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Thematic Integration in the Similarity of Abstract and Concrete Items

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Abstract

Thematic integration plays a role in similarity judgments of pairs of items that are unrelated taxonomically, like *soup* and *spoon*. We hypothesized that integration serves as a more central process in the similarity evaluation of abstract items because of their temporality, their large variability, and relational nature. Participants rated the similarity of concrete or abstract word pairs, followed by a written explanation of the ratings. Explanations were coded as thematic integration and taxonomic comparison. Consistent with our hypothesis, the rate of integration responses was higher overall for abstract items, and integration of abstract items occurred frequently even for item pairs for which taxonomic comparison was possible, unlike for concrete nouns.

Thematic Relation

Objects, persons, events, thoughts and other entities are situated in a spatial and temporal context, in which they are related systematically to other things. For example, a *spoon* is typically found in a kitchen or eating setting alongside a bowl and a fluid meal. A moment of *sadness* is typically preceded by some event that brought about this feeling in a person, and is reflected by specific behaviors. The action of *playing* involves one or more individuals, occasionally some toys, a set of rules, perhaps a framing event such as a party, and a setting such as a playroom, a gym, or a park. Thus, entities are related in everyday settings to other things and events through temporal sequences, functions and use, common locations, etc. Such thematic relations integrate entities into scenarios, such as specific settings commonly associated with particular activities and objects (e.g., the beach) or event sequences in which events are organized temporally or causally.

Relations of this kind have been explored in different lines of research. To name just a few, event sequences that are thematically organized form *scripts* (Schank & Abelson, 1977), organized schemata of actions, events, locations, and objects that are organized in memory as a unit. Objects have been shown to be associated with the settings in which they occur. If the spatial relations between an object and the contextual scene are violated, individuals' processing of a scene is slowed down (see Biederman, Glass, & Stacey, 1973; Biederman, Mezzanotte, & Rabinowitz, 1982). Entities can also be organized in "ad hoc categories" by the way in which they are used to achieve goals, broadly defined (Barsalou, 1983).

Thematic Integration

Individuals occasionally use information about relations among entities when they judge the similarity of items that

are not alignable (Bassok & Medin, 1997; Wisniewski & Bassok, 1999). In one of their experiments, Wisniewski and Bassok compared the explanations participants give for their similarity judgments for item pairs that varied in their taxonomic and thematic relation (1999, Exp. 1). Taxonomically related items were members of the same category (e.g., animals), unrelated items were members of distinct categories. The results showed that participants used thematic integration to justify ratings for item pairs that were taxonomically unrelated, but that were related thematically. For example, *tea* and *cup* were judged to be similar because *cups hold tea*, even though they are not similar.

Typically, when judging similarity, people evaluate the extent to which two items share common properties, set in some relation to their differences (Tversky, 1977). More recently, a more accurate prediction of similarity ratings has been achieved by measuring similarity as a function of the extent to which their properties can be aligned, that is, to what extent they share commonalities, such as being a vehicle of transportation, and alignable differences, such as two versus four wheels (e.g., Markman & Gentner, 1993). This differs markedly from what happens in integration according to a thematic relation. For example, items like *soup* and *spoon* should not be considered similar because their properties are different and not alignable. Yet, individuals appear to rate such nonalignable items as similar because they can be integrated thematically. Wisniewski and Bassok found that integration and comparison are in a tradeoff relation in the determination of similarity, where entities tend to be integrated only when individuals fail to align two items to be compared. Thus, if the items are taxonomically similar, e.g., *cat* and *mouse*, participants predominantly refer to their actual commonalities (*animal, alive, four legs*, etc.) rather than their thematic relation (*cats chase mice*). Only on other cases do participants resort to an integration strategy, and only if the item pairs are related thematically.

In this study, we explored the role of comparison of properties and thematic integration for *abstract* entities, as expressed by many verbs (e.g., *meeting, finding*) and abstract nouns (e.g., *thought, riddle*). In particular, given the characteristics of such entities, which are described below, we hypothesized that integration may be a more natural process for such items than property comparison, and thus may play a more central role in similarity judgments of such items than it does for concrete objects.

The Nature of Abstract Entities

Our prediction is based on three characteristics of abstract items which (among others) distinguish them from concrete

items. First, a majority of abstract items are temporal in nature and can thus be integrated quite flexibly into sequences of temporal or causal events. For example, the verbs *meeting* and *finding*, unrelated at first glance, could be integrated temporally as “one has to find a place before meeting someone”.

How general is the temporal nature of abstract items? Miller and Fellbaum (1991) describe taxonomies that accommodate all verbs and nouns in WordNet (Miller, 1990). In this model, all verbs fall into classes of action, event and state verbs. Likewise, roughly 13 out of 26 noun categories that contain abstract nouns can almost all be characterized temporally as processes and events (e.g., *communication*, *activity*, *cognition*) or as states (e.g., *feelings*). Thus, temporality can be considered a quite central characteristic of abstract entities.

Second, abstract items have been characterized as being more dependent on and closely linked to item-external entities and events (Gentner, 1981; Huttenlocher & Lui, 1979), thus perhaps making it easier to describe them in terms of their temporal co-occurrences, than in terms of their sparse internal structure. This point is further supported by the observation that individuals find it awkward and difficult to think of “properties” of abstract items, relative to concrete objects (e.g., Markman & Gentner, 1993).

Finally, abstract items allow for large variation in their exemplars because they abstract from a multitude of quite different concrete situations (Galbraith & Underwood, 1973). This allows individuals to construct specific exemplars in the context of an item comparison so that it can be integrated with the other item. We suspect that these three characteristics together contribute to integration being a frequent process in judging the similarity of two abstract items, making the abstract items more “compatible” with integration than with comparison.

Wisniewski and Bassok (1999) proposed that items that occur together in a scenario may be more compatible with integration while typically being nonalignable (i.e., belong to different taxonomic categories). While they were examining integration processes for concrete items, the principle argument can be extended to abstract items. If abstract items are characterized predominantly by external items and events and, being temporally defined, are part of event sequences, they may present a stimulus type that is most compatible with integration. Our experiment tested this possibility by comparing integration rates in a similarity judgment experiment for abstract versus concrete stimuli.

It is important to add that, due to the different nature of abstract and concrete entities, the thematic relations that they enter are also systematically different. Temporally defined entities presumably are related to each other temporally or causally (e.g., *traveling* comes before *arriving*), whereas objects are typically related through the settings or locations in which they occur (e.g., *syringe*, *band-aid*), or through complementary use (e.g., *table* and *chair*). This is evident in previous research. For example, when using noun-verb-noun triplets that describe simple scenarios involving an action, Bassok and Medin (1997)

observed examples for temporal and causal integration, whereas concrete object stimuli (Wisniewski & Bassok, 1999) were integrated through “static” relations such as function and location.

Experiment

We conducted an experiment with three types of words varied between three groups of participants: concrete nouns, abstract nouns, and verbs. For each group, 16 word pairs were constructed that varied with respect to their taxonomic similarity (same category membership, TX+, vs. different category membership, TX-), and the degree of thematic relatedness (high, TH+, vs. low, TH-). We expected for all three word types that integration would occur more frequently overall if word pairs were thematically related.

However, we predicted that taxonomic relatedness would only affect the rate of integration for concrete nouns, where integration should only occur if taxonomic comparison is not possible, consistent with previous findings (Wisniewski & Bassok). Thus, we expected to see a tradeoff relation for comparison and integration for concrete items according to which items are integrated only if alignment fails. We predicted that there would be no such tradeoff relation for abstract items. In contrast, we predicted that thematic relations would be considered more regularly in similarity judgments of abstract items (both verbs and nouns), and would be involved in the similarity evaluations independent of taxonomic relatedness. The reasoning is that integration of abstract items may be possible through flexible construction of a thematic relation for abstract items even if there is no obvious preexisting thematic relation.

We particularly expected a difference in integration responses for abstract versus concrete items in the conditions that allowed for an alternative, taxonomic justification of ratings (TX+TH+, TX-TH-). The conditions in which items are related only thematically (TX-TH+) or only taxonomically (TX+TH-) were not particularly interesting for our hypothesis because in such cases, individuals almost have no choice but to use the strategy suggested by the word materials. However, when item pairs are either related both taxonomically and thematically, or neither, the situation allows for either justification to be applied to the rating. One would expect that when participants have a choice, they would apply whichever strategy the items activate more naturally. We hypothesized that for abstract items, integration would be an equivalent procedure to taxonomic comparison when both are possible, in contrast to the predominance of taxonomic comparisons for concrete nouns.

Method

Participants were 54 college students at Northern Illinois University. Experiments were conducted in groups of 10-12 participants. Each participant rated the similarity of 16 word pairs in a booklet, and wrote down justifications for their ratings. The data were collected in a paper-and-pencil format. Each session took about 25 minutes.

Materials. Word type (concrete noun, abstract noun, and verb) was tested between subjects so that processes that may be specific to a particular word type would not influence the processing of other words. Taxonomic relatedness (allowing for comparison processes) and thematic relatedness (allowing for integration) were varied within subject in a 2 by 2 design, resulting in four sets of 4 word pairs that were either both taxonomically and thematically related, unrelated in both ways, or related in only one of the two ways. For each set of word pairs, 3 booklets were created that presented the word pairs in a different random order. The word pairs were always preceded by a three word pairs of a word type consistent with the set that included similar and dissimilar items, to provide a standardized similarity range. These items were not included in the analysis.

In previous studies on integration, item pairs were constructed so that the four conditions only differed in the second item of the word pairs (e.g., Wisniewski & Bassok, 1999). Because of the difficulties in constructing such sets for abstract items, we used different word pairs in each condition. Taxonomically related items were constructed by selecting two words from the same category, such as *cognitive processes* for verbs, *attributes* for abstract nouns, and *artifacts* for concrete nouns. Unrelated item pairs were selected from two distinctive categories. Within each level of similarity, half of the items were related thematically. Table 1 shows example pairs for abstract nouns (AN), concrete nouns (CN), and verbs (VB) that are either related thematically (TH+) or not (TH-), and related taxonomically (TX+) or not (TX-). Participants were instructed to rate the similarity for each word pair on a 6-point scale, where 1 indicated “not at all similar”, and 6 indicated “very similar”.

Table 1: Example word pairs for all conditions

		TH+	TH-
TX+	AN	weight, fullness	sadness, surprise
	CN	cat, mouse	giraffe, horse
	VB	asking, answering	losing, inheriting
TX-	AN	strategy, battle	thought, journey
	CN	hunter, deer	rubber, rose
	VB	snowing, skiing	talking, scratching

Results

The report of results will focus on the analysis of the explanations provided by participants for their similarity ratings, and more specifically, the rate of integration responses. This measure allows for the most direct test of the predictions. Other results will only be summarized briefly. Similarity ratings were significantly affected by both TH and TX for all but abstract nouns, for which TX had only a marginally significant effect ($p=0.071$). The mean ratings are shown in Table 2. As expected, the ratings were higher for conditions in which TX or TH or

both were high. No significant interactive effect on similarity ratings was found between TX and TH.

Table 2: Mean Similarity Ratings by Word Type and Relation Type

	TX+		TX-	
	TH+	TH-	TH+	TH-
Concrete Nouns	4.46	3.43	4.00	1.49
Abstract Nouns	4.11	3.46	3.83	2.04
Verbs	4.29	3.51	3.25	1.97

To test the predictions, the author and two coders who were trained but ignorant with respect to the experiment purpose classified the justifications. Items were coded in a random order so that the coders would not be cued into systematic variances in integrative versus comparative explanations. The coders coded all justifications either as comparison, integration, or uninformative. The last category was used to code items such as *they are similar*, which did not provide information beyond the rating. The percentage of uninformative justifications was highest for abstract nouns (almost 25% on a subset of 140), which is consistent with other research using abstract items in which participants find processing the items quite difficult. The initial coder agreement was tested on a set of 140 items. The agreement was not exactly high, but acceptable (78%). Differences in coding were resolved through discussion. The remaining coding was handled by the individual coders.

The first hypothesis was that the proportion of explanations related to thematic integration would be higher for relational terms than for concrete terms. Second, the rate of integration was expected to be higher for abstract item pairs in the two ambiguous conditions (TX+TH+ and TX-TH-). Third, we tested whether the proportion of integration justifications would be less affected by taxonomic relatedness for the relational terms.

Hypothesis 1. Our data supported the first hypothesis. Participants mentioned thematic integration as reasons for their ratings significantly more often for abstract items ($M=44%$ for abstract nouns and $M=45%$ for verbs) than for concrete nouns ($M=28%$), as measured by an item analysis of variance ($F(1,24)=5.61$, $p<0.05$). This effect was marginally significant in a subject analysis ($F(1,51)=2.99$, $p=0.06$). Thus, integration was a more central process in the similarity judgments for the relational terms.

To test the next two predictions, we computed the mean frequency of integration responses for abstract and concrete items for the four conditions. Figure 1 displays the proportions of integration-based explanations separately for word types and conditions. As expected, the proportion of integrations was significantly affected by the integration manipulation for all word types. That is, participants integrated more when item pairs were related thematically.

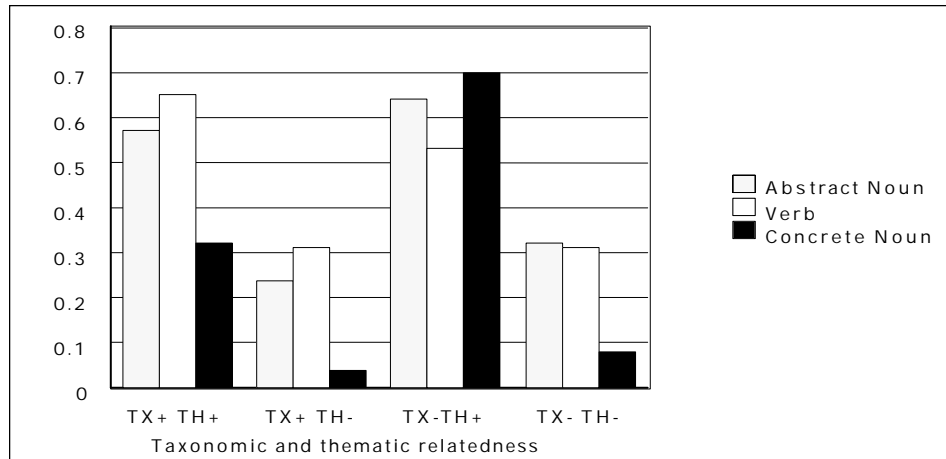


Figure 1: Integration rates for item pairs of high and low thematic (TH) and taxonomic (TX) relatedness.

Hypothesis 2. Figure 1 shows that in conditions where items were either both or neither related taxonomically and thematically, abstract items had higher integration rates than concrete items. This effect was significant as measured by an analysis of variance with the two extreme conditions, TX+TH+ and TX-TH-, as within subject variable and word type as between subject variable ($F(1,51)=7.43, p<0.05$). A post hoc analysis revealed significant differences between concrete nouns and verbs ($p<0.005$) and abstract nouns ($p<0.05$). There was no difference between the two types of abstract items. Thus, abstract item similarity judgments were justified with integration more often than concrete items when an alternative taxonomic justification was equally (un)likely.

Hypothesis 3. To what extent did taxonomic relatedness (TX) predict the rate of integrations for the three word types? We examined hypothesis 3 in two ways. First, we examined the statistical effect of TX on integration rate separately for the three word types. Second, we looked at the interaction of TX and TI to examine the “tradeoff” relationship between TX and TI as suggested for concrete items (Wisniewski & Bassok).

Overall, the rate of integration responses was significantly higher for concrete items that were not taxonomically related ($M=0.39$) than for the related ones ($M=0.18$) (subject analysis: $F(1,15)=39.47, p<0.001$; the item analysis revealed a marginally significant effect, $F(1,12)=4.64, p=0.052$). That is, participants used integration mostly when comparison was not possible. Again, this is consistent with the argument that integration is used only when stimuli cannot be aligned. For abstract items, TX had no significant effect on the proportion of integration responses. Participants used integration justifications equally often for abstract nouns that belonged to the same taxonomic category ($M=0.40$) or different ones ($M=0.48$). Likewise, verbs that belonged to the same taxonomic category were integrated equally often ($M=0.48$) as pairs from different ones ($M=0.42$). On average, abstract thematically related (TH+) pairs were

integrated by participants over half of the time in either taxonomic condition (TX+, TX-).

Wisniewski and Bassok (1999) found a tradeoff relation between integration and comparison for concrete stimuli, thus that nonalignable stimuli (here: taxonomically unrelated items) were integrated, but alignable (taxonomically related) items were not. We have argued that for abstract items, integration may be a quite natural process in similarity evaluations, and may thus also occur when taxonomic comparison is possible. A tradeoff relationship should express itself as an interactive effect such that integration responses are higher for thematically related items only if they are not related taxonomically. That is, we expected an interactive effect of thematic relation by taxonomic relation on integration rate. This effect was obtained for concrete items in a subject analysis ($F(1,15)=22.15, p<0.001$). The interaction was not significant in an item analysis ($p=0.12$). Figure 1 shows that the rate of integration was the highest for concrete items when there was a thematic, but not a taxonomic, relation.

Consistent with our predictions, the interactive effect was absent for abstract items in both item and subject analyses for both verbs and abstract nouns. Figure 1 shows that the mean rate of integration for both abstract word types did not differ between (TX+TH+) and (TX-TH+) conditions; neither did it differ for (TX+TH-) and (TX-TH-) conditions.

This pattern of differences for concrete nouns versus the two types of abstract items was found significant in a three-way interaction of TH, TX and word type, $F(2,51)=7.81, p<0.005$, as measured by a subject analysis with TX and TI as within-subject and word type as between-subject variable. That is, when taxonomic relatedness was low and thematic relation was present, the rate of integration was increased only for concrete nouns. This analysis suggests that integration and comparison are not in a tradeoff relation for abstract items.

Comparison Rates

Comparison rates across conditions mirrored the results we described for integration rates (see Figure 2). The comparison rate was higher for concrete items ($M=0.70$) than for either abstract nouns ($M=0.30$) or for verbs ($M=0.27$), $F(2,51)=30.08$, $p<0.001$. Thematic relatedness significantly affected comparison rates only for concrete items ($F(1,12)=36.84$, $p<0.001$), with a higher comparison rate when no thematic relation was present ($M=0.92$) than otherwise ($M=0.49$).

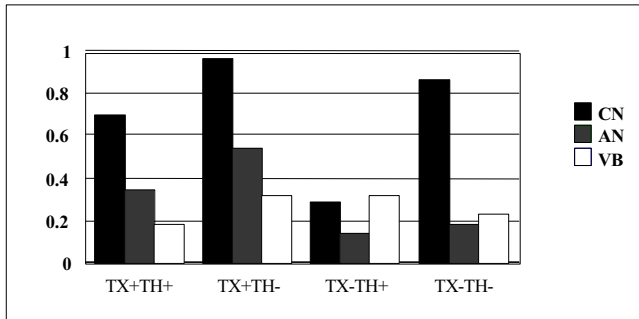


Figure 2: Comparison rates for item pairs of high and low thematic (TH) and taxonomic (TX) relatedness.

The comparison rates also supported the tradeoff effect for concrete nouns only. The comparison rate was lower in the “tradeoff condition”, TX-TH+, an expected mirror effect of the increase of integrations in this condition. Also, comparisons built the majority of justifications for concrete nouns in the TX+TH+ and TX-TH- conditions, just like integrations do for abstract items in the same conditions. Thus, participants mostly used comparison for concrete items and mostly integration for abstract items when either applied equally, that is, when thematic and taxonomic relatedness were either both present or both absent.

Discussion

We compared the use of thematic integration in similarity judgments of abstract and concrete items. We proposed that integration is a more natural and thus, more frequent process when individuals evaluate relations between abstract items, because they are relational, highly variable, and often temporal. In our experiment, participants provided written explanations for their similarity ratings of word pairs. The rate of integration was computed for word types in each of four conditions: item pairs that were related taxonomically and thematically, related only taxonomically, only thematically, or neither. We predicted and found that participants produce more integration justifications for abstract than for concrete items, averaged across items and conditions, and produce more integrations for abstract than for concrete items when comparisons are equally plausible as justifications. We predicted and found a tradeoff relation between comparison and integration only for concrete items, where integration occurs only when integration, but not comparison, is feasible.

Concrete Items

Our data were consistent with previous findings (Wisniewski & Bassok, 1999), replicating the tradeoff relation between comparison and integration processes for concrete items. Explanations for similarity ratings of concrete item pairs were integration-based frequently only if the items are not taxonomically related, and if they are thematically related (TX-TH+). For stimuli in this group, participants were quite resilient to obvious thematic relations, and found ways to compare the items that sometimes required looking beyond obvious features. For example, *dog* and *fence* were “somewhat similar” because “they both can serve as a form of protection”, *glass* and *water* because “they both are clear and translucent”, and *waiter* and *table* “both hold food”.

Abstract versus Concrete Items

In contrast to concrete items, abstract items were integrated frequently even if they were related taxonomically. This occurred about twice as often as for concrete items, consistent with our assumption that integrative processes occur more naturally in the processing of abstract items. Interestingly, abstract items were also frequently integrated when they were *not thematically related*. Some responses were quite creative. For example, *melancholy* and *purchase*, an abstract TX-TH- pair, was integrated as follows: “occasionally, purchases leads to feelings of remorse which may lead to melancholy or sadness”, or “a person may purchase a life long dream or wish, and find out that they are unhappy with their purchase”. Thus, participants seemed able to come up with flexible ways to integrate abstract items. This is consistent with the view that abstract entities can be integrated flexibly.

For concrete items, integration practically did not occur for thematically unrelated items. However, analogous to the creative integration of abstract items, participants creatively discovered comparison-based similarities of unrelated concrete items. For example, one participant rated *bumblebee* and *spoon* as quite similar because they are both “*shaped similar and oval*”. The item pair *bicycle* and *therapist* prompted the response “*they both can serve as a form of relief*”. It seems that concrete items offer as flexible ways to compare items either perceptually or functionally, as abstract items offer flexible ways for integration into event sequences.

This raises interesting questions regarding the basis for similarity in concrete versus abstract items. Integration is the exception for concrete item pairs when performing similarity ratings, and arguably does not lead to true similarity. Gentner and Brem (1999) showed that given training with feedback and sufficient time to make judgments, integration rates are reduced substantially in comparison to a limited-time condition. They argue for a confusability account, according to which integration does not play a legitimate role in similarity ratings, but affects ratings if the cognitive load disables proper metacognitive processing controls.

It will be interesting to explore this account with respect to abstract items, where, as we have shown, integration

occurs as a predominant processing strategy. This may indicate an overwhelming demand on the processing capacity for all abstract items, consistent with the argument that integration is unrelated to similarity processing. Alternatively, integration may be centrally related to the similarity of abstract items. For example, it is possible that abstract items that have properties in common can also be integrated more easily. On a related note, integration may also be relevant in the categorization of abstract items. It has recently been shown that integration is used in categorization of concrete items when thematic relations offer an equivalent sorting strategy to taxonomic similarity (e.g., Lin & Murphy, 2001). Considering the high integration rate in the current study, it is very likely that integration may also feature prominently in classification of abstract items.

Item Variability

Abstract entities were described as being variable because they abstract from quite different situations (Galbraith & Underwood, 1973), leaving many aspects of their actual occurrence in a concrete context unspecified. For example, an idea may be brilliant and positive in one context and have impact on many people, in a different scenario, an idea can be bad and have terrible consequences. To the extent that the abstract entity is underspecified in memory, participants were able to flexibly construct a specific example that can be integrated with the other item. For example, *surprise* and *sadness*, two items which are taxonomically related (*emotions*) but not thematically, twice prompted the justification “*sometimes surprises are bad, which can lead to sadness*”.

Flexibility of Integration

An example of the remarkable flexibility of integration processes in abstract nouns is the item pair “thought, journey”, which was an item pair in the unrelated condition (TX-TH-). The taxonomic explanation, provided by a few participants, would be the distinction between a *mental event* and a *physical action*. There was a large number of integrations, in which thought and journey were integrated in various ways that illustrate how easily individuals can integrate two unrelated abstract items in creative and variable ways. Thought and journey were integrated temporally as concurrent processes (“thoughts and thinking can be involved in a journey”, “most people have time to think when he/she on long trips”), as one requiring the other (“on any journey you will need much thought”), as thoughts preceding the journey (“a lot of people or couples give thought into taking a vacation”, “a journey starts with a thought”), or with the journey being conceptualized as a mental experience to integrate it with thought (“our thoughts often take us on journeys through imagined experiences”).

It seems, thus, that abstract items with no predetermined thematic relation are so unconstrained in how to be related to another item that they can not only be integrated, but can be integrated in different ways. Explanations at this point must be speculative, but this variability may be related to

the variability of abstract items’ contexts. Presumably, in each context in which a thought occurs, it is related to a different topic, preceded and followed by different actions, and so on. Abstract items are only little constrained with respect to what situations they can occur in. It may be in consequence of this that people can integrate unrelated abstract items in so many different ways.

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