

ANALOGICAL TRANSFER OF EMOTIONS

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ABSTRACT

The focus of this study is the possible influence analogy making may have upon emotions experienced in everyday life. More specifically we address the question of whether emotions inherently associated with one domain tend to be transferred to another domain via analogical mapping connections. In an experiment we demonstrate that emotional appraisal is indeed a subject to analogical transfer. We also find a substantive difference between the situation in which the two domains are meaningfully mapped and the situation in which these are simply associated because of being encountered simultaneously. We also demonstrate that at least in cases when there is no clear distinction between the two domains in terms of which domain is the base and which domain is the target there is a bidirectional emotional transfer which affects emotional attitudes towards objects from both the domains. Thus whenever a positively charged object is mapped onto a negatively charged object the positively charged object receives negative valence from the negatively charged object and vice versa.

INTRODUCTION

The debate about the interconnections between cognition and emotion is certainly not a new one (e.g. Lazarus 1982, Zajonc 1980). There have been two major directions of investigation of this relationship: the influences of emotions on cognitive processes (e.g. Bower 1981) and the influences of cognitive processes on emotions (e.g. Smith & Lazarus

1993). These topics of research are currently receiving some new insights as new theories of analogy making emerge. Nowadays analogy making is considered central to cognition by many researchers in the fields of cognitive science and psychology (e.g. Gentner 1983, Holyoak & Thagard 1989, Keane 1990).

New theories have claimed that processes involved in analogical reasoning can easily be used to explain other cognitive phenomena (including learning, memory, problem solving, etc.) thus providing a unified account of cognition with analogy making occupying its central space (e.g. Kokinov & Petrov 2001, Hofstadter 2001, Kokinov, Bliznashki, Kosev & Hristova 2007). No matter how promising such accounts appear sooner or later they will have to confront with the issue of how analogical reasoning relates to other psychological phenomena outside the realm of pure cognition. This task is especially challenging when it comes to the problem of emotion since it has been repeatedly demonstrated that emotion and cognition are closely interrelated. Nonetheless only an insignificant amount of empirical studies have addressed this issue.

Tohil and Holyoak (2000) investigated some aspects of the emotion – cognition direction of influence concerning analogical reasoning, demonstrating that situational anxiety systematically impairs subjects' ability to reason relationally. More specifically they found out that situational anxiety shifted subjects' attention towards the attributes of the problem space thus preempting them to take into account the relational structure of the task. This study provided a strong proof of

the notion that emotional state can indeed influence analogy making systematically.

Thagard and Shelley (2001) theoretically investigated the possible influence analogy making exerts on emotion. In this seminal work the authors distinguish between *analogies about emotions*, *analogies that transfer emotions* and *analogies that generate emotions*. We consider the issue of analogically transferred emotions as the most central of these, since transfer is supposed to be the crucial part of analogical reasoning, the part that generates new knowledge about the target domain. Thagard and Shelley propose that emotions are attached to the representation of a particular domain in a way that is similar to how ordinary facts are integrated. Thus an emotional state can easily be transferred from a source to a target along with the other transferred knowledge structures. The HOTCO model presented in their work makes the clear prediction that emotions are transferred the same way as other structures are as long as they are represented in the same way as ordinary objects and relations are.

Although this is a clear and intriguing prediction we have no knowledge of any empirical studies trying to test it.

In the current study we attempt to demonstrate that emotions can indeed be transferred via analogical mapping between two distinct domains.

EXPERIMENT

The goal in this experiment was to demonstrate that emotions inherently associated with given objects can be transferred from one object to another if these objects are included in certain relational structures and a meaningful mapping is established between them.

Design

The experiment included two parts. In the first part subjects saw pictorial stimuli of the type $A:B::C:D$ where A, B, C and D represented individual pictures. Subjects' task

was to make judgments about the degree to which the two sets (A:B and C:D) were analogical to each other.

There were three conditions in a between subject design. In the Analogy Condition subjects were forced to establish a meaningful mapping between the two sets of stimuli. Each of the two sets contained an emotionally valenced stimulus with set 1 containing a negatively valenced stimulus (a picture of a spider) and set 2 containing a positively valenced stimulus (a picture of a rabbit). In a so called Association Condition the same two objects were present but in a slightly modified context which changed the relational structure of the task and made it impossible for the subjects to create a meaningful mapping between the two sets. However the same two pictures of a rabbit and a spider were simultaneously present. In a Control Condition subjects were not presented with any of the two pictures and thus their baseline attitude towards the two stimuli was measured. After the first phase in an ostensibly unrelated task subjects were asked to evaluate different words on a seven point scale of emotional attitude with 1 representing a strong negative attitude towards the concept represented by a given word and 7 representing a strong positive attitude towards the same concept. The words "rabbit" and "spider" were included in the set of to-be evaluated words and their evaluations constituted our two dependent measures. There was no difference between the three experimental conditions during the second phase.

Stimuli

In the first phase of the experiment subjects were presented with several slides on a computer screen with each slide containing four different pictures. Two of the pictures were placed in the first row and two were placed in the second. The subjects' task was to use a seven point scale in order to indicate how analogical were the pictures on the first row to these on the second row. The last slides were different for the three groups and

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defined the levels of our independent variable. The three target slides are presented on Figure 1. In the slide depicting the Analogy Condition the objects in the first row and the objects in the last row represent the same relation (“eats”). More formally the analogical slide can be represented in the following way by means of the predicate calculus:

eat1(spider, fly)
eat2(rabbit, carrot)

Thus the pictures in this condition form a meaningful analogy.

The pictures in the second slide (the Association Condition) do not form a meaningful analogy:

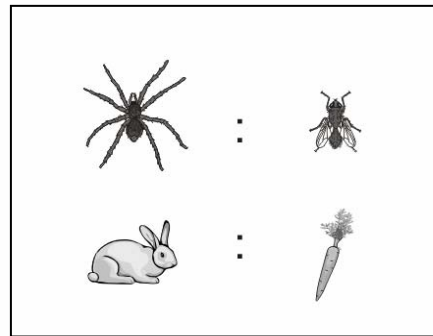
eat1(spider, fly)
have1(rabbit, ears)

Note that only the second picture on the last row was changed in that condition in order to preempt creating a meaningful mapping.

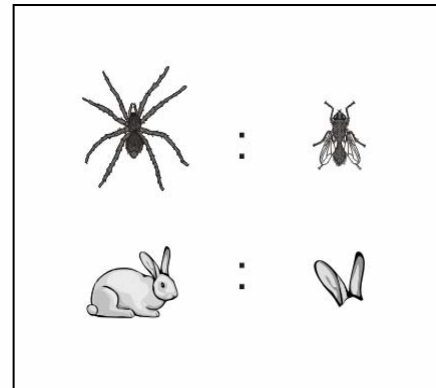
The last slide represents the Control Condition in which none of the emotionally valenced stimuli (rabbit and spider) are present.

Procedure

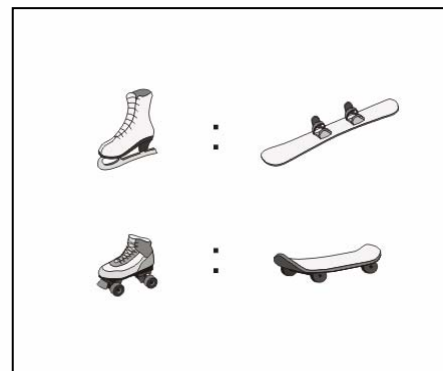
At the beginning of the experiment all subjects were instructed that they were about to participate in a pretest in which we tried to select the best out of six possible analogies. Thus the subjects were asked to use a seven point scale in order to indicate how good each of these analogies were with 1 meaning “not at all analogical” and 7 meaning “perfectly analogical”. Subjects were told that all analogies were of pictorial nature. Subjects were further instructed to judge the analogies on the basis of the relations between the objects depicted in the two rows and not on the basis of their semantic similarities. More specifically subjects were told to judge a given slide as analogical if the two objects in the first row



Analogy Condition



Association Condition



Control Condition

Figure 1. The target slides for the three experimental conditions. The condition each slide belongs to is listed right below it.

are connected in the same way as the two objects in the second row. The seven point

scale was shown below each of the six slides. The subjects experienced two practice trials (one in which the pictures formed a meaningful analogy and one in which they did not) during which the experimenter clarified further the task. All slides were consecutively presented on a computer screen with a five seconds blank ISI between them. Each slide was terminated when a subject pressed a button indicating her response. The software recorded subjects' responses on all slides. Five slides appeared before the target slides depicted above and served as filler trials. Thus there were six slides in the first phase of the experiment. All slides appeared in the same order for all participants with the target slides always appearing last. On all slides there were four pictures – two on the first and two on the last row. For all three groups there were three slides depicting meaningful analogies and three slides depicting pure associations (i.e. no meaningful connection existed between the pictures on the two rows)¹. The three levels of our dependent measure were formed by the three different slides shown on figure 1 above. The Analogy and the Association Conditions included pictures of a highly negatively valenced object (i.e. a spider) and of a moderately positively valenced object (i.e. a rabbit).

When the first stage of the experiment was over the subjects were asked to participate in a second (and ostensibly unrelated) pre-test in which they were to judge the likeableness of fifteen different words. All subjects agreed to participate in the second stage of the experiment. The subjects were instructed to use another seven point scale to indicate the degree to which they liked each

¹ Since the target slide in the Analogy and the Control Conditions depicted meaningful analogies and the slide in the Association Condition didn't we had to vary the content of one of the filler slides in order to ensure that all three groups experienced exactly three meaningful analogies and three pure associations. This was done in the same way as with the Association Condition – the second object in the last row of one of the filler slides was changed in order for that slide to form a meaningful analogy in the Association condition and a pure association in the other two conditions.

of the concepts associated with a given word. All fifteen words were presented consecutively at the center of a computer screen with a three seconds blank ISI between the different words. Each word stayed on the screen until the subject pressed a button indicating her response. After the response the trial was terminated and the next trial began. The two emotionally valenced words from the Analogy and the Association Conditions from the previous phase appeared in the set of the fifteen to-be-evaluated words. These two words always appeared in the seventh and in the twelfth ordinal positions with half of the subjects encountering the word "rabbit" in the seventh position and the word "spider" in the twelfth position while the other half experienced the reverse order. Thus the order of presentation of the two emotionally valenced words was counter balanced across participants. Subjects' evaluation of these two words constituted the two dependent variables in the study.

After the second stage the subjects were debriefed. None of the subjects showed any signs of awareness of the purpose of the experiment.

Participants

Sixty-four undergraduate students from NBU participated for partial course credit. There were 46 (72%) females and 18 (28%) males. These proportions were evenly distributed across the three groups.

Results and Discussion

Ten of the participants (16%) were excluded from the analysis because they failed to give a correct response to the target slide². Six subjects failed to appreciate the

² A wrong answer was defined as follows: On a meaningful analogy slide (the Control and the Analogy Conditions) an answer was considered wrong if the subject responded with four or less on the seven point scale. In the Association Condition an answer was scored wrong if the subject responded with four or more on the seven point scale.

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analogy in the Analogy Condition, two produced a false-positive answer to the association slide and two failed to appreciate the analogy in the Control Condition. Four other subjects (6%) were excluded from further analyses because their evaluations of either of the two emotionally valenced words were 1.96 standard deviations above or below the average of the condition they participated in. Thus we were left with 78% (50 subjects) of our original sample.

Table 1 below reports the means, the standard deviations and the number of participants within each condition:

Condition	Rabbit	Spider
Association (16)	6.2 (0.7)	1.6 (0.8)
Control (15)	5.6 (0.9)	1.9 (0.7)
Analogy (19)	4.8 (1.1)	2.7 (1.2)

Table 1. Means and standard deviations of the emotional evaluations of the words "rabbit" and "spider" for the three experimental conditions. The number of participants in each group is listed next to the name of each corresponding condition. The numbers in parentheses refer to the standard deviations of each condition.

These results are summarized in Figure 2.

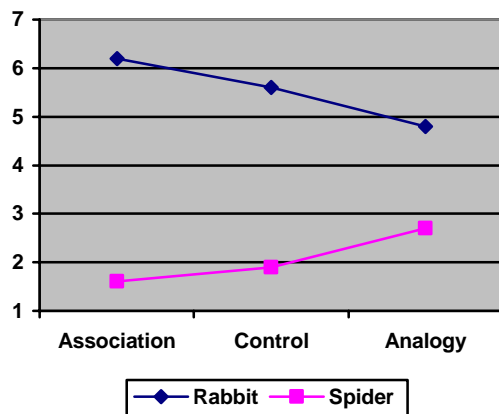


Figure 2. Emotional evaluation of the words "rabbit" and "spider" as a function of experimental condition.

It is easily seen that the trends in the data support our main hypothesis: The posi-

tively valenced word "rabbit" is shifted towards the negative end of the scale in the Analogy Condition whereas the negatively valenced word "spider" is shifted towards the positive end of the scale in the same condition. This trend is observed only in the Analogy Condition. Thus it seems that our experimental manipulation of the pictures (and more importantly of the relations they were involved in) in the first phase of the study had an effect on subjects' judgments about the corresponding concepts in the second phase.

In order to verify these observations we conducted a series of statistical analyses.

First we had to demonstrate that the two words in question were indeed emotionally valenced regardless of our experimental manipulations. In order to do this we took the evaluations of the subjects in the Control Condition and compared them to the irrelevance point (4) of our scale. Both one-sample t-tests were highly significant – $t(14)=6.8$, $p=0.000$ and $t(14)=-11.1$, $p=0.000$ for the words "rabbit" and "spider" respectively. Moreover we see that the word "spider" is much more a-priori emotionally valenced than the word "rabbit" (see also table 1).

Since we had two dependent measures we conducted a one factor MANOVA with the three conditions representing the levels of the independent variable and the evaluations of the two words representing two distinct dependent measures. The analysis indicated a highly significant overall effect – Wilk's $\Lambda(4, 92)=0.61$, $p=0.000$. Thus it appeared that our manipulation had a significant effect on emotional judgments. The univariate analyses of variance revealed significant effects both on the word "rabbit" – $F(2, 47)=9.1$, $p=0.000$ and on the word "spider" – $F(2, 47)=6.1$, $p=0.004$. None of the other words used during the second phase of the experiment showed significant differences between the three conditions at the 0.1 level, thus ruling out some possible artifacts of the procedure which may have contaminated our results.

Multiple comparisons for the word “rabbit” indicated significant differences between all three groups:

Control–Analogy: $t(32)=2.2$, $p=0.036$.
 Control–Association: $t(29)=-2.1$, $p=0.047$.
 Analogy–Association: $t(33)=4.4$, $p=0.000$.

Thus we see that the Analogy Condition significantly reduced the positive emotional valence of the word “rabbit”, presumably because of an emotional transfer of negatively valenced emotion from the picture of the spider towards the picture of the rabbit.

A similar pattern is observed when the evaluations for the word “spider” are concerned. Two of the three multiple comparisons appeared to indicate significant differences here:

Control–Analogy: $t(32)=-2.2$, $p=0.032$
 Control–Association: $t(29)=1.1$, $p=0.287$
 Analogy–Association: $t(33)=-3.1$, $p=0.004$

Four major points are to be made here:

1. The analogy between the pictures brought closer the emotional appraisal of their corresponding concepts. In other words the Analogy Condition produced an assimilation effect (e.g. Herr, Sherman & Fazio 1983) over the two emotionally valenced words.
2. This effect persisted over time since at least five minutes separated the two phases of the experiment.
3. This effect was not domain – specific since the analogy between pictorial objects influenced emotional judgments of conceptual entities.
4. A trend towards a contrast effect was present in the Association Condition (i.e. in that condition the emotionally valenced words seemed to be drawn apart relative to the Control Condition).

The only difference between the results from the evaluations of the two words seems to be that the “spider” word did not show a contrast effect in the Association Condition. We speculate that this was due to a floor effect – a trend towards a contrast effect is ob-

servable on figure 2, however it did not reach significance because the word “spider” was so negatively valenced a-priori that it could not go any “lower” on our scale after the experimental manipulation.

Our study demonstrates that analogies tend to produce assimilation effects between the two oppositely valenced stimuli. This implicates a bidirectional influence of both mapped stimuli – the positively valenced stimulus (rabbit) transfers positive emotion towards the negatively valenced (spider) and vice versa. Thus the positive stimulus becomes less positive and the negative stimulus becomes less negative in the Analogy Condition. This seems to be true at least in situations where no clear distinction is made between the sources and targets in a particular analogy as is the case with our study. This is because neither the pictures in the first row nor these in the second can be thought of as representing the base (or the target) of the task. This is exactly the case with our study since: 1) the two rows are both present simultaneously (none is retrieved from the LTM), 2) none of the rows involves missing information to be filled-up via transfer from the other row and 3) the subjects’ task was to judge the equality of the relations embodied in the two rows and the *equal* relation is reciprocal.

We collected further evidence for the bidirectional effects in both the Analogy Condition (assimilation) and in the Association Condition (contrast) in yet another way. Our reasoning was as follows: If *both* words are brought closer together by the analogical transfer of emotions between them and drawn apart by the pure association this would mean that the *total emotional valence* (positive for “rabbit” and negative for “spider”) experienced by the subjects in the different conditions should remain constant across conditions. To test whether this was so we averaged the evaluations of both words for each subject and subjected this newly created variable to a one-way ANOVA with our three groups representing the three levels of the analysis. The three means were 3.7, 3.9 and 3.8 for the Control, Association and the Anal-

ogy Conditions respectively. The lack of any significant difference was demonstrated by the ANOVA – $F(4, 47)=0.2, p=0.81$. Thus we see that *both* words are influenced reciprocally across the two experimental conditions with the Control Condition maintaining average values. That is in the Analogy Condition subjects experienced less polar emotions towards both stimuli (because of the stimuli exchanging emotions with other) while those in the Association Condition experienced more polar emotions relative to the Control Group (see figure 2). However if we average the positive emotions associated with “rabbit” and the negative emotions associated with “spider” we obtain similar values across the three conditions³.

We were able to demonstrate the bidirectional transfer by using a positively valenced and a negatively valenced stimuli. One may ask what would have happened if we used one valenced stimulus only (leaving the other one emotionally indifferent). We hypothesize that the emotionally indifferent stimulus would experience the same effect of analogical transfer and that this effect would be even stronger because the indifferent stimulus possesses no a-priori attached emotion which would serve as a constraint to the transfer. On the other hand we predict that the emotionally valenced stimulus would experience a weaker or no effect because no positive emotion can be transferred to it from the emotionally indifferent stimulus. The same

two predictions hold for the contrast effect found in the Association Condition. In our study the “spider” word was closer to the end of the emotion scale in the Control Condition than the “rabbit” word (see table 1 and figure 2). Thus if we are right we would expect to see a larger effect size for the more emotionally ambiguous word “rabbit” than for the unambiguous word “spider” because 1) for the word “spider” the stronger a-priori negative attitude is supposed impose a stronger constraint on the transfer of the positive emotions associated with the “rabbit” word and 2) the word “spider” possesses a “larger quantity” of emotion available for transfer onto the “rabbit” word than vice versa. Indeed there was a stronger overall effect size for the “rabbit” word than for the “spider” word – Adjusted $R^2_{\text{rabbit}}=0.26 > \text{Adjusted } R^2_{\text{spider}}=0.17$. These predictions however need further support.

The trend towards a contrast effect in our data was somewhat unexpected. We theorize that probably this contrast effect (in the case of the “rabbit” word) was due to the spider picture providing a contextual anchor against which the “rabbit” word was evaluated (Herr, Sherman & Fazio 1983). This was true for the Association Condition where no relation between the two stimuli existed and hence the spider stimulus could provide a contextual anchor for the rabbit stimulus but could not serve as a source for transfer. Such an explanation however needs additional investigation.

In order to further test our findings we subtracted the evaluation for the word “spider” from the evaluation of the word “rabbit” for each subject and subjected this newly created combined variable to a one-way ANOVA. We expected this difference to decrease in the Analogy Condition relative to the Control Condition (analogy-produced assimilation effect). We also tested whether this difference significantly increased in the Association Condition relative to the Control Condition (association-produced contrast effect). Figure 3 shows that this was exactly the case with our data. The average values for

³ By averaging the positive emotions inherent to the word “rabbit” and the negative emotions associated with the word “spider” we do not imply that positive and negative emotions can simply be aggregated. Obviously two opposite in valence emotions present in consciousness at a given time may have quite different behavioral consequences from two (or one) moderate emotional states although the average values may be the same in both cases. Here we simply wanted to demonstrate that the concepts associated with the words “rabbit” and “spider” were subjected to *approximately* equal (for as we shall see in a minute the word “rabbit” experienced a slightly larger effect size than the word “spider”) in magnitude influences across conditions which indicated a bidirectional emotional transfer in the Analogy Condition and (possibly) a bidirectional contrast effects in the Association Condition.

each group are reported above the corresponding bars in Figure 3.

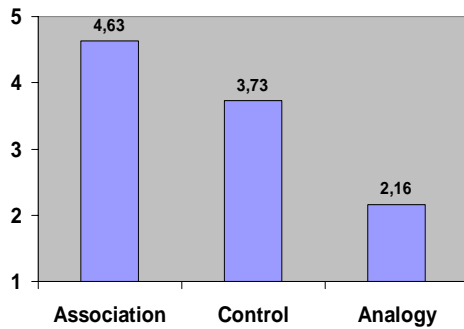


Figure 3. The difference (“spider” – “rabbit”) between the two emotional evaluations as a function of experimental condition. The average values for the three conditions are given above their corresponding bars.

The statistical analysis demonstrated a highly significant effect – $F(2, 47)=14.4$, $p=0.000$, Adjusted $R^2=0.35$. The pair wise comparison confirmed our expectations:

Control-Analogy: $t(32)=3.2$, $p=0.003$.

Control-Association: $t(29)=-2.1$, $p=0.045$.

Analogy-Association: $t(33)=-4.7$, $p=0.000$.

We see that the difference between the evaluations of the two stimuli produced the expected trend. Hence once again we obtained evidence for the notion that analogy resulted in mutual emotional transfer and assimilation while pure association produced a contrast effect⁴.

Thus we see that our manipulations significantly affected the relative positions of the tested words on the emotional scale but did not have any effect on their averaged emotional valences. That is the two words mutually repelled each other emotionally in the Association Condition and mutually trans-

ferred emotions to each other in the Analogy Condition.

CONCLUSION

We successfully demonstrated that analogy produces emotional transfer when the stimuli involved are a-priori emotionally valenced. We also found a significant contrast effect produced by pure association. It is worth mentioning that in our study the analogy-produced assimilation effect was stronger than the contrast effect found in the Association Condition in all analyses which implicates that the role analogy making plays in emotional experience is substantial and has been groundlessly neglected up to now.

In future studies we intend to further investigate these effects. More specifically we intend to:

- Replicate our findings by means of multiple analogies (contrasted with the single task used in the current study).
- Investigate the case where emotionally valenced stimuli are paired with emotionally indifferent stimuli. In such a case we would be able to compare the effects of analogical transfer on negative as well as positive emotions in a more straightforward way.
- Investigate whether the bidirectional influence found in this study still exists in the case when a clear distinction between the base and the target domains is drawn.

ACKNOWLEDGMENTS

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⁴ Although the contrast effect did not reach significance with the evaluations of the word “spider” alone here we see that the effect was significant when we analyze the difference between the two evaluations. Therefore this effect appears to be reliable in the experiment as whole.

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