



Modeling Semantic Similarity between Metaphor Terms of *Visual* vs. *Linguistic* Metaphors through Flickr Tag Distributions

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This study aims at modeling the semantic similarity between metaphor terms by means of a distributional method based on a Big Data stream: Flickr tags. As explained in the article, this distributional model, Flickr Distributional TagSpace (FDT), captures primarily relational similarity between concept pairs, that is, between tags that appear in similar tagsets (and therefore in similar pictures). A long established view in metaphor theory claims that metaphors pertain to the conceptual dimension of meaning, but while different models aim at explaining how *language* constructs and represents metaphorical conceptual structures, we still know very little about how other modalities (for example, *images*) achieve metaphor construction and expression. A comprehensive theory, which argues in favor of the conceptual nature of metaphor, cannot afford to be biased toward the analysis and modeling of one specific modality of expression, thus neglecting potential modality-specific differences. The present study, conducted through FDT, found that visual and linguistic metaphors behave differently, in that the similarity between two aligned concepts in a visual metaphor appears to be significantly higher than the similarity between two concepts aligned in a linguistic metaphor (which, in turn, does not differ substantially from the similarity between two randomly paired concepts). These findings suggest that the relational similarity between two metaphor terms (captured and modeled through FDT) is crucial for visual metaphors but not for linguistic metaphors. An additional content analysis, also reported here, shows that the type of semantic information encoded in the related tags (i.e., the contexts on which the contingency matrices of this distributional method are built) differs, in relation to the modality of the metaphor: while situation-related and entity-related features are typically associated with concepts aligned in visual metaphors, introspections, and taxonomic features are typically associated with concepts aligned in linguistic metaphors.

Keywords: metaphor, semantic similarity, distributional semantics, visual metaphors, linguistic metaphors, Big Data, Flickr

INTRODUCTION

Metaphor is recognized nowadays as a cognitive mechanism, rather than a simple figure of speech (Lakoff and Johnson, 1980; Lakoff, 1993). Through metaphors, we understand one concept in terms of another concept, the latter being generally perceived as easier or more concrete. On this view, metaphoric expressions, such as *our love is at a crossroads*, *we can't turn back now*, *together*

we are not going anywhere, suggest that when we deal with the abstract concept of LOVE (by convention, capital letters are used when referring to a concept or a conceptual domain), we might somehow envision a concrete journey going along a path. This conceptualization allows us to extend the metaphor, and imagine the two lovers as two travelers, the difficulties in the relationship as impediments on the journey, and the lovers' goals as the travel destination. From this complex and rather subconscious conceptual structure (LOVE-IS-JOURNEY), we would then derive metaphoric linguistic expressions such as those mentioned above. Thus, metaphors *transcend* their linguistic manifestations to influence conceptual structures. The cornerstone theory that suggested such a revolutionary approach to metaphors is called Conceptual Metaphor Theory (CMT, Lakoff and Johnson, 1980) and has had a very strong influence in linguistics and cognitive science, generating a large amount of supportive research, as well as critical contributions [e.g., Steen (2008)]. Among them, the career-of-metaphor theory (Bowdle and Gentner, 2005) suggests that metaphors may not always be understood by means of cross-domain mappings between base and target domains, as suggested by CMT. Instead, the way in which metaphor mappings operate, according to Bowdle and Gentner, would switch from comparison to categorization processes as the metaphor becomes conventional. For example, in the expression mentioned above, *our love is at a crossroads*, the word *crossroads* is used metaphorically to describe a moment that requires important decisions to be taken. As a (hypothetically) novel metaphoric expression, the *crossroads* (base term) and the *moment that requires decisions to be taken* would be processed by aligning and comparing the conceptual structures of these two domains. Instead, as the metaphor becomes conventional and frequently used, *crossroads* would become an acquired member of the conceptual category instantiated by the target of the metaphor and thus understood in that context by means of semantic disambiguation among different senses held by *crossroads*.

While different models have been proposed to account for the mechanisms of metaphor processing and comprehension in cognitive linguistics and cognitive science [see, for example, Black (1979), Ortony (1979), Turner and Fauconnier (2002), and Giora (2008)], the computational modeling of such mechanisms appears to be quite an arduous task [see Veale et al. (2016), for a review of metaphor and natural language processing]. One of the main problems that computational models based on natural language processing encounter, when trying to reproduce metaphor comprehension, lies in the nature of the *similarity* (intended in its wider sense) that allows two concepts to be aligned in a metaphor. Two concepts that are aligned in a metaphorical comparison need to have something in common for them to be comparable, some latent piece of semantic information that allows the comparison to emerge and be meaningful. However, the similarity that characterizes two metaphor terms is not as consistent and stable as the similarity that characterizes, for example, two synonyms. In particular, while the similarity between two synonyms is arguably based on several common features, two concepts aligned in a metaphor might share only one or a few crucial (or even not quite salient) features. The type of semantic information encoded in the shared features, which accounts for the similarity between

two metaphor terms, is still unexplored territory. In a recent study, for example, the two different cognitive processes of (verbal) metaphor comprehension (comparison and categorization) were modeled through a semantic space model (Utsumi, 2011). The author used a distributional method based on corpora of language to model the processing of verbal metaphors. However, being based on a stream of linguistic data, this approach accounts exclusively for the semantic information encoded in the shared *linguistic* patterns between the metaphor terms, thus modeling the similarity that characterizes their language use. In other words, this approach does not allow to explore different possible types of conceptual similarity existing between metaphor terms, which might not be captured by the shared linguistic patterns. On this same line, a previous attempt of modeling linguistic metaphor comprehension by means of distributional semantics was suggested by Kintsch and Bowles (2002). Very recently, a few other works used distributional semantics to model aspects of linguistic metaphor comprehension (Agres et al., 2016; Gutiérrez et al., 2016). Moreover, Shutova et al. (2015) proposed a method for metaphor identification based on distributional semantics, which draws knowledge from both linguistic and visual data.

The aim of this study is to explore and assess how, respectively, images and words afford the construction and representation of metaphor. In this perspective, metaphor similarity is here modeled by means of distributional semantics, to observe the emergence of potentially different patterns of similarity that can be ascribed to the different modalities of metaphoric expression. The present study is embedded in a larger project (COGVM) that aims at modeling and contrasting the semantic similarity between metaphor terms in visual vs. linguistic metaphors, relying on the distributional hypothesis. Three different types of distributional similarity are investigated: *attributional* similarity, *relational* similarity, and *linguistic* similarity. This goal is achieved through extensive distributional analyses based on corpora that encode different streams of semantic information and that can therefore model the three different types of distributional similarity. The present study reports the analyses aimed at modeling the *relational* similarity.

A representative sample of *visual* metaphors and a representative sample of *linguistic* metaphors are analyzed and compared. It is hereby hypothesized that the two samples are likely to afford different patterns of similarity between the involved domains. Such prediction is based on experimental evidence, showing different patterns of neural activation during matched word and picture recognition tasks (Gorno-Tempini et al., 1998; Moore and Price, 1999; Chee et al., 2000; Hasson et al., 2002; Bright et al., 2004; Gates and Yoon, 2005; Reinholz and Pollmann, 2005). Moreover, as indicated in Binder et al.'s (2009) meta-analysis, different studies argue against a complete overlap between the knowledge systems underlying word and object recognition, based on the existence of patients with profound visual object recognition disorders but relatively intact word comprehension (Warrington, 1985; Farah, 1990; Davidoff and De Bleser, 1994). Finally, a well-known and empirically supported account of cognition suggests that linguistic and visual stimuli trigger two functionally independent, but interconnected, multimodal systems, one specialized for non-verbal stimuli, which directly represents the perceptual properties

and affordances of non-verbal objects and events, and the other specialized for linguistic stimuli, which deals directly with linguistic stimuli and responses (cf. Dual Coding Theory, Paivio, 1971, 1986, 2010).

To the best of my knowledge, there are no other studies that aim at comparing the structure and functioning of these two modalities of expression in relation to metaphor. A recent body of work on visual and audiovisual representations has shown in a qualitative fashion how some of the conventional (conceptual) metaphors extracted from language use can be expressed in images as well [see, for example, Forceville (2011), Hidalgo and Kraljevic (2011), Ning (2011), and Ortiz (2011)]. The approach used by the authors, however, is top-down: given a set of conventional conceptual metaphors, the scholars searched for possible realizations in the visual modality. The purpose of this study is different, in that it aims at observing how each of the two modalities of expression of metaphor functions, independently from one another, in a bottom-up fashion, in order to see potential differences emerge spontaneously. For this reason, the present study should be considered as the first exploratory analysis of these two modalities of expression.

The research questions tackled by the present investigation can be summarized as follows:

RQ1: Can the latent similarity between metaphor terms be modeled through Flickr Distributional TagSpace (FDT), a distributional method based on tags produced by Flickr users to describe salient concepts related to personal experiences, captured in Flickr photographs?

RQ2: Can FDT model the similarity between metaphor terms in *visual* and in *linguistic* metaphors equally well?

RQ3: What type of semantic information is typically encoded by FDT? And what type of semantic information is encoded in the shared features between metaphor terms in visual vs. linguistic metaphors?

METHOD

The analyses reported in this study are performed through FDT (Bolognesi, 2014, 2016), an innovative distributional method based on annotated images.

Flickr Distributional TagSpace is substantially similar to latent semantic analysis (LSA, Landauer and Dumais, 1997) in that it is not structured (i.e., it does not include information retrieved from syntactic patterns of word co-occurrences). The three main differences between LSA and FDT, as described in Bolognesi (2016), pertain to the type of context used to create the contingency table (text documents in LSA vs. tagsets of annotated images in FDT), the measure of association between an element and each context (term frequency-inverse document frequency in LSA vs. square pointwise mutual information in FDT), and the dimensionality reduction applied before the computation of the cosine (singular value decomposition in LSA vs. none in FDT, due to the density of the matrix, as opposed to its sparsity in LSA).¹

Flickr Distributional TagSpace is based on a unique, but intrinsically variegated, source of semantic information: Flickr tags. This source of data contains spontaneous annotations of personal pictures, which are not suggested by the Flickr platform. The information encoded in Flickr tags has been classified by Beaudoin (2007) in 18 *post hoc* created categories, which include syntactic property types (e.g., adjectives, verbs), semantic classes (human participants, living things other than humans, non-living things), places, events/activities (e.g., *wedding*, *Christmas*, *holidays*), *ad hoc* created categories (such as photographic vocabulary, e.g., *macro*, *Nikon*), emotions, formal classifications such as terms written in any language other than English, and compound terms written as one word (e.g., *mydog*). Of all the 18 types of tags identified, Beaudoin reports that the most frequent are (i) geographical locations, (ii) compounds, (iii) inanimate objects, (iv) participants, and (v) events. Moreover, the reasons that push Flickr users to tag their own images have been classified in different ways, the most popular being a macro-distinction between *categorizers* (users who employ shared high-level features for later browsing) and *describers* (users who accurately and precisely describe resources for later searching) (Körner et al., 2010). Given the variability of tag types (which include both linguistic and perceptual information) and the variability of motivations that drive taggers' behaviors, it has been claimed and shown that FDT can model semantic representations of perceptually derived information better than traditional text-based distributional models (Bolognesi, 2014). In the abovementioned study, it has been shown that FDT can cluster color terms (denoting primary and secondary colors, expressed in English language) according to their perceptual similarity, thus reproducing the order in which such colors appear in the rainbow. Instead, two language-based distributional methods (LSA, Landauer and Dumais, 1997, and DM, Baroni and Lenci, 2010) generate a different semantic space. Moreover, in Bolognesi (2016), it has been shown that FDT can categorize concepts into semantically coherent groups in accordance to feature norms for concrete living and non-living things (McRae et al., 2005) better than WordNet (Bolognesi, 2016).

As suggested by Beaudoin (2007) as well as by Bolognesi (2016), Flickr tags encode primarily semantic information about the situational properties of a given concept. In fact, given a tag X, the tags that typically appear together with X across Flickr pictures express on average locations and related entities that can be found in the same context (i.e., within the same picture). It follows that the distributional similarity between a tag X and a tag Y is computed on the basis of the *relational properties* of X and Y. As suggested by Bowdle and Gentner, metaphor similarity is often relational, in that is generated by aligning relational properties (and situational objects) of base and target, regardless of whether base and target are *intrinsically* similar. As the authors suggest, "people's interpretations of metaphors tend to include more relations than simple attributes" (Bowdle and Gentner, 2005, p. 197). The centrality of relational predicates in metaphor comprehension described by Bowdle and Gentner is therefore arguably well modeled by FDT.

¹In the original description of FDT (Bolognesi, 2014, 2016), there is no dimensionality reduction on the matrices. However, for the present investigation, given the size of the contingency matrix, only the 50 tags with the highest measures of association

for each concept were included in the contingency table, on which the cosines were then computed. See the description in Section "Setting up the Distributional Semantic Space with FDT"

Using FDT, a sample of linguistic metaphors (identified through the MIPVU procedure, Steen et al., 2010) and a sample of visual metaphors (identified through the VISMIP procedure, Šorm and Steen, under review²) are contrasted in terms of the amount of knowledge that the metaphorical terms share. This similarity is also compared to the similarity between randomly paired concepts, to see whether there is a significant difference.

Materials

The sets of visual and linguistic metaphors for the distributional analyses were randomly selected from the VU Amsterdam Metaphor Corpus (linguistic metaphors) and the VisMet Corpus (visual metaphors), which are both open access digital resources accessible through the Metaphor Lab Amsterdam institutional website. These corpora are balanced and are representative of the two modalities, and therefore, they have modality-specific inherent variability.

A sample of 50 visual metaphors and a sample of 50 linguistic metaphors were randomly selected. However, as often happens when dealing with real-world data [see the discussion in Goodall et al. (2013)], in order to be suitable for the present investigation, the metaphors had to meet a number of criteria, described below:

1. The selected metaphors had to be taken from different genres. For linguistic metaphors, these are academic discourse, conversations, fiction, and news, while for visual metaphors, they are advertisements and social campaigns, illustrations, political cartoons, and photographs.
2. Different types of realization had to be taken into account, when possible. For linguistic metaphors, indirect metaphors were mainly taken into account [i.e., metaphors in which there is a contrast as well as comparison between the contextual and a more basic meaning, see Steen et al. (2010)], because of their significantly higher frequency in language use, compared to direct metaphors (see reference above). For visual metaphors, the different types in which base and target can be visually cued, according to established models, were taken into account (Forceville, 1996; Phillips and McQuarrie, 2004).

In addition to these criteria, only the visual metaphors without linguistic anchors were taken into account, which means that those images in which linguistic clues constituted a meaningful part of the metaphor and helped with its interpretation, were dropped, so that only strictly visual metaphors were included. To achieve this, those visual metaphors that were annotated in the VisMet corpus as including a metaphoric linguistic expression were dropped first,³ and subsequently, the visual metaphors were manipulated, so that all the linguistic clues presented in the images were covered. The images were then shown to three participants, who had to interpret the meaning of the image in an informal, think-aloud investigation, without relying on the

linguistic information conveyed by the linguistic anchors (which were graphically blurred). Images where at least one participant could not understand the metaphor because the linguistic anchors were covered were dropped and then replaced, until the total number of 50 visual metaphors was reached.

Procedure

Identifying the Metaphor Terms

The metaphorical terms that are compared in these metaphors were identified through specific procedures that have been proposed in the field of metaphor studies. For linguistic metaphors, the MIPVU procedure was applied (Steen et al., 2010). This procedure relies on the idea that the majority of metaphors found in language are *not* direct comparisons expressed through words (such as, for example, “my lawyer is a shark”) but are instead words used in a metaphorical way in a given context. In this sense, the majority of linguistic metaphors are expressed *indirectly*, and they rely on a contrast between the *contextual* meaning of the word (which is *metaphorical*) and its *basic* meaning (which is *literal*). According to this procedure, given a text with a potentially metaphorical word, the contextual meaning and the basic meaning of that word express the contrast from which the metaphor is created. For example, in the sentence “I see what you mean,” the contextual meaning of *see* is *understand*, while the basic meaning refers to the physical ability of sight. The two meanings (understanding and physically seeing) are contrastive, and therefore, the word *see* is to be considered metaphorical in the linguistic context “I see what you mean.”

For the identification of the metaphor terms involved in visual metaphors, the VISMIP procedure was applied (See footnote text 2). This procedure relies on the idea that images displaying visual metaphors typically present (different types of) perceptually incongruous elements that violate an expected (or “literal”) scenario. Such incongruities need to be mentally replaced with other elements, whose function it is to restore the visual feasibility (i.e., perceptual congruency) of the scenario. Detecting the incongruous elements (step 3 of the VISMIP procedure) and replacing them with elements that would help restore the expected scenario (step 4) are cognitive operations required to unravel and interpret the metaphor. In this sense, the perceptual incongruities and their replacements constitute the metaphor terms, or part of them. For example, **Figure 1** shows an advertisement for a car tire where the creative agent aims to emphasize the gripping power of the product by showing an octopus tentacle fused together with the tire. When the consumer sees this advertisement, she has to mentally replace the tire with the actual tentacle to restore the expected scenario and to identify the two terms of the metaphor: the tentacle and the tire. In fact, the gripping power of the suction cups on the tentacle is a positive characteristic that has to be transferred to the tire itself. The verbal slogan helps to convey the message (“Toyo: gripping performance”), which is nonetheless quite clear by simply looking at the image and being aware of its genre (advertising).

To summarize the identification procedures, it can be argued that both MIPVU and VISMIP seem to rely on a paradigmatic relation between two entities that constitute the two terms of the metaphor: the contextual meaning of a word vs. its basic meaning

²Šorm, E., and Steen, G. (under review). “VISMIP: towards a method for visual metaphor identification,” in *Visual Metaphor: How Images Construct Metaphorical Meaning*, ed. G. Steen (Amsterdam: John Benjamins Publishing Company).

³See documentation on the VisMet corpus website for more information: <http://www.vismet.org/VisMet/annotation.php>.



FIGURE 1 | Advertisement for a car tire brand, showing an octopus tentacle fused with a tire. Image used with permission, Copyright owner: GMASCO creative agency.

in linguistic metaphors and the perceptual incongruous element vs. its replacement in visual metaphors.⁴

Once the two procedures were applied to (respectively) texts and images, a list of 100 metaphorical correspondences expressed in A-is-B form was obtained (reported in **Table 1**).

Setting Up the Distributional Semantic Space with FDT

In accordance with the FDT method [described in Bolognesi (2014, 2016)], for each of the metaphorical terms (which will be called A and B, as in the typical metaphor formalization A-is-B) that appeared in the visual and in the linguistic metaphors, roughly 100,000 tagsets were downloaded from Flickr through the API flickr.photos.search. Following the FDT procedure, the corpus of concatenated tagsets was then subsetting and filtered, so that each tagset (i.e., each list of tags associated with one picture by one user) was unique, and displayed 15 tags, with A or B appearing among the first 3 tags (so that the tagset could be considered a meaningful context for that concept).

Consequently, the contingency matrix was created, featuring all A and B concepts on the rows and all the other tags appearing in the corpus on the columns.⁵ The raw frequencies of co-occurrence between each A or B and each co-tag were then turned into measures of association. As described in Bolognesi (2014), the measure of association chosen for FDT is the square pointwise mutual information, defined as follows:

$$\text{SPMI}_{(w1, w2)} = \log \left(\frac{f_{(w1, w2)}^2}{f_{w1} \times f_{w2}} \times N \right)$$

⁴In visual metaphors, there are other types of realizations, such as similes (or alignments), as suggested in Forceville (1996) and Phillips and McQuarrie (2004). Here, both base and target are fully represented. This type of realization is comparable to that of direct metaphors in language (explicitly expressed in A-is-B form). Direct realizations are quite infrequent in both language and images, compared to indirect expressions.

⁵The total number of unique concepts is 161, because some concepts appear as base or as target domains more than once in different metaphors.

TABLE 1 | Cosine values accounting for the relational similarity between metaphor terms (extracted through FDT) in visual and linguistic metaphors.

Linguistic metaphors	CosSim A,B	Visual metaphors	CosSim A,B
Homeland is house	0.320	Wheel is clock	0.323
Toy is girl	0.242	Cream is dandelion	0.311
Idea is object	0.204	Book is tree	0.274
Opportunity is door	0.182	Bank is beggar	0.268
Emotion is tide	0.180	Car is horse	0.238
Idea is point	0.179	Airplane is swan	0.231
Harsh is hard	0.178	America is crocodile	0.224
Center is heart	0.169	Beggar is bomb	0.200
Time is frame	0.163	Perfume is doorway	0.217
Plant is person	0.157	Barcode is jail	0.204
Attention is eye	0.147	Brain is newspaper	0.201
Food is gold	0.143	Newspaper is manhole	0.221
Opinion is eye	0.139	Cigarette is maze	0.200
Understand is see	0.134	Jeep is rhino	0.162
Explanation is drawing	0.122	Hand is fork	0.184
Possibility is space	0.118	Bottle is bullet	0.181
Institution is equipment	0.118	Seagull is book	0.180
Manner is path	0.103	Brain is turtle	0.180
Opinion is picture	0.102	Pen is bullet	0.177
End is cloth	0.102	Cup is switch	0.162
Judgment is finger	0.101	Country is bomb	0.201
Discussion is war	0.101	Bomb is flower	0.180
Purpose is destination	0.101	Dove is target	0.178
Knowledge is brightness	0.100	Cart is tank	0.276
Army is motion	0.100	Kid is piglet	0.138
Consideration is appearance	0.098	Car is dolphin	0.138
Condition is object	0.098	Mouthwash is bomb	0.137
Factory is organism	0.095	Tablet is tamer	0.121
Body is canvas	0.086	Hand is bulldozer	0.118
Accumulation is river	0.081	Radio is beggar	0.126
Aspect is surface	0.080	Globe is ice cream	0.119
Partner is food	0.080	Country is drain	0.122
Discipline is place	0.077	Cart is jail	0.122
Decision is route	0.061	Airplane is bread	0.121
Decision is movement	0.060	Sun is yolk	0.121
Rubbish is feces	0.058	Car is pepper	0.140
Feces is food	0.041	Terrorists is matches	0.121
Reason is location	0.041	Dollar is carpet	0.117
Consequence is food	0.041	Coke is dandelion	0.118
Reason is point	0.041	Sweater is gorilla	0.116
Aspect is money	0.040	Elephant is trumpet	0.097
Constraint is obstacle	0.039	Pen is thermometer	0.101
Provider is origin	0.039	Missile is dove	0.099
Governance is force	0.038	President is sun	0.079
Emotion is force	0.038	Skin is matches	0.094
Success is condition	0.020	Mouth is onion	0.083
Attitude is gas	0.020	Tentacle is tire	0.102
Rank is location	0.020	Seaweed is spoon	0.062
Organization is building	0.019	President is lion	0.059
Situation is air	0.000	Hand is zebra	0.058

where w_1 and w_2 are two words (or tags), and f is the frequency of their co-occurrence or individual occurrence in a corpus of N words (or tags). For the purpose of this analysis, w_1 was a metaphor term (i.e., A or B), while w_2 was the co-tags appearing with w_1 across Flickr tagsets.

Given the high level of noise in the data, due to the fact that Flickr tags are freely generated and not based on a dictionary, a list of stop words was compiled and the corpus of tags was filtered with this list. Words included in the stop list included non-words and spelling mistakes (such as “happppines” or “firstdayofschool”), meta-tags (camera brands such as “Nikon,” or technical terms about photography techniques such as “macro”), words expressed in languages other than English, and dates.⁶ The co-tags (w_2) of each concept (w_1 , i.e., A or B) were then sorted in decreasing order according to their SPMI value, and the top 50 tags for each concept were considered for the cosine analysis. After these filtering operations, the final contingency matrix contained 161 rows (displaying the 161 unique words for A or B) and 2309 columns (displaying the unique co-tags that appeared with any A or B in the initial corpus).

The similarities between each pair of concepts (w_1) were then computed in terms of cosines between concept vectors by means of the following established formula:

$$\text{CosSim} = \frac{\sum_{i=1}^n a_i \times b_i}{\sqrt{\sum_{i=1}^n a_i^2} \times \sqrt{\sum_{i=1}^n b_i^2}}$$

where a and b are two compared concept vectors, each with n dimensions.

Table 1 reports the cosine measures for the A-is-B pairs of visual and linguistic metaphors, extracted from the 161-by-161 table of cosines computed through FDT.⁷

ANALYSIS

CosSim in Metaphors vs. Randomly Paired Concepts

The average cosine between two concepts aligned in a metaphorical comparison is $\text{CosSim} = 0.130$ ($\text{SD} = 0.070$). In order to evaluate the significance of this value, it was compared to the average cosine between randomly associated concept pairs. To achieve this, a sample of one million images featuring the neutral tags *Nikon* or *Canon* was downloaded from Flickr, and the cosines between each two tags appearing in the sample was computed, following the FDT method. The average cosine between the randomly associated tag pairs extracted from the sample is $\text{CosSim} = 0.094$ ($\text{SD} = 0.089$). The difference between the average cosine between two metaphor terms and the average cosine between two randomly aligned terms by conventional criteria is considered to be statistically significant ($t = 3.593$, $p < 0.001$). This suggests that the similarity between two terms of a metaphor is, in general, captured by the distributional analyses of tags across Flickr, performed through FDT, because, on average, the

TABLE 2 | Average cosine values for different types of A,B concept pairs: visual metaphor terms, linguistic metaphor terms, and randomly selected pairs, and statistical significance of the difference between average cosines values in different types of concept pairs.

Type of concept pairs	Average CosSim
Visual metaphor concept pairs	0.156 (SD = 0.060)
Linguistic metaphor concept pairs	0.096 (SD = 0.056)
Random concept pairs	0.094 (SD = 0.089)
Average CosSim comparisons	T-tests
Visual metaphor vs. linguistic metaphor	$t = 5.169$, $p < 0.001$
Visual metaphor vs. random concept pairs	$t = 4.925$, $p < 0.001$
Linguistic metaphor vs. random concept pairs	$t = 0.159$, $p = 0.874$

cosine between two concepts aligned in a metaphor does differ substantially from the similarity between two randomly associated concepts.

CosSim in Visual vs. Linguistic Metaphor

As a further analysis, the modality of expression was taken into account. The average cosine between two terms aligned in a visual metaphor was compared to the average cosine of two terms aligned in a linguistic metaphor, and both those values were compared to the average cosine between two randomly paired concepts. The results of the analyses are reported in **Table 2**. As the table shows, the average similarity between two concepts aligned in a visual metaphor is significantly higher than the average similarity between two randomly paired concepts, as well as between two concepts that are paired in a linguistic metaphor. On the other hand, the average similarity between two concepts aligned in a linguistic metaphor does not substantially differ from the average similarity between two randomly paired concepts.

Content Analysis

Semantic Information Encoded in the Dataset

In order to analyze what type of semantic information conveyed by Flickr tags accounts for the similarity between metaphor terms of visual and linguistic metaphors, a content analysis was performed. The 50 tags constituting each concept vector were manually annotated, using the coding scheme related to the knowledge-based taxonomy implemented by Wu and Barsalou (2009) and adapted by Bolognesi et al. (under review)⁸ to accommodate the annotation of features related to *abstract* concepts as well as to concrete ones. The coding scheme encompasses 4 macro-categories and 20 nested categories. The four macro-categories refer to properties of the *entity* (such as entity components: <airplane-wing>, perceptual features: <swan-white>, etc.); properties of the *situation* in which the concept typically appears (such as participants in the situation: <restaurant-waitress>, locations: <lion-Africa>, etc.); *taxonomic* properties (such as hypernyms: <octopus-animal>, coordinates: <knife-fork>, etc.); and *introspections* (such as emotions: <war-sadness>, contingencies: <winter-flu>, etc.). The nested categories, as shown in the examples mentioned above,

⁶The full stop-word list will be released together with the supplementary materials used for the analysis on the COGVIM website.

⁷The 161-by-161 table of cosines will be released on the COGVIM project website.

⁸Bolognesi, M., Pilgram, R., and Van den Heerik, R. (under review). *Reliability in Content Analysis. The Case of Semantic Feature Norms Classification*.

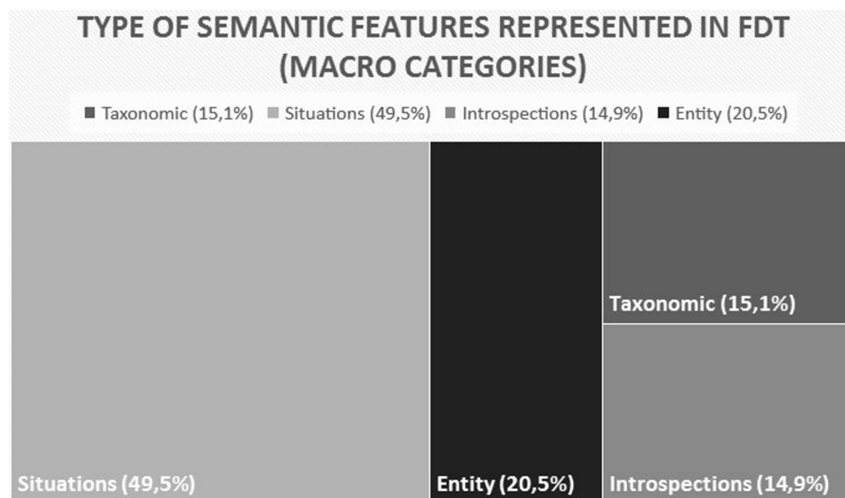


FIGURE 2 | Macro-category representation in FDT.

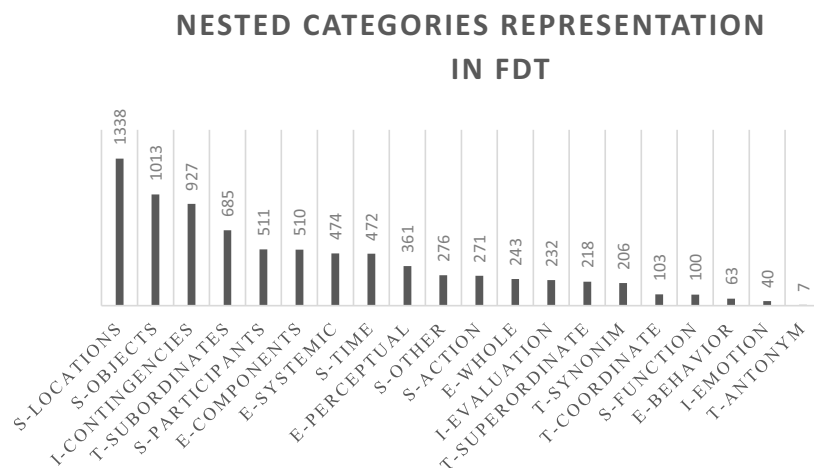


FIGURE 3 | Nested categories representation in FDT. Numbers correspond to the frequency of the type of relationship.

provide a deeper classification of the 4 macro-categories into 20 nested categories.⁹ A sample of 1250 w1–w2 pairs, covering 15.3% of the whole dataset, was manually annotated by two independent coders. Given the good interrater agreement achieved by the two independent coders ($k = 0.74$), one coder then finalized the task.¹⁰

The types of w1–w2 semantic relations encoded in Flickr tags, for the concepts analyzed, are summarized in **Figure 2** (macro types) and **Figure 3** (nested categories).

As the graphs show, the semantic relations between tag pairs mainly encode properties of the situation in which a given concept appears and, in particular, identify locations and contextual objects that can typically be found in a situation where the target concept appears. This confirms the findings of Beaudoin

(2007) and Bolognesi (2016), who showed that locations and contextual entities are the most frequent categories represented in Flickr tags.

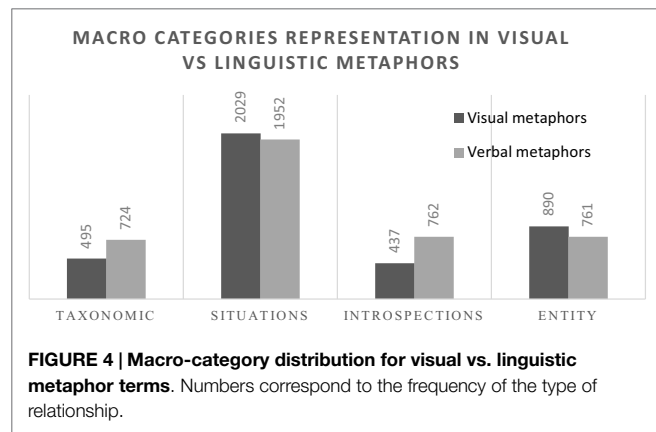
Semantic Information in Relation to the Metaphor Type (Visual or Linguistic)

As the graph in **Figure 4** shows, the related tags retrieved in FDT about the concepts involved in visual and in linguistic metaphors mainly express situational properties in which such concepts tend to occur. However, the graph also shows that the two modalities behave in slightly different ways for the other macro-categories, in that concepts involved in linguistic metaphors tend to trigger more introspections and taxonomic features, while concepts involved in visual metaphors tend to trigger more entity-related properties. A chi-square analysis confirms the significance of the different distributions (Pearson chi-square = 127.878; $df = 3$; $p < 0.001$). In **Table 3**, the analysis of the standardized residuals

⁹The adapted taxonomy and its related coding scheme are available on the COGVIM project website: <https://cogvim.files.wordpress.com/2016/04/coding-scheme-cogvim.pdf>.

¹⁰The annotated pairs will be released on the COGVIM project website.

shows that the observed situation properties and entity-related properties are significantly higher than expected for concepts involved in visual metaphors (i.e., adjusted residual >2 , as highlighted in the table) and that taxonomic features and introspections are significantly higher than expected for concepts involved in linguistic metaphors.



A closer analysis of the nested category distribution in visual vs. linguistic metaphors (**Figure 5**) shows that the two modalities of expression involve concepts for which the salient semantic information retrieved through FDT differs.

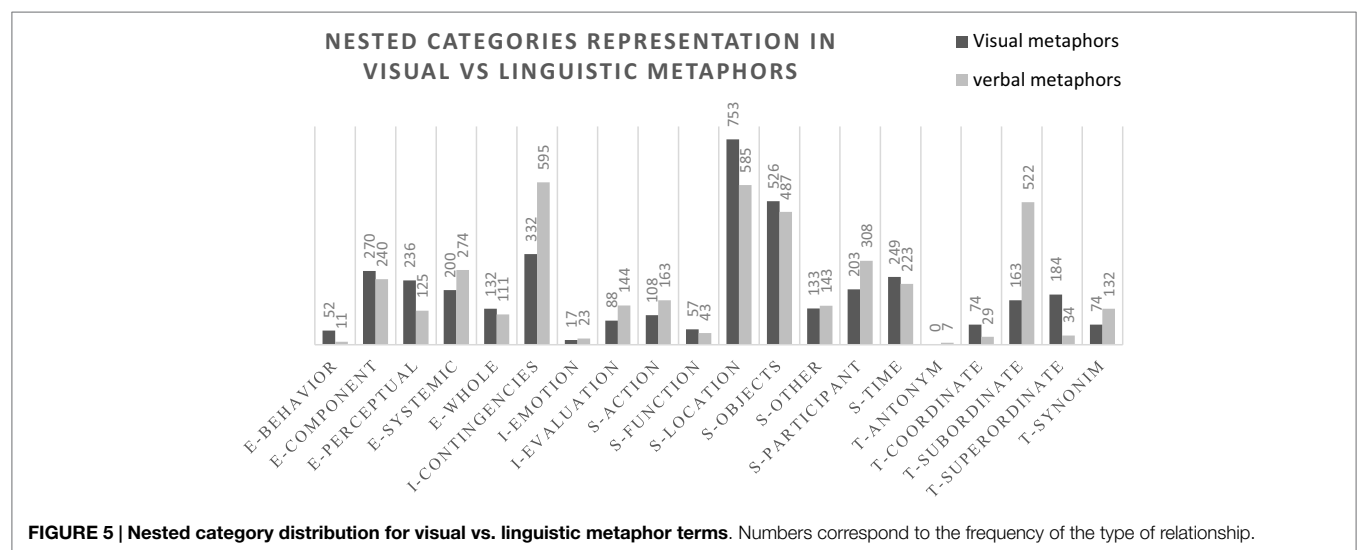
A chi-square analysis was run on the nested categories data, and the results suggest that the nested category distributions of visual vs. linguistic metaphors differ (chi-square = 544.388, $df = 19$, $p < 0.001$). The table with analysis of the residuals (which is not reported because of the limited space available) shows that at the level of $p = 0.05$, there are various standardized residuals >2 , which indicate the presence of categories for which there is a significant difference between expected and observed counts within each of the two modalities. **Table 4** reports a summary of those nested categories that are significantly related to only one of the modalities of expression.

Semantic Information Encoded in the *Shared* Features

The types of shared features between metaphor terms, which account for the relational similarity between the two concepts, retrieved by FDT, are summarized in **Figure 6** (macro-categories)

TABLE 3 | Type of metaphor \times type of feature cross-tabulation.

			Type of feature				Total
			Situations	Taxonomic	Entity	Introspections	
Type of metaphor	Visual metaphor	Count	2029	495	890	437	3851
		Expected count	1904.5	583.2	789.8	573.6	3851.0
		% within type of feature	51.0	40.6	53.9	36.4	47.8
		Adjusted residual	5.6	-5.5	5.5	-8.6	
	Linguistic metaphor	Count	1952	724	761	762	4199
		Expected count	2076.5	635.8	861.2	625.4	4199.0
		% within type of feature	49.0	59.4	46.1	63.6	52.2
		Adjusted residual	-5.6	5.5	-5.5	8.6	
Total	Count		3981	1219	1651	1199	8050
	Expected count		3981.0	1219.0	1651.0	1199.0	8050.0
	% within type of feature		100.0	100.0	100.0	100.0	100.0



and **Figure 7** (nested categories). As the figures show, these are mainly situational properties, followed by entity-related properties, introspections, and taxonomic features. More specifically, looking at the nested level, it can be observed in **Figure 7** that the shared features between two metaphor terms retrieved by FDT primarily express locations and related objects within the situational properties, perceptual features within the entity-related properties, subordinates within the taxonomic features, and contingencies within the introspections macro-category.

Semantic Information Encoded in the Shared Features in Relation to Metaphor Type (Visual or Linguistic)

The analysis of the distribution of shared feature types in relation to the modality of expression (visual or linguistic) is visualized in **Figure 8** (macro level). A chi-square analysis confirms the significance of the different distributions (Pearson chi-square = 35.865; $df = 3$; $p < 0.01$), and the analysis of the residuals (**Table 5**) suggests that taxonomic features and introspections are significantly higher than expected in linguistic metaphors, while entity-properties are significantly higher than expected in visual

metaphors (as indicated by the adjusted residuals values > 2 , highlighted in the table).

Finally, **Figure 9** shows the distributions of feature types at the nested category level in the two different modalities. A chi-square analysis at the nested category level shows that the shared features between concepts aligned in visual metaphors and the shared features between concepts aligned in linguistic metaphors are significantly different (chi-square = 128.056, $df = 18$, $p < 0.001$). The analysis of the residuals is summarized in **Table 6**, where the categories related significantly to each modality are reported.

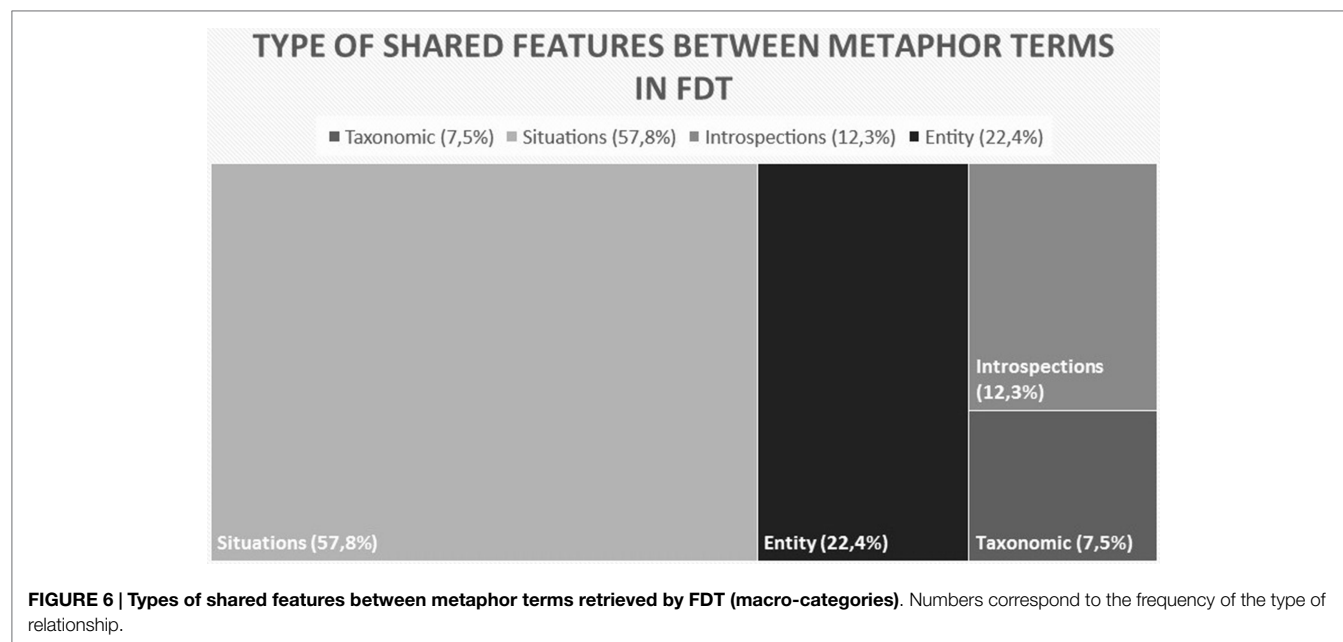
DISCUSSION

The first research question that the present study aimed to answer was whether the latent similarity between two metaphor terms could be modeled through FDT, a distributional method that encodes different types of semantic information. In Section “Cos-Sim in Metaphors vs. Randomly Paired Concepts,” it was shown that the cosine similarity between two metaphor terms obtained through FDT is significantly higher than the cosine similarity between two randomly paired concepts. This suggests that FDT does indeed capture a type of distributional similarity (based on relational properties) that is meaningful for metaphorical comparisons.

The second research question that the present study aimed to explore was whether FDT could model the similarity between metaphor terms in *visual* and in *linguistic* metaphors equally well. This question relates to the problem that the current scientific literature about metaphor is (still) strongly biased toward the analysis of the linguistic modality of expression. However, a comprehensive theory of metaphor that claims that metaphors relate to the conceptual dimension of meaning cannot be afford to be biased toward the study of one specific modality. Moreover, the studies focused on visual metaphor do not approach the analysis of

TABLE 4 | Nested categories for which the adjusted residual value in the chi-square analysis exceeds the value 2, i.e., the category is significantly related to one specific modality.

Nested categories related to one modality (i.e., observed frequency in FDT significantly higher than expected frequency)	
Visual metaphors	E-behavior, E-component, E-perceptual, E-whole, S-location, S-object, S-time, T-coordinate, T-superordinate
Linguistic metaphors	E-systemic, I-contingency, I-evaluation, S-action, S-participant, T-antonym, T-subordinate, T-synonym



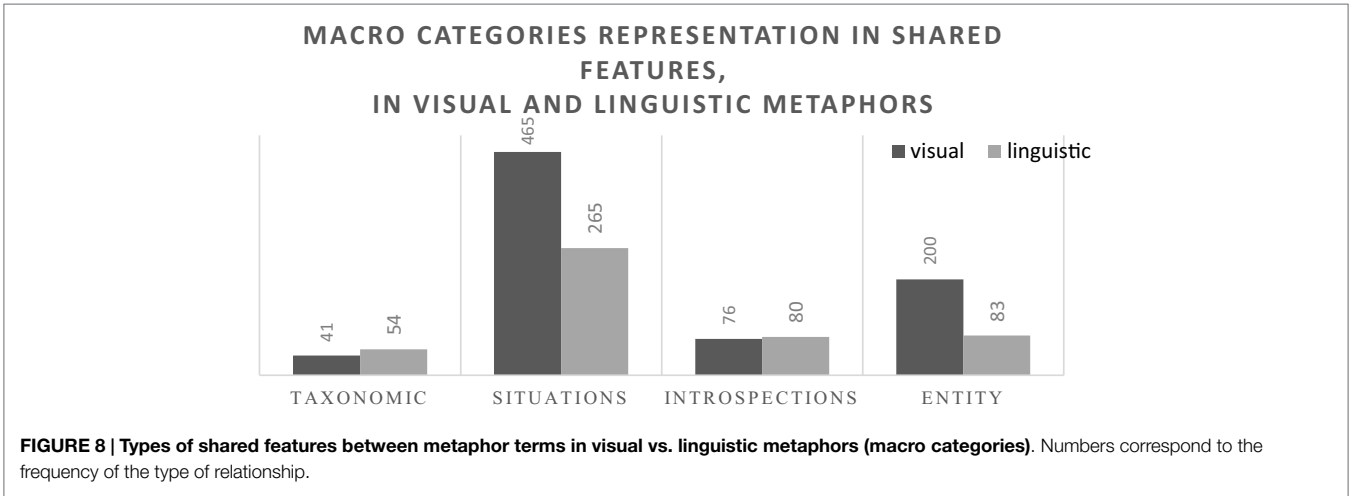
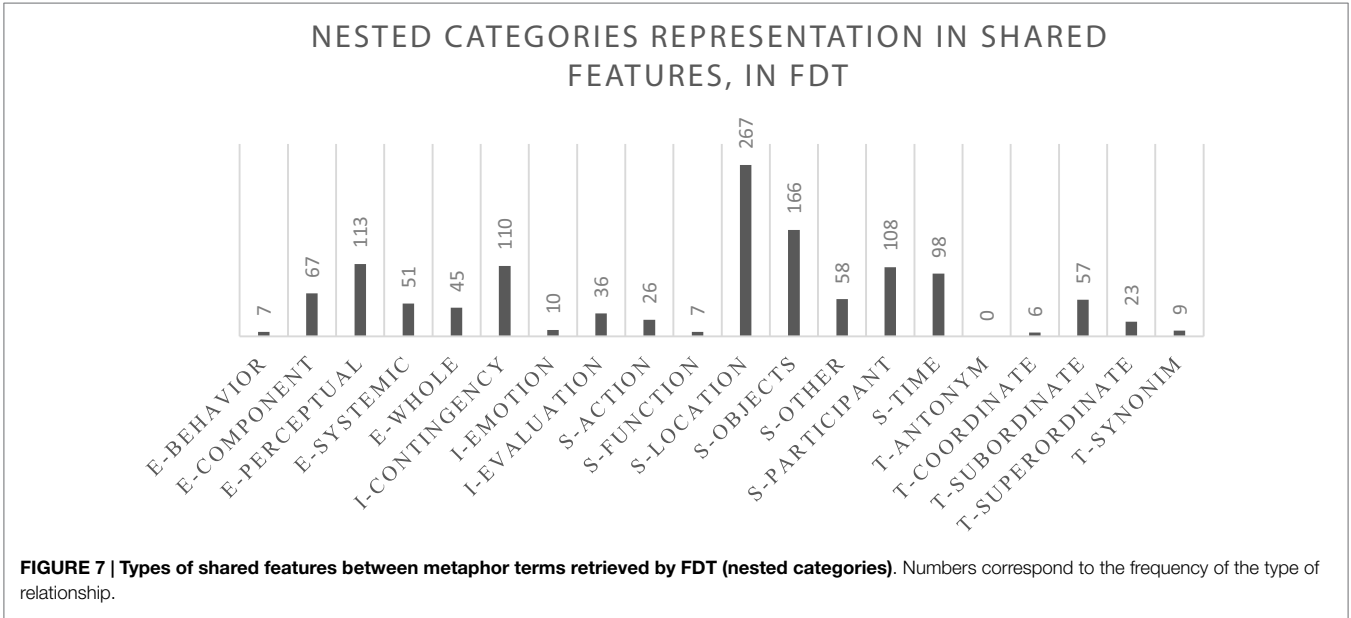


TABLE 5 | Type of metaphor × type of feature cross-tabulation for shared features categorized at the macro level.

			Type of feature				Total
			Situations	Taxonomic	Entity	Introspections	
Type of metaphor	Visual metaphor	Count	465	41	200	76	782
		Expected count	451.6	58.8	175.1	96.5	782.0
		% within type of feature	63.7	43.2	70.7	48.7	61.9
		Adjusted residual	1.6	−3.9	3.5	−3.6	
	Linguistic metaphor	Count	265	54	83	80	482
		Expected count	278.4	36.2	107.9	59.5	482.0
		% within type of feature	36.3	56.8	29.3	51.3	38.1
		Adjusted residual	−1.6	3.9	−3.5	3.6	
Total	Count		730	95	283	156	1264
	Expected count		730.0	95.0	283.0	156.0	1264.0
	% within type of feature		100.0	100.0	100.0	100.0	100.0

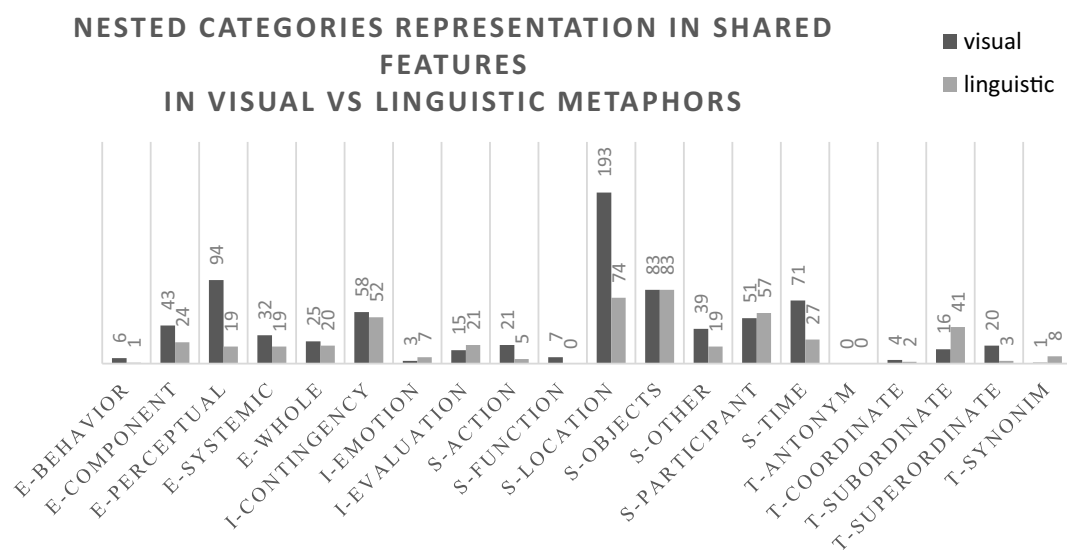


FIGURE 9 | Types of shared features between metaphor terms in visual vs. linguistic metaphors (nested categories). Numbers correspond to the frequency of the type of relationship.

TABLE 6 | Nested categories for shared features, for which the adjusted residual value in the chi-square analysis exceeds the value 2, i.e., the category is significantly related to one specific modality.

	Nested categories significantly related to one modality only
Visual metaphors	E-perceptual, S-function, S-location, S-time, T-superordinate
Linguistic metaphors	I-contingency, I-emotion, I-evaluation, S-object, S-participant, T-subordinate, T-synonym

this modality in a comparative and contrastive fashion with other modalities, while the current approach allows to explore how, respectively, words and images construct and represent metaphor. In Section “CosSim in Visual vs. Linguistic Metaphor,” it was found that while the average similarity between two concepts aligned in a visual metaphor is significantly different from the similarity between two randomly paired concepts, the similarity between two concepts aligned in a linguistic metaphor does not differ from the similarity between two randomly paired concepts. This suggests that the similarity between concepts aligned in linguistic metaphors is not captured well by FDT.

The third research question aimed at exploring the *type* of semantic information captured by FDT and how this distribution relates to the metaphor terms encompassed, respectively, in *visual* and *linguistic* metaphors. In Section “Content Analysis,” I reported the outcomes of a content analysis aimed at classifying, for each analyzed concept, the type of semantic information encoded in its related tags, retrieved by FDT. The analyses, based on an established knowledge-based taxonomy of semantic relation types between concept–feature pairs (Wu and Barsalou, 2009), led to the following observations:

- (1) FDT primarily encodes situation-based relations (<seagull-beach>, or <judgment-court>), followed by

entity-related properties (<seagull-wings>, or <location-public>), taxonomic properties (<lion-animal>, or <location-California>), and introspections (<war-sad>, <flower-beautiful>).

- (2) Comparing the two modalities of expression, it appears that the concepts involved in linguistic metaphors, in relation to those involved in visual metaphors, typically involve more taxonomic features and introspections than normally expected, while the concepts involved in visual metaphors typically involve more situational properties and entity-related properties than expected.
- (3) The shared features between two metaphor terms, which account for the similarity between them, primarily express situation-related properties, followed by entity-related properties, introspections, and taxonomic features.
- (4) Looking at the shared features between metaphor terms and comparing the two modalities of expression (visual and linguistic), it appears once again that the shared features between metaphor terms in linguistic metaphors involve more taxonomic features and introspections than expected, while the shared features between metaphor terms in visual metaphors involve more situational properties and entity-related properties than expected.

Overall, the results suggest that FDT primarily captures relational properties (situation-based features), followed by attributional properties (entity-related features) and that it can thus successfully model the distributional similarity based on relational and (partially) attributional properties. This type of similarity seems to play a crucial role in *visual* metaphors but not so much in linguistic metaphors. The latter type of metaphor, therefore, seems to work in a dimension of meaning that is not captured well by FDT. As a matter of fact, the features that are shared by metaphor terms in linguistic metaphors (and which therefore account for the similarity between the two compared concepts) primarily express

taxonomic features such as subordinates and synonyms, as well as introspections such as contingencies and emotions. Such features are not particularly well represented in FDT, compared to situational properties and entity-related features. Thus, the similarity between metaphor terms in linguistic metaphors is not high, when modeled through FDT. In a parallel study (embedded in the COGVIM project, as explained in Section “Introduction”), metaphor similarity has been investigated by means of a distributional method trained on linguistic corpora (distributional memory, Baroni and Lenci, 2010). As we predicted, this method captures higher similarity scores for the terms aligned in linguistic metaphors, compared to those aligned in visual metaphors (Bolognesi and Aina, under review¹¹). This, we argue, is due to the fact that taxonomic and introspective information are well represented in the linguistic corpus. The difference in the patterns of similarity captured by FDT and Distributional Memory provides additional evidence to support the claim that the two modalities (images and words) construct and represent metaphor in significantly different ways.

The final remark regarding the present study: the reader might argue that there is a substantial difference in the nature of the visual stimuli, as opposed to the linguistic stimuli, which lies in the fact that the concepts involved as metaphor terms in visual metaphors are typically more concrete than those involved as metaphor terms in linguistic metaphors. This is due to the fact that the visual modality of expression requires the metaphor terms to be represented or cued by graphic means, while the verbal modality allows the direct expression of abstract concepts through dedicated words. From this perspective, the degree of concreteness of the concepts involved as metaphor terms in the two modalities can also be considered a variable that might influence the results reported here. A formal investigation, which is currently in progress, will explain how and to what extent visual and verbal metaphors differ in terms of concreteness, as well as modeling the cognitive operations that explain how abstract concepts emerge from metaphorical images. The present study and the distributional analyses currently in progress based on text corpora precisely suggest that language and images are two different modes of communication that classify knowledge and represent meaning in different ways. Because of their inner characteristics, the two modes have their inner strengths (i.e., they can easily express some types of knowledge) and inner weaknesses

(they need to use indirect ways to express other types of knowledge). Such characteristics are reflected in the type of knowledge that is typically shared by two concepts compared in visual vs. linguistic metaphors, despite the fact that metaphors are matters of thought. A comprehensive theory of metaphor, not biased toward analyses of linguistic expressions, cannot avoid the differences between these two communication modes.

CONCLUSION

The results reported in this study show how FDT, a distributional method based on a stream of Big Data (Flickr tags), can successfully model the distributional similarity between metaphor terms and provide insightful distinctions between the degrees of relational similarity that characterize two different metaphor modalities (visual vs. linguistic).

As explained in Section “Method,” the investigation is based on a sample of visual metaphors and a sample of linguistic metaphors, randomly extracted from modality-specific corpora, and analyzed through established procedures for metaphor identification. The samples analyzed here are therefore considered to be representative for their respective modalities of expression. Further investigations currently in progress within the COGVIM project¹² will provide additional insight into the peculiarities of and differences between these two modalities of expression, and how such characteristics affect metaphor construction and comprehension.

AUTHOR CONTRIBUTIONS

MB, the first and unique author of the present contribution, has conceptualized and designed the present study, drafted the article, and submitted it.

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¹¹ Bolognesi, M., and Aina, L. (under review). *Similarity is Closeness: Using Distributional Semantic Spaces to Model Similarity in Visual and Linguistic Metaphors*.

¹² <https://cogvim.org/>

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Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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