

2008. Shen Y. & Eisenamn, R., “‘Heard melodies are sweet, but those unheard are sweeter’: Synaesthesia and cognition”. *Language and Literature* (17:2), 101-121.

“‘Heard melodies are sweet, but those unheard are sweeter”’: Synaesthetic metaphors and cognition.*

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*** This research was supported by THE ISRAEL SCIENCE FOUNDATION administered by THE ISRAEL ACADEMY OF SCIENCES AND HUMANITIES, no. 939/02, and 878/05**

ABSTRACT

Synaesthetic metaphors exhibit a robust tendency to use the "lower-to-higher" structure more frequently than the inverse one. This robust pattern was found across discourse types (poetic and non-poetic discourse), language boundaries (e.g., English, Hebrew, Arabic, Chinese, Japanese), and historical periods.

A cognitive account of this pattern was introduced, according to which this lower-to-higher mapping reflects a cognitively simpler and more basic directionality than the inverse one. Several predictions that follow from this account were tested, using various psychological measures (interpretation generation, recall, difficulty in context generation, and naturalness judgments), and various linguistic forms (noun-adjective constructions, and verb phrases with two conjoined modifying adjectives).

In accordance with the present account, it was found that the lower-to-higher structure is easier to assign a meaning to, is judged as more natural than its inverse, is better recalled and is judged as easier to construct a context for. Furthermore, sentence ordering is judged as more natural when lower sensory adjectives precede higher ones than in the opposite ordering.

Synaesthesia (Greek, *syn* = together + *aisthesis* = perception) is a fascinating psychological condition as well as a linguistic phenomenon that has attracted scholars from various disciplines for a long time (for a thorough, updated review see Dann 1999). As a psychological phenomenon 'synaesthesia' refers to the involuntary experience of a cross-modal association. That is, the stimulation of one sensory modality reliably creates a perception in one or more other senses, such as seeing a particular color every time you hear a particular sound. However, this psychological phenomenon is quite rare (see Cytowic 1989; 1993). In contrast, the linguistic use of synaesthetic metaphors is fairly common. These are metaphorical expressions in which we talk about a concept from one sensory domain in terms of another sensory domain. For example, in "heard melodies are sweet" Keats is talking about an auditory concept (heard melodies) in terms of sweetness, which belongs to the domain of taste. When we say "a cold light" we are talking about light, which belongs to the visual domain, in terms of coldness, which belongs to the tactile domain. In more technical terms, we may describe the synaesthesia "sweet melodies" as consisting of a mapping from the source domain of taste onto the target domain of sound. For the sake of simplicity, in all the following examples the source of the mapping is represented by the adjective and the target by the noun.

Previously, researchers on synaesthesia focused mainly on the first phenomenon, namely, synaesthesia as a psychological condition (see Dann 1999 for a review). Those interested in synaesthetic metaphor have focused on questions such as: What is the difference between synaesthetic metaphor and other metaphor types? What are the communicative and esthetic functions of synaesthesia? To what extent is it a universal phenomenon? What role does synaesthetic metaphors play in the writings of individual writers or schools of writing? (see Dann 1999, Abraham 1987).

Dombi (1974, 23) distinguishes among three types of studies of synaesthesia in poetry:

The first type treats the sensorial combinations of a single poet devoting sometimes a distinct chapter to this phenomenon within the framework of characterization of the individual style. On St. Ullman's suggestion a new type of study appeared, which studies the problem of synaesthesia parallels in the style of several poets. The third type of study tends to give a comprehensive view about the synaesthesiae characteristic of a literary school or a certain period.

Tsur (1987) introduces another type of study, namely, the exploration of "the nature of individual synaesthetic transfers, their perceived qualities...as well as their contribution to their more immediate context in the poem as a whole" (p. 214).

One major issue that most of these studies have ignored is that of the directionality of mapping in synaesthetic metaphors as they are used in poetic and non-poetic language (for exceptions, see Ullman 1957; Day 1996; Shen 1997) - that is, the question of whether certain modalities are more likely to be mapped onto others, or whether any modality can be mapped onto any other. In the first section of the paper we review evidence from different sources for the claim that synaesthetic metaphors do exhibit a general pattern across contexts. In the second section we introduce a series of experiments that provide empirical support for a cognitive account of this pattern.

Section 1: The structural options: the "low to high" and "high to low" mapping

It is commonly assumed (see e.g., Ullman 1957; Tsur 1992; Day 1996; Cytowic 1989; 1993) that the perceptual modalities are organized along a scale ranging from the 'highest' modality - sight - followed (in this order) by sound, smell, taste - to the 'lowest' sense, namely, touch.

Given this scale or hierarchy, any synaesthetic metaphor may exhibit either a mapping from a lower to a higher modality or vice versa.

Compare, for example, the following two instances of synaesthesia:

[1a] sweet melody

[1b] melodious sweetness.

In [1a] the direction of mapping from source to target is a lower to higher mapping: the source term (i.e., the adjective *sweet*) belongs to a lower modality on the scale than the target melody. By contrast, [1b] represents the opposite directionality: from a higher to a lower modality. Given these two basic structural options, the question of directionality in poetic synaesthesia can be formulated more precisely: Do synaesthetic metaphors occurring in natural discourse make use of one of these two options more frequently than the other, across contexts? In other words, is there a universal preference for one of the options over the other?

Elsewhere (see Shen 1997; Shen & Cohen 1998) the first author have described this pattern as characterizing mainly the use of synaesthetic metaphors in poetry. Those studies, however, were indeed restricted to poetry. The question remains whether this pattern characterizes only the language of poetry, or can be extended to other discourse types, such as literary prose and ordinary discourse. In what follows, we introduce and review additional studies that lend support to the claim that the lower-to-higher mapping pattern cuts across genre boundaries and can be extended to literary prose and ordinary language use (the latter corpus will be analyzed for diachronic meaning change).

We argue that the evidence suggests that the lower-to-higher mapping is a robust general pattern characterizing the use of synaesthetic metaphors in natural language in general, across types of discourse (e.g., literary vs. non-literary genres), novelty (i.e., novel vs. conventional uses of synaesthetic metaphors), languages and cultures.

WE begin by reviewing past research on the use of synaesthetic metaphors in poetry, and then move on to literary prose and ordinary discourse.

The evidence for lower-to higher-mappings in poetic discourse

Poetry

European poetry

Ullman (1957), in a seminal study on the topic of synaesthesia, sampled over 2000 synaesthetic metaphors extracted from the poetry of 12 nineteenth-century poets in three different European literary sources:

English, French and Hungarian poetry. An analysis of this large corpus revealed a clear-cut tendency (with a small number of exceptions) to use synaesthetic metaphors conforming to the above generalization rather than ones that do not. It is obvious (although Ullman himself is not explicit on this point) that this tendency would be even more marked if a chance distribution were taken as the standard of comparison.

It is noteworthy that there is a single exception to this generalization, involving the two highest modalities (i.e., sight and sound). Ullman points out that when a synaesthesia involves these two senses, each of them is equally likely to become either the target or source concept. The reason for this is not clear, though Ullman himself, as well as other researchers (e.g., Tsur 1992), have provided some initial suggestions.

In another study (Arsenic, n.d) a corpus of nineteenth and twentieth-century Serbo-Croatian poetry was studied, using 129 synaesthetic metaphors excerpted from over 1200 poems written by various poets belonging to different historical periods and poetic schools (e.g., Jovan Ducic of late symbolism, the futurists Todor Manjlovic and Miroslav Krleza, the surrealist Dusan Matic, and so forth). The analysis of the results revealed a similar pattern to the one found in the other poetic corpora: the lower-to-higher structure included 60 cases (79%), while only 16 (21%) of the cases represented the higher-to-lower structure (about 53 cases were the non-directional sight/sound cases, as explained above).

Chudnowsky (n.d.), who analyzed nineteenth and twentieth-century Russian poetry, found a similar pattern. Five periods in the evolution of Russian modern poetry were studied, each represented by four major poets. Out of 231 synaesthetic metaphors, 77% represented a lower-to-higher structure while only 23% represented the opposite mapping. There was not a single (sub) period or even a single poet for

which the higher-to-lower structure occurred more frequently than the lower-to-higher one. A similar finding was pointed out by Dombi (1974), who studied modern Romanian poetry.

Hebrew and Arabic Poetry

Elsewhere (see Shen 1997) a similar pattern was found in modern Hebrew poetry. Hebrew poetry introduces a different set of poets belonging to a different cultural environment. The corpus analyzed consisted of 130 instances of poetic synaesthesia taken from the writings of 20 modern Hebrew poets who wrote during the period from 1900 to 1980. The poets chosen represent four distinct historical periods in the evolution of Hebrew poetry, with substantially different poetic characteristics.

It is thus unlikely that the structural pattern emerging from this analysis could be attributed to contextual factors, such as the particular poems from which the synaesthesias were excerpted, or the individual poets who composed them, or the particular generation or poetic school with which a given poet is affiliated. The fact that the four poetic corpora (the three analyzed by Ullman and the one reported here) are four national literary corpora provides even stronger support for the generalization proposed. Therefore, there is no reason to assume that any of the specific contextual factors mentioned above could have affected the pattern of selection of the lower-to-higher mapping in the Hebrew and European samples.

Another poetic corpus that has been analyzed is a sample consisting of about 70 synaesthetic metaphors excerpted from modern Arabic poetry (Nil, abu-Amana: unpublished manuscript). The researcher found out that the majority of the cases (about 80%) conformed to the lower-to-higher mapping format rather than the alternative.

Literary and non-literary prose

Further support for this tendency was found by Manor (unpublished manuscript), who analyzed the use of synaesthetic metaphors in the novelette "Etzel", written by a well known Hebrew novelist, Uri

Genesis. Similar findings were found by Williams (1976) for English and Japanese, and for literary and ordinary language (Yu 2003).

The picture that emerges from all these studies suggests that the lower-to-higher mapping in synaesthetic metaphors is a robust pattern that cuts across various specific context. It appears in poetry as well as in prose, in literary as well as non-literary texts, in novel as well as conventional synaesthetic expressions, and in diverse and historically unrelated languages. Such a robust pattern calls for an account that is basic and general enough to explain it.

Diachronic meaning extension for sensory terms

Evidence from diachronic meaning extensions in various languages is also compatible with the above generalization. Thus, Williams (1976) who studied synaesthetic adjectives mainly in English (but also in Japanese and several Indo-European languages), came up with the following generalization:

If a lexeme metaphorically transfers from its earliest sensory meaning to another sensory modality, it will transfer from a lower to a higher modality (except for the sound-color modalities):

For example, 'sharp' may transfer to the domain of taste (sharp tastes), color (dull colors), or sound (soft sound). Taste words do not transfer back to tactile experience, but rather to higher modalities, such as smell (sour smell) (Williams, 1976; p. 463).

Considering languages other than those studied by Williams, Yu (1992) and Shen & Gadir (forthcoming) found a similar pattern for Chinese and Hebrew, respectively.

For example, the adjective **xad** means sharp in Biblical Hebrew, but it extends its meaning in post-Biblical Hebrew to other sensory domains, such as taste (as in "the mustard **mexaded**=sharpens their mouth") or smell (as in "the **xidud**=sharpness of the smell) and sound (as in "the voices of women and eunuchs are **xadim yoter** = sharper than the voices of the people").

Section 2: The cognitive account

Following Shen (1997) and Shen & Cohen (1998) we propose a cognitive account. It suggests that the lower-to-higher structure is cognitively more natural than its inverse. In this respect synaesthesia is but a special case of a cognitive principle which applies to metaphors in general. The principle states: **Mapping from a more accessible concept onto a less accessible one is more natural than the inverse.** This principle characterizes the direction of metaphorical mapping in general, as many studies have shown (see Shen 1997). For example, Lakoff and Johnson (1980), as well as Johnson (1986), have shown that the knowledge we have about concrete domains with which we have immediate contact via bodily experience, such as up-down orientation, physical objects, containers and the like, is projected onto less concrete (hence less accessible) domains, rather than vice versa. This unidirectional tendency is reflected in the verbal expressions we use in ordinary language. For example, we conceive of emotions using the source domain of orientation or containers, as revealed by our use of expressions such as *I feel up/down* or *he is full of anger/fear*. This mapping is clearly unidirectional, since we do not usually conceptualize orientations or containers in terms of emotions, and therefore there are no conventionalized expressions in language which reflect such a counter-directionality.

Applying this general cognitive principle to synaesthesia suggests that the concepts belonging to the lower senses, such as touch and taste, are more accessible than those belonging to higher senses, such as sound and sight (see also Shen & Cohen 1998).

This proposal results from two complementary considerations:

(1) A distinction can be drawn between experiencer-based and object-based sensations (for a related distinction see Viberg 1984). Experiencer-based sensations are those that are sensed as a physiological sensation of the experiencer, while object-based sensations are those that are understood as belonging to

the object taken as causing the sensation. Clearly, experiencer-based sensations are more concrete or immediate in that they represent a direct bodily experience.

It seems likely that lower sensations - namely, touch, taste, and, to a certain extent, smell - are experienced-based sensations. Cold and warmth, for example, are not perceived as belonging only to the cold or hot object but are also part of the experiencer's physiological sensation of heat or cold. In contrast, the sensation that something is white or has a quiet musical sound is not experienced as though it were an actual sensation of the experiencer's body (although it may occasionally happen that especially strong sensory stimuli are experienced in this way, such as a sharp light or a particularly high note).

(2) The senses are also distinguished by the level of immediacy of the connection between the sense and the object of perception. The lower senses – touch and taste – involve direct contact between the sensory modality and the object of perception. Smell does not necessarily entail such immediate and direct contact, although there generally is a kind of closeness between the body and the source of the smell; the higher senses – hearing and vision – do not even require the minimal distance required by the sense of smell.

Taken together, these characteristics of the sensory domain suggest that the lower the sensory term, the more immediate and concrete is the sensation it represents. The same logic that makes concrete concepts more accessible than abstract ones (in metaphorical mapping in general) also determines that lower sensory concepts are more ‘concrete,’ that is, more accessible, than higher ones. As in the case of metaphorical mapping in general, here too the cognitively preferred mapping is from a more concrete or immediate concept (the lower sensory modality) onto a less concrete and immediate concept.

Our proposal, then, is that the highly selective pattern of synaesthetic expression in natural discourse, across contexts, is accounted for by assuming that the use of synaesthesia in natural discourse is constrained by the above general cognitive principle.

In fact, we take the previously mentioned pattern of diachronic meaning change from lower to higher senses of synaesthetic expressions as suggesting that lower sensory domains are more accessible

and therefore more readily used as sources of meaning extensions than higher sensory domains. As pointed out by Sweetser (1990) and Lakoff (1987), it is usually the case that metaphorical meaning extension proceeds from more accessible (typically more concrete) domains to less accessible ones rather than the other way around. The fact that meaning extension proceeds from lower to higher sensory meanings is compatible with the claim that lower sensory meanings are more accessible than higher ones.

Experiments supporting the cognitive account

Certain predictions that follow from this account have been previously tested empirically. Thus Shen (1997) has introduced some empirical evidence supporting the prediction that the low-to-high structure is better recalled than its inverse. Shen & Cohen (1998), have further shown that the low-to-high structure is easier to interpret compared with its inverse. These studies, however, suffered from certain shortcomings that were corrected in the studies reported below:

(1) The selection of the experimental stimuli (in Hebrew) for the recall and interpretation-generation experiments (in Shen 1997) was not controlled for novelty\conventionality. This is an important factor that that could have influenced our results, since recall or ease of interpretation could be higher for conventional than for non-conventional synaesthetic metaphors.

(2) The experimental items in those experiments were limited to noun-adjective constructions (in Hebrew the adjective typically follows the noun). In two of the experiments reported below another type of linguistic forms was used, namely, a conjunction construction. If the above directionality principle applies to synaesthetic

metaphors, the preference for the lower-to-higher mapping should apply to various linguistic forms in which synaesthetic metaphors may be instantiated.

(3) The experimental tasks used in previous studies were limited to two - namely, interpretation generation and recall. To substantiate an adequate account for the robust pattern (of the more frequent use of the lower-to-higher mapping) described above, converging evidence from other types of experimental tasks will be added to the initial findings of the recall and interpretation tasks.

(4) The materials were not controlled for their equal distribution along the modality scale: the 10 potential configurations of synaesthetic metaphors (each of the five senses could be combined with each of the other four senses, thus yielding 10 potential configurations) were not equally represented in the item set.

As explained, these shortcomings were corrected in the following three experiments. These experiments provided a wide range of tasks that had not been used in our past research. In addition, the selection of the items was controlled for novelty and for equal distribution of the synaesthetic metaphors among the 10 potential configurations.

Experiments 1-2: Ordering sensory adjectives?

The goal of the first two experiments was to provide some initial (albeit indirect) support for the assumptions underlying the cognitive account we are proposing here, namely, that claim that the modality scale represents an accessibility scale where lower terms are more accessible than higher ones. So far, the only evidence supporting this assumption has been the linguistic evidence, previously discussed, according to which the predominant direction of meaning extension of synaesthetic adjectives is from lower to higher modalities rather than the other way

around. Note, however, that this linguistic evidence reflects diachronic historical processes, and cannot necessarily be taken to reflect psychological or cognitive processes that take place in the minds of individuals. Thus, in order to substantiate the claim that lower terms are, psychologically more accessible than higher ones, psychological measures are required. This is precisely the goal of the first experiment.

Consider, for example, the following sentence, in which two sensory adjectives predicate a certain noun: “Sara’s life was warm and bitter.” This form allows us to examine another aspect of the directionality issue, namely, the way synaesthetic adjectives are ordered in sentence structure, an issue which is directly related to accessibility. Previously it was argued (e.g., Shen 1997, 1998) that accessible terms tend to appear before less accessible ones. For example, in the metaphorical expression “On his way to war the soldier packed his shirt and grief,” which illustrates a typical word ordering in poetry (see Shen 1998 for a fuller discussion), the more accessible term, “shirt” (in the context of “things one packs”), tends to appear before the less accessible term “grief.” Thus, it was found (see Shen 1998) that in recall subjects tend to reverse the ordering of nouns in sentences in which the less accessible term precedes the more accessible one significantly more than they do for the reverse case. In another study, Kelly, Bock and Keil (1986) showed that sentences in which prototypical members of a category (i.e., more accessible ones) precede less prototypical members are judged as more natural than their inverse versions.

Given, then, the assumption that accessibility is related to adjective ordering, and given our assumption that lower sensory terms are more accessible than higher ones, we hypothesized that synaesthetic expressions in which lower sensory terms precede higher ones (as in “Sara’s life was warm and bitter”) will be judged as more natural, and will require shorter reading times than expressions in which higher sensory terms precede lower ones.

The goal of the following two experiments was to test these hypotheses.

Experiment 1: Naturalness judgments

Method

Subjects

Thirteen volunteer undergraduate students took part in the test as part of a course.

Materials

The test included 12 incomplete sentences with two synaesthetic adjectives (of two distinct sensory modalities) taken from the original list of nouns and adjectives used in Experiment 2.

Each sentence ended with an abstract noun and had two empty slots where the synaesthetic adjectives were to be inserted. The two adjectives followed the sentence, with one adjective placed above the other. In half of the cases the lower sensory adjective appeared on top of the higher one and in the second half they were in the opposite order. The sentences were presented in random order. The test had two versions. The only factor that was manipulated between the versions was the order in which the adjectives were presented. For every sentence, if in the first version the higher adjective was on top, then in the second version the same sentence appeared with the inverse order of adjectives. A few stimuli items are given below:

She hoped for a _____ and a _____ luck (sweet / scented).

Sara's life was full of a _____ and a _____ worry (warm / bitter)

The patient felt a _____ and a _____ pain (blunt / salty).

Procedure

In the written instructions the subjects were asked to complete the sentences with the given adjectives in the order they found most natural. They were also instructed to complete the task even if they found it difficult or strange at times.

Results

As predicted, subjects preferred to complete the sentences using the lower adjective first, followed by the higher adjective. This was the case for most subjects, as well as for most of the items. The significance of the effect was assessed in a one-tailed t-test for dependent variables. The significance for the subject analysis was $p < 0.01$, for the item analysis $p < 0.05$.

Experiment 2: how long does it take for people to read different orders of synaesthetic adjectives?

Method

Subjects: Twenty-four students at Tel-Aviv University were paid for their participation in the experiment. All were native Hebrew speakers.

Materials

The materials were identical to the ones used in the previous experiment. Each expression appeared with either the lower sensory adjective first (as in "The baby gave her mother a fragrant and colorful smile") or with the higher sensory adjective first (as in "The baby gave her mother a colorful and fragrant smile").

Thus, each of the two lists of the sentences contained examples with the same components as those in the other list, but in inverse order. Half of the sentences in each figure

conformed to the canonical directionality, while the other half conformed to the non-canonical directionality. The two lists were thus counterbalanced.

Each list also had two distracters and two practice items that were constructed in the same way as the other items, but with no difference between the literal/metaphorical level of the two nouns or adjectives.

Three computerized versions of the experiment were printed as booklets. In each version the subjects were given the following printed instructions: "Thanks for your cooperation. Soon you'll be given different kinds of sentences, one after the other. The sentences might seem unusual or odd to you. You are asked to read each sentence carefully and try to understand it, so as to answer questions about it at a later stage. When you feel that you understand the sentence, press the space bar. If you tried but you still do not understand it, press the marked bar on your left. Now put your right forefinger on the space bar and your left forefinger on the marked bar on your left, to get ready. We appreciate your cooperation. If you have any questions, please ask the experimenter. If instructions are clear, press the space bar." Then the subjects were told, "Now you'll see several practice sentences. Press the space bar when ready." The subjects were presented with two practice items. All sentences stayed on the screen until the subject responded. Following the subject's response we used a 850ms interstimulus interval to let subjects "rest and get ready again", to avoid automatic responses. Then the subjects were presented with the items of one kind and their distractors, in random order. Another instruction screen then appeared, "Now you'll see a different kind of sentence. Again, try to understand them so as to answer questions about them later on. When you understand the question, press the space bar. If you have tried to but still don't understand it, press the left marked bar". The subjects were then given two practice items and then the items themselves and their distractors, again in a random order. They were then thanked for their efforts and told to go to the experimenter who would ask them

the questions. The questions were "How was the task?". and "Do you have any remarks?" The subjects were thanked and paid.

The experiment was run on a PC computer, designed on Superlab software, on which the subjects' responses and response time were also recorded. The experiment was run individually in a quiet room.

Results and discussion

The time needed to understand inverted synesthesias ($m=5593\text{ms}$, $SD=2808$) was significantly longer than the time needed to understand standard synesthesias ($m=4785\text{ms}$, $SD=1884\text{ms}$); ($t(25)=2.31$, $p<0.03$).

As previously explained, we assumed that word order in this case reflects the greater accessibility of lower sensory adjectives over higher ones (for a similar position see Kelly, Bock and Keil 1986 and Shen 1998). This assumption is fully compatible with the findings regarding the diachronic meaning extension of sensory adjectives in diverse languages - from lower to higher meanings rather than the other way around.

Taken together, the findings of experiments 1 and 2 support the general hypothesis that lower sensory modalities are more accessible than higher ones.

Experiment 3: Naturalness judgments for synaesthetic metaphors

The second experiment was designed to find out whether the lower-to-higher structure would be judged by readers as more natural than the inverse. It has generally been assumed (following a large body of metaphor research, notably, Lakoff & Johnson 1980) that mapping

from a more accessible concept onto a less accessible one is more natural than the inverse mapping. Hence, we hypothesized that mapping from lower sensory terms onto higher ones would be judged by subjects to be more natural than the inverse. The present experiment tests this hypothesis.

Method

Subjects: Thirty undergraduate students at Tel Aviv University participated in the experiment as volunteers. All of them were native Hebrew speakers.

Materials

Twenty novel pairs of synaesthetic expressions were composed (these pairs differed from those used in the previous experiment, for which we have not controlled for conventionality). Each pair consisted of a lower-to-higher synaesthesia, (e.g., “perfumed rustle”) and a corresponding higher-to-lower synaesthesia (e.g., “rustling perfume”). These pairs were constructed as follows. Five nouns and their correlated adjectives were chosen for each sensory modality (in this experiment, both sight and sound terms were included in the experimental items, since we wanted to find out whether there would be differences between the two types, according to our general prediction). The nouns represented meanings directly reflecting certain sensory features, such as paleness, aroma, whisper, saltiness, roughness; we did not include nouns representing meanings of objects perceived by certain modalities (such as picture, song, etc.). The adjectives were selected in such a way as to exclude these that represent aesthetic predicates, such as tasty, beautiful or painful.

The nouns and adjectives were randomly combined, yielding non-familiar expressions. To control for the familiarity of the synaesthetic expressions (so that preference would not be determined by familiarity or conventionality) they were rated by four judges for their

conventionality. The judges were given a list of 40 synaesthetic expressions, half of which were conventional and familiar, while the other half were novel (representing the lower-to-higher mapping). The judges were asked to mark the familiar expressions. An expression was judged conventional if at least three of the four judges found it familiar. This procedure yielded twenty **novel** synaesthetic expressions (according to the judges' rating) that were used in the experiment.

Each combination of the 10 possible configurations was represented by two pairs (each of which consisted of a lower-to-higher structure and its corresponding higher-to-lower structure), yielding 20 pairs. For example, the smell and sight configuration was represented by two pairs, 'stinking paleness' (versus 'pale stink'), and 'smelly tan' (versus 'tanned smell'.)

Two booklets were prepared, differing in the internal order of the pairs of expressions. In one booklet the canonical directionality structure appeared above the 'non-canonical directionality and in the second booklet it was the opposite way around. The pairs were presented randomly. The 10 pairs that appeared first in one booklet appeared last in the second booklet (see Table 2). Thus the two booklets were counterbalanced.

Table 2: A selection of the two lists of synaesthesia

<i>Set 1:</i>	<i>Set 2:</i>
A hot bitterness	a bitterish heat
A salty bluntness	a blunt saltiness
A suntanned sharpness	a sharp suntan
A hot paleness	a pale heat
A whispering roughness	a rough whisper
A pale sourness	a sour paleness

Procedure

Subjects were given written instructions to choose the expression in each pair that seemed more natural to them. In addition they were asked to provide a brief explanation for their decision. This requirement was mainly intended to prevent the subjects from adhering to a certain strategy of decision, but also to allow us to see whether the choice was made for unconnected reasons.

Results and discussion

A one-tailed t-test for dependant variables revealed a significant effect of the sense directionality. As predicted, subjects significantly preferred the expressions in which the source represented a sense lower in the hierarchy than the target. This significance was found for both subject analysis ($p < 0.015$) and for item analysis ($p < 0.02$).

Thus, the first prediction was confirmed, namely, that subjects judge the lower-to-higher structure as representing a more natural structure than its inverse. Interestingly enough, this judgement was general enough to apply to all sensory modalities in the scale, including the visual and auditory ones. This is interesting since the visual-auditory combination was the only configuration of sensory modalities that did not exhibit the preference for lower-to-higher mapping in the poetic corpora analyzed. At this point we do not know how to account for this discrepancy between the textual and the psychological analyses.

Experiment 4: Recall for synaesthetic metaphors

Preference judgment is a conscious activity on the part of readers. To extend the evidence supporting the present account, we wanted to examine less conscious and less controlled processes underlying the comprehension of synaesthetic metaphors. We therefore conducted a recall experiment. We hypothesized that if the lower-to-higher structure is indeed cognitively more basic and simpler than the inverse, as suggested, then recall for this structure should be better than for the inverse.

Subjects: Twenty-one undergraduate students took part in the test as part of a course.

Materials: 12 synaesthetic metaphors were chosen out of the original list of 20 synaesthesias used for the previous experiment. There were two considerations that led us to reduce the number of items.

1. A recall task requires a great deal of attention on the part of the subject. Since a previous study (Shen 1997) had resulted in a very poor recall rate for synaesthetic metaphors, we wanted to reduce the memory load on the subjects by reducing the number of such metaphors that they would be asked to recall.

2. Given the previous consideration, we decided to discard the (two pairs of the) sight-sound combination. As previously explained, past research (e.g., Ullman 1957; Tsur 1992) has shown that the lower-to-higher structure does not necessarily apply to the sight-sound combination, in that the number of mappings from “sound” onto “sight” terms in poetry was not greater than that of the inverse structure. We therefore decided that discarding the sight-sound combination will not affect our general argument and would reduce the subjects' memory load.

Half of the 12 synaesthesias used conformed to the canonical directionality and half were in the non-canonical directionality. A corresponding inverted list was constructed for each of the synaesthesias, namely, for every canonical directionality synaesthesia in the first list a corresponding non-canonical directionality synaesthesia was constructed in the second list. There were thus two sets of 12 synaesthesias with identical components but inverse structures. This assured the counterbalancing of the two lists.

Procedure

The experiment was run in two separate classrooms, with each class receiving one of the two sets. The procedure was identical in the two groups. Subjects received a sheet of paper with a set of synaesthesias; the experimenter then read them the following instructions: “The following is a list of expressions which have appeared in various texts. Read them attentively, and try to remember them as they are, because you will be asked to recall them later on.” After finishing reading the expressions, the lists were collected and the subjects were given blank sheet of papers. After about five minutes the subjects were asked to write down whatever they could recall of the list they had read and heard. They were given ten minutes to this, after which the experimenter collected the lists.

Scoring

The subjects' recall was scored as follows: 2 points for full recall, 1 point for partial recall, no points for no recall. In most cases scoring the protocols was straightforward, although there were a few cases (6) in which a subject created a new expression, different from what had originally appeared on the list. These were actually blends consisting of a source concept (modifier) from one expression and a target concept (subject) from a different expression. These blended expressions were scored 1 point for partial recall.

Results and discussion

A one-tailed t-test analysis for dependant variables was performed. As predicted, the directionality had a significant effect on subjects' recall. Subjects did significantly better in recalling the expressions representing the lower-to-higher hierarchy than the inverse mapping. This effect was found significant for both subject analysis ($p < 0.033$) and item analysis ($p < 0.031$).

Experiment 5: Ease or difficulty of generating a context for synaesthetic metaphors

In the next experiment, subjects were presented with a different task than those used in the previous two experiments. Subjects in the present experiment were required to generate a context and use introspection to evaluate the degree of difficulty of doing so. We assumed that this task would allow us to explore the cognitive account from a different angle. The assumption was that in order to generate a context one has to first generate an interpretation of the expression in question and then access some context which is compatible with this interpretation. In this respect context generation is part of a comprehension process, and might shed some light on the entire process. In accordance with our general account, we hypothesized that subjects would find it more difficult to generate a context for non-canonical than for canonical synaesthetic metaphors.

Method

Subjects: 24 undergraduate volunteer students took part in this experiment as part of a course.

Materials: For this study 18 items were used. They included all the items used for first experiment, except for the two instantiations of sight and sound (the reason for this is discussed in Experiment 2).

Half of the 18 synaesthesias used conformed to the canonical directionality and half had non-canonical directionality (Set 1). A corresponding inverted list (Set 2) was constructed for each of the synaesthesias - namely, for every canonical-directionality synaesthesia in the first list a corresponding non-canonical-directionality synaesthesia was constructed in the second list.

Hence there were two sets of 18 synaesthesias with identical components, but with inverse structure. The expressions were presented in random order. The first 10 expressions in Set 1 appeared last in Set 2. Thus the two sets were counterbalanced.

Procedure

Each subject was given one of the two versions of the questionnaires (all in all, 11 subjects received Set 1 and 13 subjects received Set 2). Subjects were given written to try to provide a context in which each of the expressions could be uttered by a speaker, and then to rate the difficulty of generating such a context on a 1 - 5 scale: 1=very easy, 2=easy, 3=moderate, 4=hard, 5=very difficult.

Results and discussion

We analyzed only the ratings provided by the subjects, and ignored the contexts they generated. The rationale for this is that the only reason for including the actual generation of contexts by the subjects was to encourage them to process the task more deeply before they gave their ratings.

For the first analysis each subject was given two means, one for his/her average score on the canonical-directionality expressions, and the other for the non-canonical-directionality expressions. As predicted, the canonical expressions were rated lower than the non-canonical ones, that is, most subjects found it easier to generate a context for a canonical synaesthesia than a non-canonical one. T-tests showed a significant effect of directionality ($p < 0.01$).

In the second analysis we analyzed the two versions of each synaesthesia, namely, the canonical and the non-canonical one. This analysis also revealed that most of the items were rated lower when they appeared in the canonical form – that is, subjects found it easier to generate a context for the canonical than for the non-canonical structure of a given synaesthesia.

A t-test was performed to compare the means of the canonical items with the non-canonical ones and here again there was a significant effect ($p < 0.02$).

SUMMARY AND GENERAL DISCUSSION

Synaesthetic metaphors exhibit a robust tendency to use the "lower-to-higher" structure more frequently than the inverse one. This robust pattern was found across discourse types (poetic and non-poetic discourse), language boundaries (e.g., English, Hebrew, Arabic, Chinese, Japanese), and historical periods.

A cognitive account of this robust pattern was introduced, according to which this lower-to-higher mapping reflects a cognitively simpler and more basic directionality than the inverse one. Several predictions that follow from this account were tested, using various psychological measures (interpretation generation, recall, difficulty in context generation, and naturalness judgments), and various linguistic forms (noun-adjective constructions, and verb phrases with two conjoined modifying adjectives).

In accordance with the cognitive constraints theory, it was found that the lower-to-higher structure is easier to assign a meaning to, is judged as more natural than its inverse, is better recalled and is judged as easier to construct a context for. Furthermore, sentence ordering is judged as more natural when lower sensory adjectives precede higher ones than in the opposite ordering.

Extrapolating from these findings, one may argue that the various linguistic and psychological findings suggest that synaesthesias share some non-trivial similarities with metaphors in general. Thus, the evolution of meaning extension in polysemous metaphorical expressions greatly resembles that of meaning extension in synaesthetic adjectives, in that in both cases the more accessible (or concrete) meanings of polysemous terms precede the less accessible meanings in the evolution of a given language. For example, Sweetser (1990) showed that in all Indo-European languages the meanings of verbs of perception (e.g., "to see", "to taste") follow a strict pattern

according to which the more accessible (concrete) meaning of a given verb (as in “I can see this building”) precedes the less concrete one (as in “I see your point”). Similarly, as Williams (1972), Shen & Cohen (1999), and Yu (1992) here shown, more accessible (i.e., lower sensory) meanings of a given synaesthetic adjective precede less accessible (i.e., higher sensory) ones in the evolution of a given language. Another significant similarity between metaphors in general and synaesthesia may be their sensitivity to word order in a sentence: In both cases we saw that sentences in which more accessible terms precede less accessible ones are judged as more more natural than the inverse structures.

The present paper may also shed some light on the relation between poetic and non-poetic language. Traditional theories addressing this issue have suggested that poetic language differs radically from non-poetic language, in that the former aims at creating aesthetic effects based on creativity and novelty (e.g., Shklovsky, 1965; Tsur 1992). The case of the synaesthesia shows that this creative use is highly constrained by cognitive principles, even though it clearly shows creative associations of sensory modalities. These cognitive constraints, while allowing a certain amount of freedom for poetic language, help make it more easily interpretable by blocking various options. A beautiful illustration of this claim is the following complex synaesthesia, from Keats (cited in Ullman, 1957): "Taste the music of that vision pale". This is a complex, highly creative and novel synaesthesia, involving the sensory domains of taste, sound, and sight. Even this highly creative and novel expression, however, strictly follows the constraint we introduced. Starting from the noun phrase "the music of that vision pale", the mapping proceeds from sound ("the music") to sight ("that vision pale"). This sound-sight combination is the target of the entire sentence whose source comes from a lower sensory term, "taste". This conformity to the aforementioned constraint may be

responsible for the fact that this metaphor seems more readily available to interpretation than a similar synaesthesia with opposite directionality.

The present proposal regarding synaesthesia is fully compatible with recent studies of (non-verbal) creative structures and behavior. Many recent studies of creativity, and creative thinking in particular (e.g., Smith, Ward, and Finke, 1995), have suggested the notion of “structured imagination” (Ward, 1995). Structured imagination is the theory that new ideas created by human imagination are heavily structured and constrained by the properties of existing categories and concepts. For example, Ward (1995) claims that structured imagination does not mean merely that we make use of prior knowledge when creating novel concepts. Rather he claims, “An important aspect of structured imagination, however, is that the exact features of old ideas that are retained in new ideas are readily predictable from the general principles of categorization...” (Ward, 1995, 158). This view, which involves non-verbal creativity, is fully compatible with the present view of the verbal creativity manifested by synaesthesia. In both verbal and non-verbal creativity, novel structures, be they conceptual or verbal, are constrained by basic cognitive principles and constraints that apply equally to creative and non-creative structures (see also Shen, 2002).

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