The Impact of Analogical Distance as a Mental Stimulus in Ideation Processes using Change of Perspective: Jumping

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Abstract

Over several decades, a variety of studies have analysed analogical thinking as a cognitive mechanism, in which the individual transfers information from similar situations or problems and uses it to solve problems. However, less research is given that focuses on the use of predefined analogies as external stimuli for the ideation process. As a result, there has been very little information available on how to use analogies in practice, i.e. during an ideation workshop.

This paper reports the results of an experiment that analysed the influence of predefined analogies on ideation processes using analogical thinking. Twenty-three students individually used analogous thinking in an ideation workshop with predefined near and far analogies as external stimuli. Results show some first indications that the distance of the analogies as well as the level of detail have an influence on the ideation outcomes.

1. Introduction

As a result of globalization and improvements in technology, the competitive pressure on companies and other organizations has increased dramatically. As a consequence, innovative capability has become more important. One aspect of this is the ability to produce ideas 'on demand' in order to solve specific challenges.

One technique for idea generation that has become recognized in this context is analogous thinking, i.e. the use of related situations to inspire ideas [2]. In this approach, similar situations are considered with a view to transferring known or imagined solutions to the task at hand. Analogies exist on a spectrum of conceptual distance to the original situation. For example, department store is a near or close analogy to a supermarket, while an airport might be considered to be a far or distant analogy.

As part of the design process of an ideation workshop, a facilitator must decide whether the group will develop their own analogies or use ones provided. In the latter case, he/she must make a judgement regarding their closeness or distance to the subject matter. Furthermore, he/she may or may not supply additional explanatory information about the analogies.

Until now, there has been very little information available on how to make these choices. The purpose of this paper is to partially rectify this situation. Thus, the research question is:

How do the characteristics of an analogy, used as an external stimulus, influence the ideation process of an individual using analogical thinking?

2. Knowledge base of ideation

2.1. A cognitive approach to ideation

According to Mednick [17], an ideation process can be assumed as the exploration and transformation of conceptual spaces of an individual to generate new ideas. Lubart [16] argues that in terms of a comprehensive understanding of the ideation process, researchers need to specify the fundamental sub-processes of an individual. Several researchers [5, 18, 19, 22, 26] have used cognitive models to specify and study these cognitive processes of an individual and their application to existing knowledge structures for the generation of ideas. For example, by adapting the model of memory retrieval [20], the cognitive model SIAM [19] specified a creative process as a controlled associative process that proceeds in two stages.

In the first stage, the individual activates previously acquired knowledge in the long-term memory (LTM) as a result to a search cue. The model assumes that knowledge in the LTM is partitioned into images: knowledge structures that consist of a central concept and a number of features of that

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concept or associations with that concept. Images have fuzzy boundaries, may overlap to a considerable degree, and have mutual associations. Thus, a concept within an image has links of different strength to other images that contain related concepts.

A search cue is generated in the working memory (WM), a temporary storage system that has limited capacity and functions, by external stimuli that are received through the five senses of the individual. The individual can modify a given search cue in the WM by adding previously retrieved knowledge or combining different stimuli. Which image in the LTM will be activated is probabilistic and depends on the association between the search cue and the concepts of the image. The activated image will be temporarily stored in the WM, after which the concepts and associations of that image become accessible.

In the second stage, active knowledge is used in the WM to generate ideas by forming new associations or by applying knowledge to a new domain [17]. The individual combines the concepts of the image with one another or with elements of the search cue. If the individual gets the impression that the active knowledge only leads to few new ideas, a new search cue needs to be generated.

Without any external stimuli, the individual will modify the search cue by adding previously generated ideas or activated knowledge. Thus, the activated knowledge areas will be semantically related to each other. As a result, the likelihood of forming new associations between previously unrelated images decreases and only a small area of the solution space will be considered [8].

2.2 Methods to support ideation

In practice, idea generation techniques provide a variety of approaches to support the cognitive processes of an individual. Most of these techniques provide a step-by-step sequence of actions or instructions to generate and use haptic, visual or acoustic stimuli. However, no clear guidelines have been available for the selection and combination of appropriated idea generation techniques for a given strategic goal. As a result, a facilitator needs experience for the design of ideation workshops.

From a research perspective, idea generation techniques provide different social and cognitive principles, which can be characterized by the following ingredients [14]:

- Algorithm - represents a principle that guides the cognitive activities of an individual.
- Format - defines how the group members interact during the ideation process as well as what tools or materials can be used to support the mental activities of the individuals.
- Setting - defines how to create an environment that supports the ideation process.

Common idea generation techniques can be analysed and compared against the three ingredients to capture given work tactics, which influence the cognitive and social activities of a group during ideation.

With regard to the ingredient Algorithm, the change of perspective paradigm represents a possible approach to analyse and compare the underlying principles of idea generation techniques. A change of perspective (CoP) is defined as 'a mental principle that uses external stimuli to activate larger areas of the knowledge network of an individual that would not be activated by an associative process' [14]. An analysis of common well-known known idea generation techniques shows that the underlying principles involved can be mapped onto three abstract principles [14]:

- Pumping - refers to a cognitive mechanism called application, the adaptive use of existing knowledge in its habitual context to generate new ideas [26]
- Jumping - refers to a cognitive mechanism called analogical thinking, in which the individual retrieves knowledge from different situations or problems to generate ideas [5, 7].
- Dumping - refers to the cognitive mechanism of challenging characteristic attributes of the creative task to generate a new perspective.

In practice, the change of perspective approach can be used to define and teach guidelines for the design of an ideation workshop [12]. Thereby, a pattern approach can be used to provide information on when to choose a change of perspective with regard to the given creative task. For example, the CoP: Jumping can be formalised as follow [14]:

Change of Perspective: Jumping

Input:
- *a creative task*

Output:
- *a set of possible solutions for the creative task*

Setup:
- *Ensure that participants understand the creative task.*

Process:
- *Let participants collect characteristic attributes of the creative task.*

- *Let participants collect analogous situations with the same characteristic attributes.*
- *Let participants collect similar creative tasks for the given analogous situations.*
- *Let participants collect solutions how the analogous creative tasks has been or might be solved.*
- *Let participants collect ideas how this solution can be applied to the original task.*

Different studies show the positive influence of external stimuli on the outcome of an ideation process [10, 15, 22]. With regard to CoP: Jumping, external stimuli can be used in different ways to guide the cognitive processes of an individual. For example, concepts of a creative task can guide an individual during the activation of analogous images. Furthermore, a set of predefined analogies can draw the individual's attention to specific characteristics of the predefined analogous image.

Research shows first indications that stimulus characteristics can be used to define rules for the design and use of stimuli for the activation of analogous images [15]. However, less research has focused on the design and use of predefined analogies. To close this research gap, the paper will discuss in the next section existing literature on analogical thinking and the use of external stimuli. Based on the literature review, assumptions and hypotheses will be introduced on how the characteristics of an analogy, used as an external stimulus, could influence the ideation process of an individual using analogical thinking.

3. Analogical thinking

Gentner [23] proposed a theory of analogy by the structure mapping theory. The theory assumed that knowledge is partitioned into domains, which represent a network of nodes and predicates. Nodes are proposed as concepts of this network, which are defined by their applied predicates. Predicates can be distinguished between attributes and relationships. Thus, attributes are predicates taking one argument, which describe properties of a node. Relations are predicates taking two or more arguments, which describe events, comparisons, or states applying to two or more notes or predicates. An analogy can be defined as a structure mapping process, where an individual maps attributes and/or relations between knowledge domains [23].

With regard to cognitive model SIAM, analogical thinking can be described as a multistage process. Confronted with a creative task, an individual creates a search cue in the WM to access useful knowledge domains in the LTM. This process will terminate when activating an image with an analogical connection to the creative task. An analogical connection is given, if relational predicates, but few or no attributes, can be mapped from the knowledge domain of the creative task to the analogous knowledge domain [23]. The activated image will be temporarily stored in the WM where the individual can map corresponding parts of the knowledge domains onto each other, and finally apply the transferred knowledge to generate ideas.

The amount of overlap in attributes and relations between the knowledge domains can be used to characterize an analogy on a continuum from 'near' at one extreme to 'far' at the other [23, 24]. Near analogies represent a relatively small conceptual distance between the knowledge domains. They often fall into the category of 'literal similarity' in terms of high degrees of both shared relations and shared attributes [23]. In contrast, far analogies have a limited amount of shared attributes and therefore represent a large conceptual distance between the knowledge domains.

A variety of studies have analysed the influence of near and far analogies on ideation processes [1, 2, 4, 6, 13]. From practice, Gassmann and Zeschky [6] have analysed how organisations use analogical thinking for the development of product innovations. The authors found that individuals only identify far analogies by abstracting the creative task to its structural relationships. Similar results were found by Kalogerakis et al. [13] who analysed the use of analogies in design and engineering consulting firms and propose a positive relation between the analogical distance and the solution novelty. Dahl and Mourau [2] used empirical studies to analyse the influence of different types of analogies on originality in concept ideation and design. They have focused on the use of external primes and found support that the existence of any concrete example can inhibits the use of far analogies.

4. Assumptions and hypotheses

Research indicates that far analogies can serve as the basis for 'mental leaps' which could enhance the originality of the resulting ideas [11]. However, no research can be found that focuses on the use of far analogies as external stimuli for the ideation process. Currently, external stimuli are used to represent examples of a possible solution for the creative task [2] or criteria for a good solution [22]. This represents a gap in research and practice. To gain further insight about the influence of external stimuli

on idea generation techniques, the paper focuses on the research question:

How do the characteristics of an analogy, used as an external stimulus, influence the ideation process of an individual using analogical thinking?

The identification of analogies typically depends on the cognitive abilities and the personal experience of an individual [2, 21]. Individuals can only activate analogies whose elements were already associated by the individual to the creative task [9]. In this context, individuals tend to activate well-known knowledge domains during analogous thinking rather than knowledge domains that show a large conceptual distance to the creative task (path-of-least resistance [24]). Therefore, in this paper it is assumed that:

During an analogical thinking process using no external stimuli, an individual will tend to activate and use near analogies rather than far analogies.

In contrast, stimulus characteristics can be used to define rules for the design and use of stimuli for the activation of analogous images [15]. Thereby, stimuli can represent predicates of the knowledge network of the creative task. These predicates can provide strongly as well as weakly related attributes and/or relations of the knowledge domains. As far analogies represent wildly discrepant domains, weakly related predicates could lead to more far analogies instead of predicate with a strong relation to the knowledge domain. Therefore, in this paper it is assumed that:

During an analogical thinking process using external stimuli, an individual can be guided to activate and use far analogies rather than near analogies.

The following null hypothesis is defined to investigate the influence of predefined analogies on ideation processes using analogical thinking.

H_0: *By using analogical thinking in combination with a set of predefined analogies as external stimuli, there is no significant impact of analogy characteristics on the outcome of the ideation process.*

As different studies have shown the positive influence of external stimuli on the outcome of an ideation process, the following hypothesis is defined:

H_1: *By using analogical thinking in combination with a set of predefined near analogies as external stimuli, individuals will generate a higher number of good ideas, compared to individuals using analogical thinking without a set of external stimuli.*

Research further indicates that far analogies can serve as the basis for 'mental leaps', which could enhance the originality of the resulting ideas [11].

H_2: *By using analogical thinking in combination with a set of predefined far analogies as external stimuli, individuals will generate a higher number of good ideas compared to individuals using analogical thinking in combination with a set of predefined near analogies or without a set of external stimuli.*

As far analogies represent wildly discrepant domains, further information about an analogy could support an individual to map corresponding parts of the knowledge domains onto each other, and finally to apply the transferred knowledge to generate ideas.

H_3: *By using analogical thinking in combination with a set of predefined far analogies as external stimuli with a higher level of detail, individuals will generate a higher number of good ideas, compared to individuals using analogical thinking in combination with a set of predefined far analogies with a lower level of detail.*

5. Evaluation of the hypotheses

An experiment was designed to evaluate the impact of predefined analogies on an ideation process using analogical thinking. The creative task was '*How can a supermarket increase its popularity among its customers?*' This task was used because all participants of the experiment were customers of a supermarket and therefore have knowledge about the creative task.

The CoP: Jumping was used to formalize and guide the ideation process. To analyse the impact of analogy distance, the experiment manipulates the use of external stimuli as an independent variable in a between-subjects design. During the design of the experiment, two data sets of analogies were used to generate a set of near and far analogies as external stimuli.

5.1. Selection of near analogies

A pre-study was used to generate near analogies for the creative task. According to the path-of-least resistance model [24], individuals tend to activate and use near analogies during analogous thinking rather than far analogies. In a result, the pre-study implements the first phase of an ideation process using analogical thinking to collect analogous situations for a supermarket.

During the pre-study, eleven PhD students from a large university participated individually. Each

participant received an introduction on how to use analogical thinking to generate ideas for a creative task. An example was used to demonstrate the process in detail. After the introduction, each participant received a sheet of paper containing the task to list all analogies for a supermarket that came to their mind. The participants were allowed to use as much time as needed to complete the task.

Adapting the procedure used by Ward et al. [25], *output dominance* was determined for each of the generated analogies. Thereby, the number of participants who listed a distinct analogy were counted. Each analogy was also coded for *rank*, defined as the average output position across all lists on which the analogy appeared. Furthermore, *output precedence* was computed to reflect the combined influence of frequency of listing and output position. Thereby, the output position of a distinct analogy in a list was subtracted from the total number of analogies in this list. The resulting values were summed for each analogy across the participants.

In total, the participants generate fifty-six distinct analogies for a supermarket (M: 11.18, SD: 4.69). Output dominance for these analogies ranged from 7 (for *building centre*) to 1. Table 1 includes all analogies that were listed by 3 or more participants, along with the output dominance, rank and output precedence.

Table 1. Output dominance (OD), rank, output precedence (OP) of the generated analogies, listed by 3 or more participants

analogy	OD	rank	OP
building centre	7	4.86	53
car dealer	6	6.50	39
shopping mall	6	4.33	58
food store	6	2.83	61
discount shop	5	6.60	33
department store	5	3.00	35
market	5	4.20	43
online shop	5	4.20	48
small corner shop	5	1.80	42
electronic shop	4	5.00	22
flea market	4	8.25	38
furniture shop	4	8.25	28
library	3	11.00	18
bookstore	3	12.33	6
drugstore	3	6.67	17

The analysis of the generated analogies shows a high output dominance and a low rank for analogies with a strong analogical connection to a creative task (e.g. *food store* (OD: 6, rank: 2.86) and *small corner shop* (OD: 5, rank: 1.80)). On the other hand, analogies with a low output dominance and a high rank show a weaker connection to the creative task (e.g. *bookstore* (OD: 3, rank: 12.33) and *library* (OD: 3, rank: 11.00). As near analogies represent a relatively small conceptual distance between the creative task to the analogous knowledge domain, a set of seven near analogies were selected by their high output dominance and their low rank:

building centre, car dealer, shopping mall, food store, market, online shop, small corner shop

5.1. Selection of far analogies

A set of far analogies were selected from a data set that were generated during an experiment by Knoll and Horton [15]. Similar to the given paper, the experimental design used the same creative task and analysed the influence of external stimuli on an ideation process using the CoP: Jumping. During the experiment, twenty-two participants were instructed to generate analogies by using statements about the creative task as external stimuli, which were characterized by their relationship to the context of the creative task.

Table 2. Output dominance (OD), number of stimuli: typical / relevant (T/R), typical / not relevant (T/¬R), not typical / relevant (¬T/R) and not typical / not relevant (¬T/¬R) that were used to generate an analogy

analogy	OD	T/R	T/¬R	¬T/R	¬T/¬R
building centre	13	6	17	1	2
car dealer	10	5	2	4	5
shopping mall	10	3	5	2	2
food store	9	7	12	2	0
discount shop	5	4	4	1	1
department store	6	5	3	2	4
market	7	8	2	0	0
online shop	14	14	11	3	0
small corner shop	6	5	1	1	0
electronic shop	8	8	4	0	5
flea market	5	6	1	0	0
furniture shop	9	2	9	1	2
library	13	2	9	3	3
bookstore	8	3	7	0	0
drugstore	8	8	5	0	1
airport	11	2	6	6	1
authority	11	1	2	11	1
financial institution	10	1	1	2	7
hairdresser	7	1	1	6	1
health facility	11	3	2	6	8
hotel	6	1	1	2	2

An external stimulus was characterized as *typical* if it describes the context of the creative task. For example, the context of the creative task '*How can a supermarket increase its popularity among its customers?*' is a supermarket. Concepts which are

strongly associated to the image *supermarket* are *has shopping carts* or *presents goods on long shelves.*

An external stimulus was characterized as *relevant* if it is strongly associated to the creative task itself. Here, the image *customer* provides concepts that represent problems (e.g. *at a supermarket you have to stand in a queue)* or purposes (e.g. *a supermarket treats everyone equally*) which can be used to generate ideas.

During the experiment, twenty external stimuli were used to generate analogies, five stimuli for each of the four categories: typical/relevant (T/R), typical/not-relevant (T/¬R), not-typical/relevant (¬T/R) and not-typical/not-relevant (¬T/¬R).

In total, the participants generate 465 distinct analogies (M: 44.91, SD: 6.89). Again, *output dominance* was determined for each of the generated analogies. Furthermore, the *number of stimuli* that lead to an analogy were counted to reflect the influence of stimuli characteristics. Table 2 includes some of these analogies along with the output dominance, and the number of stimuli.

The analysis shows that all analogies of the pre-study were also generated during this experiment. Thereby, analogies with a higher output dominance were generated by more stimuli with the characteristic '*typical*' instead of '*not typical*'. As far analogies represent a large conceptual distance between the knowledge domains, in this paper it is assumed that stimuli with the characteristic '*not typical'* will lead to more knowledge domains that shows a smaller amount of shared attributes between the creative task and the analogy. This property was used to select a set of far analogies that 1) were not listed during the pre-study of the near analogies and 2) shows a higher relation to '*not typical*' stimuli. From the data set, the following six far analogies were selected:

airport, authority, financial institution, hairdresser, health facility, hotel

5.3. Experimental design

An experiment with two phases was designed to evaluate the impact of predefined far and near analogies on an ideation process using analogical thinking. Twenty-three students from a large university participated individually in an ideation workshop, thirteen woman and ten men.

Upon arrival, a facilitator informed the participants verbally about the creative task of the experiment. Each participant received an introduction on how to use analogical thinking to generate ideas for a creative task. An example was used to demonstrate the process in detail.

5.3.1. Phase 1: Influence of near analogies as mental stimuli on an ideation process. During the first phase of the experiment, participants were split into the groups *Group-A1* and *Group-A2* (see Table 3, Phase 1). Participants in the control group with no stimuli condition (*Group-A1*) received the instructions to use individually analogous thinking for 15 minutes to generate solutions for the creative task: *'How can a supermarket increase its popularity among its customers?'*. During the experiment, the participants received a sheet of paper to list all analogies and resulting ideas for this task that came to mind.

Table 3. Group constellation of the participants (P01-P23) during the experiment

		Phase 2					
		Group-B1			Group-B2		
Phase 1	Group-A1	P01	P02	P03	P07	P08	P09
		P04	P05	P06	P10	P11	P12
	Group-A2	P13	P14	P15	P18	P19	P20
		P16	P17		P21	P22	P23

Participants in the group with stimuli condition (*Group-A2*) received the instructions to use individually a set of near analogies in an analogous thinking process to generate solutions for the creative task. The process sequence used can be described as follows:

Repeat the following steps until all of the provided stimuli have been used:

Step 1: *The participant receives a near analogy as a stimulus for the creative task.*

Step 2: *The participant uses individually the provided analogous situation to generate solution for the creative task, by thinking how this task has been or might be solved in this analogous situation (duration: 3 minutes).*

Each participant received a set of five randomly selected near analogies as mental stimuli. During the experiment, each of the seven near analogies was used not less than eight times as a mental stimulus. To assign resulting ideas to a provided analogous situation, the participants received a set of forms that documents these relations by predefined identification numbers.

5.3.2. Phase 2: Influence of far analogies as mental stimuli on an ideation process. To evaluate the impact of a stimuli description, the second phase of the experiment manipulates the level of detail of far analogies as an independent variable in a between-subjects design.

The participants were split into the groups *Group-B1* and *Group-B2* (see Table 3, Phase 2). Participants in the group with stimuli with a lower level of detail (*Group-B1*) received the instructions to use individually a set of far analogies in an analogous thinking process to generate solutions for the creative task *'How can a supermarket increase its popularity among its customers?'*. The process sequence used can be described as follows:

Repeat the following steps until all of the provided stimuli have been used:

Step 1: *The participant receives a far analogy as a stimulus for the creative task.*

Step 2: *The participant uses individually the provided analogous situation to generate solution for the creative task, by thinking how this task has been or might be solved in this analogous situation (duration: 4 minutes).*

Participants in the group with stimuli condition (*Group-B2*) received a set of far analogies in combination with further information that describes the relation between the analogy and the creative task. Furthermore, a set of specific features were provided for each of the analogies:

airport:
- *provides services for travellers*
- *provides a high safety standard*
- *provides an efficient logistic system*

authority:
- *provides services of the state*
- *has access to the personal data of the citizens*

financial institution:
- *provides financial services*
- *has access to the financial data of the customers*
- *provides access to online services*

hairdresser:
- *provides a wide range of hairdressing services*
- *touches the customers*
- *distinguishes between male and female customer*

health facility:
- *provides medical and nursing care*
- *has access to the medical data of the patients*
- *patients go there to increase their personal well-being*

hotel:
- *provides accommodation and catering*
- *provides further ancillary services such as laundry service, wellness offers, renting meeting rooms…*

The process sequence used can be described as follows:

Repeat the following steps until all of the provided stimuli have been used:

Step 1: *The participant receives a far analogy in combination with further information as a stimulus for the creative task.*

Step 2: *The participant uses individually the provided analogous situation and the further information to generate solutions for the creative task, by thinking how this task has been or might be solved in this analogous situation (duration: 4 minutes).*

Each participant of the two groups received a set of five randomly selected far analogies as mental stimuli. During the experiment, each of the six far analogies was used not less than nine times as a mental stimulus. To assign resulting ideas to a provided analogous situation, the participants received a set of forms that documents these relations by predefined identification numbers.

5.4. Analysis of the experiment results

A post experimental questionnaire was used to collect the impressions of the participants with the two phases of the experiment. The questionnaires used a Likert scale from 1 to 4, at what the value 4 represent the best value. Participants were asked to indicate for each phase of the experiment how difficult it was to generate ideas for the creative task, if they find the provided stimuli helpful to generate ideas and whether they felt restricted by the provided stimuli.

Generated ideas were digitalised including information on 1) the participant generated the idea 2) the analogy that was used as a stimulus, and 3) the position of the analogy in the set of stimuli of the participant. Adapting the procedure to restructure ideas before evaluation used by Dean et al. [3], statements for each participant were excluded that do not specifically address the creative task, that are general or ambiguous to the extent that their specific intent cannot be determined or represents a duplicate.

Three research assistants, who were blind to the condition, assessed the data set of ideas. The raters used a four-point scale to score the ideas for originality:

Score of 4: *the idea is not expressed before (rare, unusual) AND surprising*
Score of 3: *the idea is unusual, interesting*
Score of 2: *the idea is interesting*
Score of 1: *the idea is common, mundane, boring*

The procedure of scoring the ideas was as follow: In a first phase, each rater independently scored the ideas using the four-point scale. The raters achieved a 87.03 percent overlap in their lists. The raters then met to discuss and reconcile all discrepancies in a group decision workshop.

Currently, much academic papers in creativity research tend to use the idea-count, sum-of-quality, and average-quality measures to evaluate ideation interventions. From a practical point of view, these metrics are useless, since neither provides relevant information for real-life projects in which at most a handful of ideas can be implemented each of which should be of the highest possible quality. For this study, good-idea measure, as recommended by Reinig et al. [27], was used to evaluate the influence of near and far analogies on the ideation process. Thereby, three different good-idea-count measures were computed which represents different cluster of good ideas: number of ideas that were surprising and not expressed before (score of 4), number of ideas with were indicated as unusual or surprising (score of 3 or 4), and number of ideas that were not common (score of 2, 3 or 4).

5.4.1. Influence of near analogies According to the Hypothesis H_1, the analysis of the first phase of the experiment shows that individuals in the group *Group-A2* with a stimuli condition generated more ideas (M=17.55, SD=8.214) than individuals in the control group *Group-A1* with no stimuli condition (M=6.42, SD=2.575); t(11.795)=4.304, p=0.001. However, there was no significant different in the number of good ideas for stimuli and no stimuli conditions (shown in Table 4).

Table 4. Means, standard deviations and welch's t-test results of good-idea-count for near analogies

		Group-A1 control (N=12)			Group-A2 stimuli condition (N=11)			
		n	M	SD	n	M	SD	t-test
	idea-count	77	6.42	2.575	193	17.55	8.214	t = 4.304 df = 11.795 p = .001
good-idea-count	score (2,3,4)	8	0.67	0.778	21	1.91	2.256	t = 1.734 df = 12.170 p = .108
	score (3,4)	6	0.42	0.669	9	1.91	2.256	t = 2.11 df = 11.606 p = .057
	score (4)	3	0.25	0.452	0	0.00	0.000	t = 1.915 df = 11 p = .082

The analysis of the used analogies during the first phase shows that most of the generated and used analogies of the control group *Group-A1* were also generated during the pre-study to generate near analogies (e.g. *shopping mall, small corner shops, market* and *furniture shop*). However, none of these near analogies leads to a good idea with a score higher than 2. Rather, most individuals came up with new analogies at the end of the process (e.g. *tablet computer, factory* and *authority*), which lead to all of the unusual and surprising ideas.

In group *Group-A2* only the three near analogies: *building centre*, *car dealer* and *online shop* lead to good ideas with a score of 2 or 3. Only common ideas were generated by using the analogies: *food store*, *small corner shop* and *market*, which have a very strong relation to the creative task.

The analysis of the questionnaire shows that group *Group-A1* found it more difficult to generate ideas (M=2.58, SD=0.9) than group *Group-A2* with a stimuli condition (M=1.9, SD=0.3); t(14) = 2.45, p = 0.029. Otherwise, group *Group-A2* found the near analogies helpful to generate ideas (M=3.45 SD=0.69) but at the same time some individuals feel restricted by them (M=2.18 SD=0.6).

In conclusion, the presented Hypothesis H_1 could not be proved. The results show that during an analogical thinking process using no external stimuli, the individuals tend to activate near analogies at the beginning of the ideation process. As longer analogous thinking were used, as more far analogies were generated by the individuals. These far analogies also lead to more good ideas.

On the other hand, the use of near analogies as stimuli can support the generation of ideas but also increase the number of bad ideas. This could be a negative consequence as this situation can lead to an information overload during idea evaluation. With regard to the analogy characteristics, the experiment shows some indications that analogies with a strong relation to the creative task make it difficult for the individuals to generate unusual and surprising ideas.

5.4.2. Influence of far analogies According to the Hypothesis H_2, compared to the first phase of the experiment, all groups generated more good ideas by using far analogies. There was a significant difference in the number of good ideas (score for 3 or 4) for the individuals of the group *Group-A1* (P07-P12), who used far analogies with a higher level of detail during the second phase (M=2.17, SD=0.98) and no stimuli during the first phase (M=.33, SD=0.82); t(12)=3.51, p=0.006.

Table 5. Means, standard deviations and welch's t-test results of good-idea-count for far analogies

		Group-B1 control (N=12)			Group-B2 stimuli condition (N=11)			
		n	M	SD	n	M	SD	t-test
	idea-count	217	19.73	9.971	207	17.25	6.717	t = .692 df =17.324 p = .498
good-idea-count	score (2,3,4)	20	1.82	1.168	37	3.08	1.881	t = 1.955 df =18.582 p = .066
	score (3,4)	16	1.45	1.214	30	2.50	1.446	t = 1.883 df =20.855 p = .074
	score (4)	4	0.36	0.674	7	0.58	0.793	t = .718 df =20.896 p = .481

According to the Hypothesis H_3, the analysis shows no significant different in the number of good ideas for stimuli and no stimuli conditions (shown in Table 5). The analysis of the used analogies during the second phase shows that by the group *Group-B2* with stimuli condition all of the six analogies were used to generate good ideas (score for 3 or 4). In contrast, in the group *Group-B1* with no stimuli condition, the far analogy: *financial institution* only leads to good ideas that were not common (score of 2).

Finally, the analysis of the questionnaire shows no significant between the groups *Group-B1* and *Group-B2*. Both groups found the far analogies helpful to generate ideas (*Group-B1*: M=3.55 SD=0.69; *Group-B2*: M=3.08 SD=0.67) but at the same time group *Group-B2* feels more restricted by them (M=2.17 SD=0.58) as group *Group-B1* (M=1.73 SD=0.79).

In conclusion, the results provide no significant support for the Hypothesis H_2 and H_3. However, the data provide some indications that the level of detail of a far analogy has a positive influence on the ideation outcomes.

5.4.3. Limitations of the experiment results. A number of limitations exist in the experiment. As the study only used one creative task, results cannot be generalised to other tasks. Limitation is also given by the experimental design. As each group used far as well near analogies, the influence of the first phase on the outcome of second phase is still unclear. Another experiment is need to run the second phase independently from the first phase. Furthermore, a larger sample size is needed to reduce the effect of possible outliers in the measured data on the result.

6. Discussion and implications

This paper presents the results of an experiment that analysed the influence of external stimuli on the ideation process of an individual using analogical thinking. The results provide some first indications that predefined far analogies can be used as stimuli to enhance the originality of the resulting ideas. The practical implication for process designers is given in different ways.

In a group with domain expertise that is asked to generate analogies, the number of occurrences of any analogy is inversely proportional to its nearness. At the same time, in this paper it is determined that far analogies are better suited to generating high-quality ideas. For the facilitator, this implies that if he/she elects to let the group develop their own analogies, then the common analogies should then be discarded in favour of the more unique ones.

As a further guideline, participants tended to generate the far analogies towards the end of the allotted time, which suggests that enough time for analogy generation must be planned; a period that is short may result in no useful analogies being generated.

The data further provide some indications that the higher number of good ideas produced by far analogies over near analogies can be further enhanced by adding further detail to the analogies provided. For example, instead of just providing the far analogy "hairdresser", it is productive to include hints such as "distinguishes between male and female customers". Participants also state that they felt that these hints facilitate idea generation. These findings also have immediately applicable value for the practitioner.

An additional finding is that participants were not able to successfully apply analogical thinking on their own. Consequently, the facilitator must at least walk them through the method step by step, or even provide the analogies up front. Considering the potential for time-saving, the latter approach appears to be preferable.

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