Cross-Cuing versus Self-Cuing-
What Enhances Performance in a Brainstorming Task?

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Abstract

Group brainstorming and collaborative remembering are two research lines studying social influence on cognitive processes of knowledge retrieval. Both show that coacting others impair performance due to production blocking and/or retrieval strategy disruption. There is no evidence indicating performance enhancing effects of being cued. In two experiments, we investigated whether retrieval cues under conditions that avoid production blocking and retrieval strategy disruption might enhance brainstorming performance. Results of the first study show that using the last ideas out of one's own retrieval clusters as self-cues improved individual idea generation. This result was replicated in the second study and contrasted with the effects of cross-cuing. Whereas participants in the cross-cuing condition did not produce significantly more ideas than those in a control condition without cuing, participants in the self-cuing condition outperformed those of both other conditions. These results are in line with a retrieval strategy interpretation: although cuing usually disrupts retrieval strategies and thus reduces performance, self-cuing can optimize retrieval strategies and thus enhance performance. Cross-cuing, however, can at most be ineffective.

Keywords: brainstorming; cognitive stimulation; cross-cuing; self-cuing; retrieval strategy disruption; part-list cuing.

Brainstorming

Osborn (1957) assumed that people in problem-solving situations produce a greater number of creative and good ideas if they attempt to produce those ideas in an unconstrained, uncritical brainstorming environment. Empirical studies, however, soon showed that collaborative idea generation in face-to-face groups result in lower performance when compared to nominal groups (Taylor, Berry & Block, 1958). Nominal groups are control groups of the same number of people working alone (cf. Diehl & Stroebe, 1995). The superiority of nominal groups regarding the quality and quantity of produced ideas has been replicated in several empirical studies (Lamm & Trommsdorff, 1973; Mullen, Johnson & Salas, 1991). Mutual production blocking (the fact that in face-to-face groups only one person can speak at a time and the other group members have to listen without being able to express their own ideas) has been shown to be the main cause of this productivity loss in face-to-face-groups (Diehl & Stroebe, 1987, 1991).

The basic processes underlying idea production are knowledge retrieval strategies. For this reason it seems to be of relevance to concentrate on cognitive processes in order to find ways to improve people's performance when brainstorming alone or in a group.

Individual and Group Remembering

Collaborative remembering in groups, meaning the recall of studied information by a group of people working together, has been researched in experimental psychology of memory. Meudell, Hitch & Kirby (1992) argued that if two people merely combined their separate recalls, then, necessarily, the collaborating pair would tend to outperform either individual through social facilitation. In other words, people might cross-cue each other in a way, so as to generate items not available to either member of the pair individually. Meudell et al. (1992) devised four experiments to examine cross-cuing in pairs. All these experiments used variants of the same design in which all the subjects first recalled information on their own. Then some people were assigned to pairs and were asked to recall the information cooperatively. As it was known what each member of the pair could recall on their first (solitary) recall attempt, it was possible to identify whether any new recollections appeared in the joint recall protocol of the pairs. A control group was also run consisting of individuals who recalled first on their own and then, at later time, in pairs. Once again the same information was recalled in pairs as in isolation. All four experiments provided the same results: pairs of people did not generate more new information than did the people in the control group. Meudell et al. (1992) concluded that there was little evidence to support the hypothesis that pairs of people might in some way cross-cue each other so as to generate new memories.

Meudell, Hitch & Boyle (1995) tested different cross-cuing conditions by requiring subjects to recall categorized lists of words. The opportunity for the facilitation of memory through cross-cuing did not lead to new information by collaborating pairs compared to individual controls. In the discussion of these findings, they debated the possibility of pairs inhibiting each other rather then cross-cue each other in the used experimental setting. They suggest that a social phenomenon takes place within pairs that involves inhibition rather than facilitation. They also mention the assumption that a "part-list" effect (Slamecka, 1968) is involved in the found results. This effect arises if a list of words is presented to subjects for learning and then a subset of words is made available as potential aids to retrieval of the others. In fact, the presence of this part of the list actually inhibits the retrieval of the non-cued words compared to the control condition where no subset of the original list is provided at retrieval.

Basden & Basden (1995) offered an explanation for the part-list cuing effect that they called *retrieval strategy disruption*. They reported some experimental results that supported the hypothesis that inhibition results when a whole-list retrieval strategy is abandoned for a less effective part-list retrieval strategy.

Weldon & Bellinger (1997) reported two experiments that compared recall in nominal and collaborative groups with a group size of three. They reported that collaborative groups in both experiments recalled less than nominal groups and they showed that group members failed to retrieve items that they had previously recalled alone as individuals. They called this *collaborative inhibition*.

In the same year Basden, Basden, Bryner & Thomas (1997) generalized their explanation of the part-list cuing effect to collaborative recall settings in which each participant is exposed to the recall of the other group members. Because each participant's retrieval strategy is unique, the optimal retrieval orders would be at variance with one another. Each member in a collaborating group will not be able to stick to his or her own retrieval strategy in the face of the (subjectively seen as) "out-of-order" retrievals by other group members. Just as for participants faced with part-list cues, the person remembering in a group is likely to adopt a less efficient retrieval strategy than he or she would use when tested in isolation. As a consequence of this disrupted retrieval, recall in collaborative groups should be lower than that in nominal groups. Taking these considerations into account, Basden et al. (1997) ran a set of experiments on cross-cuing in the recall of studied information by groups of individuals working together compared to nominal control groups. The reported results showed that cross-cuing leads to collaborative inhibition. They therefore concluded that collaborative inhibition like part-list cuing is produced by a disruption of individual retrieval strategies in groups. This results in disorganized and less effective retrieval by each individual in the group.

Finlay, Hitch & Meudell (2000) replicated the inhibition effect found in previous studies of collaborative recall. Collaborative pairs consistently recalled fewer items than nominal pairs and failed to retrieve items they recalled in a previous individual free recall. Finlay et al. (2000) tested a number of predictions drawn from the retrieval strategy disruption explanation concluding that retrieval processes differ in individual and collaborative recall and that collaborative inhibition is due to people's tendency to disrupt one another's retrieval strategies in face-to-face groups.

There are methodological difficulties in the interpretation of the reported findings regarding cross-cuing in collaborating groups. Studying collaborative remembering in face-to-face groups is always influenced by the fact that only one person can speak at a time and the other group members have to listen without being able to express their own contributions. This *mutual production blocking* has been shown to be the main cause of productivity losses in brainstorming face-to-face-groups and we assume the same is true for face-to-face groups dealing with other memory tasks.

To test the assumed *retrieval strategy disruption effect* (Basden et al., 1997) independent from the influence of production blocking, we suggest using a different paradigm in future experiments, namely, a computer based paradigm. In brainstorming research, it could be shown that the performance level of nominal groups can be reached by computer based groups when all ideas can be entered simultaneously without members being blocked by each other (Gallupe, Bastianutti & Cooper, 1991).

However, even under conditions without production blocking, no increase in performance due to cross-cuing (Ziegler, Diehl & Zijlstra, 2000) could be shown. The lack of cognitive stimulation through the ideas of other people may be explained by the fact that the ideas of other group participants inhibit individual generation of ideas by retrieval strategy disruption. To be able to generate ideas creatively, it is necessary that knowledge becomes activated and accessible. If the retrieval strategies are interrupted, it is hard to combine different knowledge items into ideas.

We suggest that it is important to design experiments that control for the processes of production blocking and retrieval strategy disruption so as to study which kind of cuing can be efficient to enhance retrieval processes and therefore idea generation.

Self-cuing versus Cross-cuing

The current experiments used a paradigm which avoided mutual production blocking and retrieval strategy disruption. Cues were only available on demand at a time when the participants did not generate any more new ideas on their own. We implemented this *cue on demand* - action to be sure that the participants were really aligning their attention to the given cues. We wanted to test our hypothesis that self-cuing under certain conditions can enhance the performance of individuals.

Diehl (1991) showed that ideas following each other belong to the same semantic category if a person is brainstorming alone, i.e. ideas are produced in semantically related clusters. The individual clustering corresponds with the individual semantic memory structure. Clusters are broken off and people switch to a new semantic category if the process of thinking becomes too difficult and the pauses between the generated ideas begin to lengthen. The assumption that ideas that are located at the end of a cluster (ideas that have a long pause after their naming) are especially useful for cognitive stimulation is based on assumptions drawn from cognitive theories. The long-term memory is assumed to be organized in categories, localized sets of strongly connected and interrelated features. These categories are connected in a rich network with many associations and different levels (e.g. Anderson & Bower, 1973). When searching a category does not lead to the production of more new ideas, people switch to a new category. Before switching categories, usually the pauses between the generated ideas become longer because the associations to these ideas are less strong and are therefore hardly accessible. We hypothesized that if people were cued with the last idea out of a cluster, this self-cue would enhance performance by making those ideas and associations accessible that they would not be aware of on their first search. Self-cuing should make it possible to continue the retrieval of items from clusters that were broken off.

Experiment 1

The possibility to measure the individual temporal structure of idea production and to select ideas online allowed for a software-based selection of cues/ideas. The last idea of a cluster is characterized by the criterion *long pause after the last mentioned idea*. Looking at the individual differences of idea production processes, we developed an algorithm that uses individual time lengths in between the ideas. A "long pause" is therefore "long" compared to the other pauses of the person from whom the ideas are selected. The algorithm we developed selected 10 ideas/self cues for each person. To test whether *long pause* and *after the last mentioned idea* are both necessary conditions to detect these cues, we chose the following design which provided every possible combination of rules connected to our assumption for the selection algorithm and also included a control group without stimulation to have a comparable baseline (Mueller & Diehl, 2005).

Method

Participants

Participants in the first study were 77 students (29 males, 48 females) of the University of Tuebingen. Students' age ranged from 20 to 41 years (*M*=25.32; *SD*=4.81). Students were either paid 8 Euros for their participation or received credit for their participation.

Design

Table 1: Design first study

Position of pause	Length of the pause	
	Long pause	Short pause
Pause before last idea	N=14	N=12
Pause after last idea	N=14	N=12

Control condition without cuing (N=25).

Independent variables. A 2*2 factorial design was used, crossing length of the pause (long vs. short) with position of the pause (before vs. after the last idea) as principles for selecting ideas out of the individual idea production process. A control group as a baseline without cuing was also run.

Procedure. First the participants were informed verbally about the task and the brainstorming rules. The brainstorming topic was "What can you do to improve your health in everyday life?". Participants were then seated in front of a computer and asked first to generate ideas on their own and type them into the computer (for 15 minutes). The sequence and temporal structure of ideas were recorded by the software. According to the detected pauses between the mentioned ideas and the rules specified in the different conditions, 10 ideas/self cues were identified online.
In the second part of the experiment (lasting 20 min), the selected ideas were given to the participants on the screen on demand by clicking on a button. To make sure that no retrieval strategy disruption or self inhibition would occur in the experiment, participants were instructed to request a cue/idea only if they could not think of a new idea on their own.

Dependent variables. The major dependent variables were quantity of ideas (number of non-redundant ideas) and quality of ideas produced. To define high quality ideas different quality measures were used (originality, feasibility and effectiveness ratings on a 5-point scale). Multiple cut-offs on these dimensions resulted into the upper 33% of ideas. The number of ideas defined as high quality ideas within the different conditions were used as a dependent variable.

Scoring
Quality. The ideas recorded by the computer were assessed independently by 2 raters blind to condition. All ideas were rated for originality, feasibility and effectiveness on three 5-point scales. One rater classified all ideas, a second rater classified a subset of ideas (25 % of all idea). Reliability was assessed based on this subset. Intraclass correlations were calculated for all measures showing correlations between .60 and .79, all of them significant (p>.05).

Data analysis

Results: quantity of ideas.

Table 2: Mean number of ideas

Position of pause	Length of pause	
	Long pause	Short pause
Pause before last idea	*M*=28.07; *SD*=16.40	*M*=35.00; *SD*=19.54
Pause after last idea	*M*=42.14; *SD*=23.02	*M*=26.83; *SD*=10.73

Control condition: *M*=27.00; *SD*=12.91

A planned contrast between the experimental conditions and the control condition on the quantity of ideas showed no significant main effect for cognitive stimulation per se ($t(72)=1{,}68$; $p=.098$). An ANOVA on the quantity of ideas showed no significant main effect for length of pause and position of pause but a significant interaction between length and position of pause ($F(1,51)= 4{,}84$; $p=.033$). The criterion length of pause makes no difference if the pause is before the cue. If pause after the cue is used as a selection rule however, cuing is successful given a long pause.

Results: quality of ideas.

Table 3: Mean number of high quality ideas

Position of pause	Length of the pause	
	Long pause	Short pause
Pause before last idea	*M*= 9.36; *SD*=6.71	*M*= 8.50; *SD*=5.02
Pause after last idea	*M*=14.07; *SD*=6.22	*M*=12.67; *SD*=12.89

Control condition: *M*=8.88; *SD*=4.86

A planned contrast between the experimental conditions and the control condition on the number of high quality ideas (upper 33% regarding originality, feasibility and effectiveness) showed no significant main effect for cuing $t(72)=1{,}29$; p=.202. An ANOVA on the number of high quality ideas showed no significant main effect for length of pause. A nearly significant main effect for position of pause was found $F(1,51)=3{,}83$; p=.056). If the pause after the last mentioned idea is used as a criterion, the quality of the produced ideas increases. Length of the pause as criterion appears not to be relevant for the number of high quality ideas produced.

Discussion

Self-cuing did not stimulate idea generation per se. Self-cuing with the last idea out of a cluster according to the operationalisation *long pause* and *after the last mentioned idea* improved idea generation regarding the number of ideas. With respect to the number of high quality ideas, it seems to be of relevance that the self-cue is selected according to the pause after the idea.

Experiment 2

Looking at the results of the first study, we assume that self-cuing is an effective way to stimulate people in a brainstorming task if they are selected from the cluster ends. Cross-cuing with ideas of other people will not increase performance because they will not act as successful search cues in an associative memory system of another person. Therefore, we compared a cross-cuing setting similar to the self-cuing setting of the first experiment.

To test the assumption that self-cuing is superior to cross-cuing and no cuing, we designed the following experiment. The number of participants in the cross-cuing condition was higher because we needed pairs in this condition. The cues were again selected in the first part of the brainstorming session according to the rule *long pause after the last mentioned idea* and in the cross-cuing condition person A received the cues of person B and vice versa.

Method

Participants and task

Participants in the second study were 169 students (86 males, 83 females) of the University of Tuebingen. Students` age ranged from 18 to 52 years (*M*=24.74; *SD*=4.75). Students were paid 8 Euros or received credit for their participation.

Design

Table 4: Design second study

Stimulation	
Self-cuing	*N=49*
Cross-cuing	*N=76*
No cuing	*N=44*

Independent variables. In a 1*3 factorial design self-cuing, cross-cuing and no cuing (control) conditions were carried out.

Procedure. The only difference compared to the procedure of the first experiment was a change in the topic of the brainstorming task ("What can you do to protect the environment in your everyday life?"). The self-cuing condition replicated the *long pause after the last idea*-condition of the first experiment. In the cross-cuing condition, the participants received the ideas of another person working simultaneously but alone and vice versa according to the same selection rules used in the self-cuing condition.

Dependent variables. The dependent variables were quantity of ideas (number of non-redundant ideas) and quality of ideas produced on the given topic. The quality dimensions originality, feasibility and effectiveness were ratings on a 5-point scale and according to multiple cut-offs, the upper third of the ideas were defined as high quality ideas.

Scoring

Quality. The ideas were assessed on three 5-point scales independently by 2 raters blind to condition on the dimensions originality, feasibility and effectiveness. Intraclass correlations were calculated for all dimensions, showing correlations between .60 and .91 which were all significant (p<.05).

Data analysis

Results: quantity of ideas.

Table 5: Mean number of ideas

Stimulation	
Self-cuing	*M*=26.43; *SD*=13.40
Cross-cuing	*M*=21.77; *SD*=11.11
No cuing	*M*=19.20; *SD*=13.43

Planned contrasts were calculated: First, the conditions cross-cuing and no cuing were contrasted. They showed no significant difference (t(166)=1,09; p=.276).This allowed for the next planned contrast in which self-cuing was contrasted with cross-cuing and no cuing taken together. This showed a highly significant difference (t(166)=2,79; p=.006). Participants in the self-cuing condition outperformed both other conditions.

Results: quality of ideas.

Table 6: Mean number of high quality ideas

Stimulation	
Self-cuing	*M*=10.75; *SD*=6.16
Cross-cuing	*M*=10.09; *SD*=6.55
No cuing	*M*=9.72; *SD*=7.52

Planned contrasts on the mean number of high quality ideas were calculated: First cross-cuing and no cuing were tested against each other. They showed no significant difference (t(166)=0,29; p=.772).
This allowed for the next planned contrast in which self-cuing was tested against cross-cuing and no cuing. No significant difference was found (t(166)=0,74; p=.462). The number of high quality ideas in the compared conditions did not differ significantly.

Discussion

Participants in the cross-cuing condition did not produce significantly more ideas than those in the condition without cuing. Participants in the self-cuing condition produced many more ideas than those in the cross-cuing condition and in the control group.
This shows again that self-cues from the cluster ends can increase people's performance much better in cuing new ideas than the ideas from another person can.
The number of high quality ideas produced, however, did not differ significantly between the different cuing conditions. Self-cues and cross-cues did not make a qualitative difference regarding the produced ideas.

General Discussion

Self-cuing according to the selection rules used for detecting the last idea of a cluster seems to be a good way to stimulate people in a brainstorming task in the used computer paradigm. This is in line with retrieval strategy interpretations: self-cuing can optimize knowledge retrieval strategies and thus enhance performance in a task that requires knowledge activation and retrieval to recombine knowledge items in a creative way to produce ideas. We found that cross-cues are not better than thinking without any cue given. However their stimulating potential is significantly poorer when compared to the self-cuing condition with ideas from the cluster ends. The used paradigm allows us to conclude that even under conditions free of blocking without retrieval strategy disruption, and with ensured attention focused on the given cross-cues from another person, these were not stimulating in the sense that they cued more ideas than a person can retrieve without any cuing. However, we did find a way to enhance individual performance in an idea generation task with online selected self-cues from the individual's cluster ends.
For future research, we suggest using a non confounded research paradigm to ensure that the retrieval strategy disruption explanation for the lower performance of collaborative remembering in groups is correct. The described positive effects of self-cues from the cluster ends should be studied in future research to find out more about the underlying processes of knowledge retrieval strategy optimization.

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References

Anderson, J.R. & Bower, G.H. (1973). *Human associative memory*. Washington, D.C.: Winston.

Basden, D.R. & Basden, B.H. (1995). Part-list cuing inhibition as retrieval strategy disruption. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21,* 1656-1669.

Basden, B.H. Basden, D.R., Bryner, S. & Thomas R.L. (1997). A Comparison of group and individual remembering: Does collaboration disrupt retrieval strategies? *Journal of Experimental Psychology: Learning, Memory and Cognition, 23 (5),* 1176-1189.

Diehl, M. (1991). Kollektive Kreativität. Zur Quantität und Qualität der Ideenproduktion in Kleingruppen. [Collective creativity: On quantity and quality of idea generation in small groups.] Habilitationsschrift University of Tuebingen.

Diehl, M. & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology, 53(3),* 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 (3),* 392-403.

Diehl, M. & Stroebe, W. (1995). Brainstorming. In Manstead, A.S.R & Hewstone, M. (Eds.). *The Blackwell Encyclopedia of Social Psychology.* Cambridge (USA): Blackwell.

Finlay, F., Hitch, G.J. & Meudell, P.R. (2000). Mutual inhibition in collaborative recall: Evidence for a retrieval-based account. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 26 (6), 1556-1567.

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

Lamm, H. & Trommsdorff, G. (1973). Group versus individual performance on tasks requiring ideational proficiency (brainstorming): A review. *European Journal of Social Psychology, 3(4),* 361-388.

Meudell, P.R., Hitch, G.J. & Kirby, P. (1992). Are two heads better than one? Experimental investigations of the social facilitation of memory. *Applied Cognitive Psychology, 6,* 525-543.

Meudell, P.R., Hitch, G.J. & Boyle, M.M. (1995). Collaboration in recall: Do pairs of people cross cue each other to produce new memories? *Quaterly Journal of Experimental Psychology, 48A,* 141-152.

Mueller, S.Ch. & Diehl, M. (2005). Cognitive stimulation in computer-supported idea generation. *Poster presented at the 27th Annual Conference of the Cognitive Science Society*. Stresa, Italy.

Mullen, B., Johnson, C. & Salas, E. (1991). Productivity loss in brainstorming groups: A meta-analytic integration. *Basic and Applied Social Psychology,* 12(1), 3-23.

Osborn, A.F. (1957). *Applied imagination*. New York. Scribner.

Slamecka, N. J. (1968). An examination of trace storage in free recall. *Journal of Experimental Psychology, 76,* 504-513.

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

Weldon, M.S. & Bellinger, K.D. (1997). Collective memory: Collaborative and individual processes in remembering. *Journal of Experimental Psychology: Learning, Memory and Cognition, 23,* 1160-1175.

Ziegler, R., Diehl, M. & Zijlstra, G. (2000). Idea Production in nominal and virtual groups: Does computer-mediated communication improve group brainstorming? *Group processes and intergroup relations, 3(2),* 141-158.