effect was only marginally significant: $F(1,36) = 2.96$, $p = .094$).

*Idea quality*

We performed a MANOVA with a 2 (Quality: originality vs. feasibility) × 2 (Activity: production vs. selection) × 2 (Type of Group: interactive vs. nominal) × 2

[2] An ANOVA on the number of minutes spent brainstorming revealed a main effect for task separation ($F(1,36) = 12.39$, $p = .001$, $\eta^2 = .26$): one-task groups spent more time in idea generation ($M = 31.59$, $SD = 7.25$) than two-task groups ($M = 24.32$, $SD = 5.48$). There were no other significant effects ($ps > .1$).

(Task Separation: two tasks vs. one task) mixed design. Quality and activity were within-subjects factors; type of group and task separation were between-subjects factors. The analysis revealed a significant main effect of quality ($F(1,38) = 950.09$, $p < .001$, $\eta^2 = .96$): The generated and selected ideas were higher in feasibility ($M = 3.81$, $SD = 0.37$) than in originality ($M = 1.49$, $SD = 0.30$). There was no effect of activity, indicating that the average quality of the selected ideas was not significantly different from the average quality of the generated ideas ($p > .5$). We also found a significant Quality × Activity × Type of Group interaction ($F(1,38) = 8.79$, $p = .005$, $\eta^2 = .19$). To analyze the interaction, we performed separate analyses for originality and feasibility.

*Originality*

A 2 (Originality: originality of the generated ideas vs. originality of the selected ideas) × 2 (Type of Group) × 2 (Task Separation) mixed ANOVA revealed a marginal interaction of Originality × Type of Group ($F(1,38) = 2.97$, $p = .093$, $\eta^2 = .07$). Further analysis showed that nominal groups generated more original ideas ($M = 1.56$, $SD = 0.21$) than interactive groups ($M = 1.40$, $SD = 0.23$; $F(1,38) = 4.87$, $p = .033$, $\eta^2 = .11$), but that this difference was not present for the selection task ($p > .5$). The disappearance of this difference was due to the interactive groups selecting ideas that were slightly more original ($M = 1.55$, $SD = 0.45$) than their average production ($M = 1.40$, $SD = 0.23$), although this difference was only marginally significant ($F(1,38) = 3.16$, $p = .083$). For nominal groups, no such difference was found.

*Feasibility*

A 2 (Feasibility: feasibility of the generated ideas vs. feasibility of the selected ideas) × 2 (Type of Group) × 2 (Task Separation) mixed ANOVA revealed a significant interaction of Feasibility × Type of Group ($F(1,38) = 5.69$, $p = .022$, $\eta^2 = .13$). Interactive groups generated more feasible ideas ($M = 3.94$, $SD = 0.37$) than nominal groups ($M = 3.69$, $SD = 0.20$; $F(1,38) = 6.93$, $p = .012$, $\eta^2 = .15$), but this difference disappeared in the selection task ($p > .5$). As with originality, this interaction effect was driven by the interactive groups; interactive groups selected ideas that were slightly (but not significantly) less feasible ($M = 3.77$, $SD = 0.54$) than their average production ($M = 3.94$, $SD = 0.37$; $F(1,38) = 3.0$, $p = .091$). Again, no such difference was found for the nominal groups.[3]

[3] As a composite measure of idea quality, we also computed the proportions of good ideas (i.e., ideas that were rated 3 or higher on both originality and feasibility) among the generated and selected ideas. The average proportion of generated good ideas was .09, and the average proportion of selected good ideas was .11. These proportions were not significantly different: $t(41) = 1.35$, $p = .18$. In 66.7% of the cases, no good ideas were selected.

*Correlations*

The non-significant difference in quality between the generated and the selected ideas suggests that our participants' selection was not really better than chance, and that they would have done just as well taking a random sample from their production. If so, we would expect the quality of the selected ideas not to be dependent on the availability of good ideas (i.e., the productivity), but on the *average* quality of the generated ideas. This hypothesis was supported by the correlations between our dependent variables. Productivity was neither related to the originality ($r = -.13$, $p = .41$) nor to the feasibility of the selected ideas ($r = -.19$, $p = .23$), whereas the average originality of the generated ideas was related to the average originality of the selection ($r = .32$, $p = .036$), and the feasibility of the generated ideas was related to the feasibility of the selected ideas ($r = .41$, $p = .007$).

*Video recordings*

Because participants in the one-task conditions were not explicitly instructed to separate idea generation and idea selection, it was possible that these participants would shift back and forth between the two tasks; such a strategy might affect both the generation and the selection process. Alternatively, they might spontaneously separate the tasks in the same way as the two-task participants were instructed to do: generate ideas first, and only start selecting ideas after the generation process had ended. Inspection of the video recordings showed that all of the one-task groups chose the latter option. In all groups, participants spent the first part of the task on idea generation exclusively. The onset of the selection process was usually marked by utterances such as "I don't think we can come up with more ideas; let's select the best ones" (in the interactive groups) and by the group members reaching for the colored selection form and starting to leaf through the ideas (in both interactive and nominal groups).

*Satisfaction*

Table 2 presents the means and standard deviations for the satisfaction scores; these were aggregated to the group level by averaging the three group members' scores. Our participants were generally satisfied with their performance, both with regard to idea generation and idea selection: all overall means were significantly above the central value ($p < .001$). There was no difference between conditions in the satisfaction with the number of generated ideas ($p > .5$). Members of interactive groups were marginally more satisfied with the quality of their ideas ($M = 6.63$, $SD = 0.87$) than members of nominal groups ($M = 6.15$, $SD = 0.88$; $F(1,38) = 3.13$, $p = .085$, $\eta^2 = .08$). Members of interactive groups were also more satisfied with the selection process ($M = 7.45$,

Table 2
Means and standard deviations for satisfaction

| Measure | 1 Task | | 2 Tasks | |
|---|---|---|---|---|
| | Nominal group | Interactive group | Nominal group | Interactive group |
| Satisfaction with number of generated ideas | 6.07 (0.84) | 6.20 (0.82) | 5.90 (1.78) | 5.94 (1.04) |
| Satisfaction with quality of generated ideas | 5.93 (0.97) | 6.60 (0.64) | 6.37 (0.76) | 6.67 (1.05) |
| Satisfaction with quality of selection process | 6.73 (0.62) | 7.47 (0.32) | 7.27 (0.68) | 7.44 (0.48) |
| Satisfaction with quality of selected ideas | 6.50 (0.80) | 7.10 (0.61) | 6.73 (0.94) | 7.61 (0.84) |

*Note*. Maximum value = 9. $N = 42$ groups. Standard deviations are in parentheses.

$SD = 0.41$; $F(1,38) = 7.39$, $p = .01$, $\eta^2 = .16$) and the quality of the selected ideas ($M = 7.38$, $SD = 0.77$; $F(1,38) = 8.26$, $p = .007$, $\eta^2 = .18$) than members of nominal groups ($M = 7.0$, $SD = 0.69$, and $M = 6.62$, $SD = 0.90$, respectively). There were no other significant effects.

## Discussion

Previous brainstorming research has focused on idea generation, but neglected idea selection. The primary aim of this study was to fill this void by comparing interactive and nominal groups in an experiment that involved both tasks. Our secondary aim was to study whether the strict separation of idea generation and idea selection is as important as is usually assumed; in order to address this question, we removed this task separation for half of our groups.

With regard to idea generation, our study replicated the production loss usually encountered in interactive brainstorming groups: nominal groups generated more ideas than interactive groups. This advantage of nominal groups was even more pronounced when the strict separation between idea generation and idea selection was removed. Our interactive groups generated fewer ideas per minute in the one-task condition than in the two-task condition, which was in line with our prediction that removing the task separation would increase evaluation apprehension and production blocking in groups. However, because one-task interactive groups devoted more time to idea generation, they eventually were as productive as the two-task interactive groups. One-task nominal groups generated slightly more ideas per minute than two-task nominal groups. Because they were also more persistent, one-task nominal groups generated more ideas than did two-task nominal groups. Apparently, removing task separation increased the participants' motivation to generate many ideas, perhaps because it was more salient that eventually they would need many good ideas to choose from. In interactive groups, evaluation apprehension and blocking counteracted higher productivity, but in nominal groups the increased motivation did lead to higher levels of performance. This finding qualifies the often-assumed benefits of task separation: only in interactive groups did task separation lead to a more efficient brainstorming session (in terms of ideas per minute).

Although there were differences in the quality of the generated ideas (nominal groups generated ideas that were more original, interactive groups generated ideas that were more feasible), these differences disappeared in the selection stage. It appears that interactive groups indeed managed to overcome their productivity loss by making an effective selection. However, the quality of the selected ideas was only slightly different from the average quality of the available ideas. The ideas selected by interactive groups were only marginally more original, and marginally less feasible, than their average production; the nominal groups did not even show this small difference. These findings suggest that, with regard to creativity, the selection process was hardly more effective than taking a random sample from the available ideas. This interpretation is supported by the pattern of correlations found, which shows that the quality of selected ideas was related to the average quality, and not the quantity, of the available ideas.

Interestingly, the fact that our participants appear to be unable to distinguish good from poor ideas is consistent with findings reported by Simonton (2003) in his analysis of creativity in science and literature. Simonton reports that people are not very good at recognizing their best ideas, and that this does not improve over the course of their careers.

Our participants' low selection effectiveness notwithstanding, they were generally satisfied with the quality of their selection. This raises the question of what criteria our participants used when selecting ideas. The experimental task was explicitly framed as a creativity task, the purpose of which was to come up with creative ideas, but we did not explicitly instruct participants to use originality and feasibility as their selection criteria; thus, we cannot exclude the possibility that they used other criteria. For example, because the brainstorming topic we used was highly relevant to our participants, it is plausible that they simply selected those ideas that they found most important, rather than the most original or feasible ideas. This view is supported by inspection of the video recordings: many of the group discussions revolved around specific complaints regarding the Psychology curriculum, teachers and classes.

To test the hypothesis that our participants would have been more effective in identifying creative ideas, had they been provided with more explicit selection criteria, we conducted a small study: we presented 30 participants with a randomly chosen set of ideas from the first study, and asked them to select the four best ideas from this set. We instructed half of the participants to use specific selection criteria (originality and feasibility); the other participants were simply instructed to select 'the best' ideas. However, the selection effectiveness of participants with explicit criteria was not different from that of participants without selection criteria.[4] This makes it highly unlikely that the poor selection performance in our study was due to the absence of explicit selection criteria. Nevertheless, because all participants in this follow-up study worked individually, we cannot exclude the possibility that providing interactive groups with explicit selection criteria would enhance selection performance.

Another possible explanation of the low selection effectiveness is that the originality and feasibility of the available ideas may have been strongly negatively correlated, making it difficult for participants to select good ideas. We therefore computed the average correlation between originality and feasibility for the generated ideas and for the selected ideas[5] (first performing a Fisher $r$-to-$Z$ transformation on all correlations, and then transforming the average value back to $r$). The average correlation between originality and feasibility was only marginally significant for the generated ideas ($r = -.284$, $p = .07$) and not significant for the selected ideas ($r = -.103$, $p = .60$). Thus, while there was a slight negative association of originality and feasibility in the available ideas, this correlation was not very strong.

It should be noted that, in our study, nominal group members generated *and* selected ideas individually. Thus, none of them had access to the total group's production. This may have contributed to the nominal groups' failure to profit from their high productivity. However, given the low effectiveness of the selection process, we suspect that pooling the generated ideas before the selection task would not have resulted in a higher quality of selected ideas. If people are not very good at recognizing and selecting their best ideas, it cannot be expected that selecting from the nominal group's total production will lead to a higher quality choice. Nevertheless, future research should address this issue in more detail. It is possible that a combination of nominal and interactive idea generation and selection would yield optimal results on both tasks.

Another interesting possibility is to study whether the use of different perspectives or goals has an influence on idea generation and selection. It is possible that interactive groups do have some benefit to offer in those cases where idea selection is best undertaken from a variety of viewpoints. In general, ways of improving the selection process seem an interesting area for future study, both from an applied and a theoretical perspective.

In conclusion, the existing brainstorming literature is very useful to brainstorming professionals who wish to increase brainstorming productivity. However, we argue that, from an applied perspective, brainstormers and researchers who focus on productivity and neglect idea selection are missing the point: getting brainstorming to yield high-quality solutions. If brainstorming is used as a way to come to a limited number of creative ideas or solutions, productivity clearly is not enough. The advantage of having many creative ideas at one's disposal can easily be undone by a sub-optimal selection process. Instead of simply making groups more *productive*, it may be more fruitful to make them more *effective* in all stages of the creative process.

[4] The originality of the selected ideas was not higher for participants with selection criteria ($M = 1.83$, $SD = 0.28$) than for participants without selection criteria ($M = 1.95$, $SD = 0.58$; $t(28) = 0.69$, $p = .49$). Similarly, the feasibility of the selected ideas was no higher for participants with selection criteria ($M = 3.55$, $SD = 0.61$) than for participants without selection criteria ($M = 3.68$, $SD = 0.47$; $t(28) = 0.67$, $p = .51$).

[5] In some cases, these correlations could not be computed, due to the absence of variance in the quality scores. Thus, for the generated ideas, $n = 41$; for the selected ideas, $n = 25$.

## References


Amabile, T. M. (1979). Effects of external evaluation on artistic creativity. *Journal of Personality and Social Psychology, 37*, 221–233.

Camacho, L. M., & Paulus, P. B. (1995). The role of social anxiousness in group brainstorming. *Journal of Personality and Social Psychology, 68*, 1071–1080.

Cicchetti, D. V., & Sparrow, S. A. (1981). Developing criteria for establishing interrater reliability of specific items: Applications to assessment of adaptive behavior. *American Journal of Mental Deficiency, 86*, 127–137.

Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology, 53*, 497–509.

Diehl, M., & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. *Journal of Personality and Social Psychology, 61*, 392–403.

Gallupe, R. B., Bastianutti, L. M., & Cooper, W. H. (1991). Unblocking brainstorms. *Journal of Applied Psychology, 76*, 137–142.

Hennessey, B. A. (1989). The effect of extrinsic constraints on children's creativity while using a computer. *Creativity Research Journal, 2*, 151–168.

Laughlin, P. R., Bonner, B. L., & Altermatt, T. W. (1998). Collective versus individual induction with single versus multiple hypotheses. *Journal of Personality and Social Psychology, 75*, 1481–1489.

Laughlin, P. R., & Shippy, T. A. (1983). Collective induction. *Journal of Personality and Social Psychology, 45*, 94–100.

Laughlin, P. R., VanderStoep, S. W., & Hollingshead, A. B. (1991). Collective versus individual induction: Recognition of truth, rejection of error, and collective information processing. *Journal of Personality and Social Psychology, 61*, 50–67.

McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods, 1*, 30–46.

Nijstad, B. A., & De Dreu, C. K. W. (2002). Creativity and group innovation. *Applied Psychology: An International Review, 51*, 400–406.

Osborn, A. F. (1953). *Applied imagination*. Oxford, UK: Charles Scribner's Sons.

Paulus, P. B., & Dzindolet, M. T. (1993). Social influence processes in group brainstorming. *Journal of Personality and Social Psychology, 64*, 575–586.

Paulus, P. B., Dzindolet, M. T., Poletes, G., & Camacho, L. M. (1993). Perception of performance in group brainstorming: The illusion of group productivity. *Personality and Social Psychology Bulletin, 19*, 78–89.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86*, 420–428.

Simonton, D. K. (2003). Scientific creativity as constrained stochastic behavior: The integration of product, person, and process perspectives. *Psychological Bulletin, 129*, 475–494.

Smith, G. F. (1998). Idea-generation techniques: A formulary of active ingredients. *Journal of Creative Behavior, 32*, 107–133.

Stasser, G. (1999). The uncertain role of unshared information in collective choice. In L. L. Thompson, J. M. Levine, & D. M. Messick (Eds.), *Shared cognition in organizations: The management of knowledge* (pp. 49–69). Mahwah, NJ: Lawrence Erlbaum Associates.

Stroebe, W., Diehl, M., & Abakoumkin, G. (1992). The illusion of group effectivity. *Personality and Social Psychology Bulletin, 18*, 643–650.

Sutton, R. I., & Hargadon, A. (1996). Brainstorming groups in context: Effectiveness in a product design firm. *Administrative Science Quarterly, 41*, 685–718.

Taylor, D. W., Berry, P. C., & Block, C. H. (1958). Does group participation when using brainstorming facilitate or inhibit creative thinking? *Administrative Science Quarterly, 3*, 23–47.