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A new understanding of metaphors: from collective data to individual cases

Abstract. Most theories on metaphor processing are categorical, focus on semantics, and ignore important empirical findings. In this paper, we show how complex systems science can help us understand the apparently contradictory findings in the literature. We claim that metaphors are best understood as processed by the dynamic interaction between different factors, with dynamically shifting weights, in different time scales. To understand what a metaphor means, we must consider the multidimensional aspects of meaning: a) schemas, frames, scenarios, etc.; b) attributes (e.g., big, cruel, etc.); c) phenomenological schemas (e.g., mappings of visceral sensations); d) valence (positive, neutral, negative), etc. These constructs are not an object in the mind or the same for everyone. They are formed by experiences — with some overlaps, depending on people's sharing of cultural and embodied similarities. We never know how one person will interpret a metaphor but can make informed guesses based on empirical findings.
Keywords: metaphor processing, dynamic systems, meaning, Psycholinguistics, Cognitive Linguistics.

1. Introduction

Blame it on Descartes or the computer metaphor of mind, but somewhere in the past cognition was separated from the body, the environment, and time. Consequently, its study was also largely isolated from other sciences. Generative linguists have explicitly stated that syntax is a module with its own rules, and many structuralists view language

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as an unparalleled object. These positions justify the study of language turning a blind eye to our human biopsychosocial existence. Cognitive Linguists, on the other hand, made a different promise to not overlook other sciences while developing theories, known as the cognitive commitment. However, they soon discovered that this was easier said than done.

Although language has distinct characteristics, producing and comprehending language is a behavior similar to others. Science has made substantial progress in understanding behavior as a multifactorial adaptation to local contingencies. One of the primary insights shared by scientists is that the phenomena we study are usually not categorical, but dimensional. This leads us to expect that findings do not apply to all people and all situations, and that theories claiming "all Xs are Ys" are often incorrect. For instance, it is not true that every individual who has the gene for depression will develop depression, or that every person who has experienced trauma will have depression. These are two of the dimensions that may contribute to depression, but they do not determine it.

Furthermore, it is evident to scientists that knowing a person possesses a particular trait does not guarantee that they are going to behave in a specific way in every instance. For instance, knowing that someone tends to be rude does not mean that they will display rudeness in every situation. Science cannot predict how individuals will behave in specific circumstances. Nevertheless, it is usual for linguists to extrapolate from general group tendencies to individuality (or from general tendencies to every context) when examining individual language usage or discourse. This involves using some tendency in word meaning, such as dictionaries, corpora, or theories and applying it to people's linguistic outputs.

When it comes to theories, it is still very common to theorize about different phenomena in language in categorial fashion: all metaphors are processed in one way or another. Either they are all processed as categorization (Glucksberg 2008), or analogies (Gentner 1988), or by resorting to conceptual metaphors (Lakoff 1993), or they must access the lexicon first, then contextual effects will follow (Giora 2008), and so on and so forth.

Besides, a great effort to integrate insights from different theories has been made by incorporating time as a variable into metaphor theorizing. Thus, Bowdle and Gentner (2005) have proposed that metaphors are processed as analogies when they are novel, and as categorizations when they get conventional, all the way to when they lose their metaphoricity by losing connection with their original source domain. Steen (2017) has readily adopted the bipartite theorizing style and stated that deliberate metaphors are processed by analogy, and non-deliberate ones are processed as lexical disambiguation.

However, these theories, along with others currently available, do not fully account for the psycholinguistic findings obtained through years of metaphor research. Therefore, the goal of this paper is to take us one step closer to making sense of these findings in a scientifically consistent way, in line with other fields. To achieve this, we argue that we

need to consider not only the variable of time, as suggested by Bowdle and Gentner, but also many other variables (such as environmental, conceptual, individual, social factors, etc.), as we will discuss here. Metaphor processing is the outcome of the interaction of various variables, with dynamic weight, over different timescales, and hence it is contextual. However, acknowledging the contextual nature of metaphor processing does not mean ignoring the role of the conceptual system (or "the lexicon," as some authors prefer to call it) in terms of tendencies in mappings or meanings (Giora 2008; Lakoff 1993). Ultimately, the conceptual system is one of the dynamic variables that affect, but do not determine, metaphor processing.

Since the wealth of data available on metaphor processing cannot be covered in one paper, our goal is to outline a new approach to metaphors based on research results and some complex systems science concepts that will be introduced when necessary.

2. Behavior: from collective data to individual cases

Human behavior is diverse and can vary between individuals and within individuals depending on various probabilistic factors. This phenomenon is referred to as self-organization since there is no central control that determines how we must behave (Siman 2022). Instead, behavior is a product of the interaction between multiple variables with dynamic weights operating on multiple timescales. To explain behavior, we need to consider different systems, such as neurons, hormones, cultures, interpersonal relationships, environment, memory, biases, and the developmental history of the agent. The emergence of behavior is the result of biases from different timescales and systems integrating the person, which makes the study of any behavior, linguistic or otherwise, an interdisciplinary endeavor.

Scholars acknowledge that prior experience can influence subsequent behavior. For instance, being primed with temperature-related concepts facilitates the processing of a novel metaphor such as "our marriage is an icebox." (Gildea & Glucksberg 1983). Knowing that a speaker is often ironic can make it easier to understand the ironic meaning of the metaphor "your son is an angel," which implies ill behavior (Pexman et al. 2000). Different types of prior knowledge can also affect how a subsequent metaphor is processed. This phenomenon is not limited to experiments as various variables operating on different timescales can influence our behavior in daily life. For example, not sleeping well at night may lead to increased irritability and rudeness during the day.

Thus, to comprehend why an individual has acted aggressively, for example, it is essential to understand various factors that trace back to the evolution of our species (Sapolsky 2017). Some species tend to be more aggressive than others, which may make all individuals more prone to aggression. Within a species, males or females may exhibit more aggression, and culture may develop where aggression is promoted or justified. Additionally, an individual's developmental history, such as experiencing abuse or neglect,

may lead to a propensity for aggression and other antisocial behaviors. Recent hormonal or neurological changes, cognitive biases, and living in a socially hostile environment are other potential factors that can increase the likelihood of aggression. Typically, no single source of causation is responsible for aggression, and instead, many variables may contribute to it in non-linear ways (Sapolsky & Balt 1996).

Scientists continue to discover how different variables, in different timescales, affect adult behaviors and outcomes. For example, the hormones an individual is exposed to in fetal life can impact them in various ways as an adult (Culbert et al. 2008). If the individual's mother experiences chronic stress, they may be more susceptible to developing psychological conditions (Coussons-Read 2013; Entringer et al. 2008). If the mother is food-deprived, the individual may be prone to obesity, and if the mother is facing poverty, the individual may experience neurological changes that affect their success in adult life (Engle & Black 2008; Magnuson 2008). However, none of these variables guarantees a specific behavior or outcome in life because variables interact with other contextual or environmental constraints and may contribute to an outcome or behavior. Every complex behavior, including aggression, thinking, and speaking, is multifactorial (i.e., determined by the interaction of multiple factors) and probabilistic (i.e., each factor may contribute from 0 to 100%).

Let us provide some examples to support the claim that behavior is affected by dimensional and probabilistic variables, not categorical ones. Numerous studies have demonstrated that animals in subordinate positions tend to experience more chronic stress than dominant animals. This is understandable, as animals with lower ranks often suffer abuse from dominant animals who may attack them out of frustration or for pleasure. However, it is important to note that this is not always the case, as Sapolsky (2004) points out. In certain species, being dominant can actually be more stressful than being subordinate.

For instance, in marmosets (Callithrix jacchus), subordinate individuals cooperate with their dominant counterparts and wait their turn to become dominant. Consequently, these subordinate marmosets do not exhibit high levels of stress (Abbott et al. 2003). On the other hand, in wild dog species, being dominant requires constant aggression to maintain dominance, which can lead to higher levels of stress in dominant animals (Creel et al. 1997). Even within the same species, subordinate animals may not always experience high levels of stress, as long as there is a culture of reconciliation among them (Sapolsky 2006). Besides, during a severe drought, subordinate baboons may not experience stress because dominant animals are too focused on finding food rather than attacking subordinates (Sapolsky 1990).

Context also plays a crucial role in determining whether being subordinate is beneficial or not. For instance, when a dominant animal dies or an animal from another group competes for dominance, the dominant animals in that group may experience stress,

while the subordinates do not (Sapolsky 2004). Moreover, when a new dominant animal enters a group and starts to terrorize subordinates, we would expect all subordinates to be stressed, but only those who are attacked will experience more stress, and in proportion to the amount of abuse they receive (Sapolsky 2004).

Lastly, an animal's personality can also influence its tendency to experience stress. Some individuals may have overactive stress responses, which can lead to higher stress levels even if their social position in life is good (Sapolsky 1990).

In a previous publication (Siman et al. 2021), we argued that while experiments on metaphoric framing effects identify variables that play a role in producing such effects, they cannot predict whether those variables will generate similar effects in real-life situations. Some studies indicate that metaphors at the end of a text do not affect reasoning (Thibodeau & Boroditsky 2011), but depending on their function, they may have an impact (Robins & Mayer 2000). Metaphors in a text may influence reasoning, but their effect can be countered by a contradictory source of information, such as an image (Hart 2017). Metaphors may shape reasoning when people have beliefs that are consistent with the metaphor, but people may reject the metaphor when it is inconsistent with their beliefs (Elmore & Luna-Lucero 2017). Recent research suggests that metaphors may influence thought when people feel uncertain about their knowledge of a subject (Flusberg et al. 2018). However, we have not yet explored how insecurity about one's knowledge interacts with the credibility of the speaker who produces the metaphor (e.g., if the metaphor comes from Donald Trump and the reader is an "insecure" left-winger). There are many variables involved in metaphoric framing effects, and even ecologically valid experiments can only test a limited number of possible interactions. Moreover, in experiments, participants are asked to make judgments immediately after reading the metaphor, which may not reflect how people react to metaphors in real-world situations. Therefore, we cannot currently predict the effects of any single metaphor in real-life situations.

Scientists in many disciplines understand that there is no universal human being and that the concept of a "norm" is merely an abstraction or illusion. Every person is unique, even though shared properties are relevant for the scientific understanding of human bodies and minds. This is true for medicine and linguistics alike. Dictionary definitions of words may serve as a helpful abstraction across different people and contexts, but the mind cannot be reduced to a dictionary. The meaning of a word depends on the recurrent and different experiences that each individual has with that word within the context in which it is used. Fortunately, shared experiences within a culture ensure that we can understand each other probabilistically.

To capture the idea that words have senses that are more frequent or relevant, but not necessarily the sole meaning of the word, we describe the mind as a high-dimensional space, in which the most "central" aspect of meaning is an attractor basin. This concept serves two purposes: first, the idea of an "attractor basin" ensures that the central aspect

of the meaning is accessed probabilistically during language processing, without the need to retrieve the full meaning of the word. Second, different attractors can exist alongside the central one, allowing for different nuances of the meaning of the word to be accessed depending on a person's experiences with that word and the context in which it is used.

Thus, while experiments (and other studies) in biology, psychology, and linguistics show highly distributed tendencies in human behavior under specific conditions (which can generalize well or not), when we look at an individual, we do not know what's caused his behavior or what is in his mind. We may make informed guesses based on science, knowing that this practice is incomplete and knowing that an in-depth analysis of the individual's contingencies may support or contradict our informed guesses.

3. Metaphor processing: from collective data to individual cases

People do not start processing a metaphor from an unbiased situation. Their minds are not a blank space where processing begins unconstrained by previous experience and information. In complex systems terms, processing is affected by variables in different timescales, from people's past experiences with a metaphor to their personalities — different biases affect processing, we just need to explain how.

Moreover, when people come across a metaphor, by reading it or listening to it, their minds do not derive all possible meanings a metaphor can have. They derive one or a few, but not all of them. Most often, the meaning of the metaphor will be derived unconsciously, but even if one tries to derive meanings consciously, only a few possibilities will be available in one's mind. The mind is not a database from which you can retrieve — at your power — all the possible meanings for a metaphor. "Life is a journey" could mean something along the lines of "long", "short", "has a beginning, a middle, and an end", "is a process", "has a departure point and a destination", "is tiring", "is full of obstacles", "is fun", "exciting", etc. Certainly, no one will come up with all plausible meanings for this metaphor — we just need to explain how our minds derive (some) meanings. Not only that, we must explain how the same person can derive different meanings for the same metaphor in different contexts. So here are some of the questions we must explain about metaphors:

1) How different people can derive different meanings for the same metaphor.
2) How the same person can derive different meanings for the same metaphor on different occasions.
3) How different people can derive similar meanings for the same metaphor, so that we can understand each other (and different meanings, so we can misunderstand each other, as stated in #1).
4) What the "mechanism(s)" responsible for metaphor processing is.
5) How metaphor processing changes in time.

There are, of course, many other important questions about metaphor processing that we cannot explore here, among which: when and why we project new information to metaphors (Bowdle & Gentner 2005), how metaphors can be a type of loose talk in some contexts (Sperber & Wilson 2008), why we are conscious of some metaphor mappings in some contexts but not others (Steen 2008), etc.

All human behavior, metaphor processing included, is self-organized by the interaction between different variables in different timescales. A self-organized system is one which does not have a predetermined blueprint but is instead organized by the interactions between organism and environment (Gibbs 2019; Spivey 2006). In the case of metaphor processing, the variables involved in producing an outcome, a metaphor comprehension, are (among others):

(i) conceptual: from previous experiences of processing metaphors by cross-domain mappings.
(ii) individual: the experiences of each individual with the metaphors they have been more or less exposed to in a culture — people's minds are unique. This can be broken down into tendencies that can be found in different age groups, different sexes, different neurological make-ups, different personalities, different ideologies, different analogic abilities (Trick & Katz, 1986), differences in fluid and crystallized intelligence (Stamenković et al., 2019), etc.
(iii) linguistic: metaphors may appear in different grammatical forms, which can affect their meanings. Most notably, similes and metaphors can be processed differently (Bowdle & Gentner 2005).
(iv) immediate information: this includes the interaction — or what a person knows about their interactant and what the interactant has recently said; priming effects, information that is available in the context and co-text, etc.
(v) metaphors' characteristics: familiarity, aptness, conventionality, semantic density, history of previous uses, etc.
(vi) time: onset of processing, or later stages of processing.
(vii) task: interpreting a poem, processing an uninteresting conversation, etc. See more in (Gibbs 2013).

Metaphor processing is a very complex phenomenon. However, a very simple way to illustrate the gist of this dynamic theory would be to consider Figure 1.

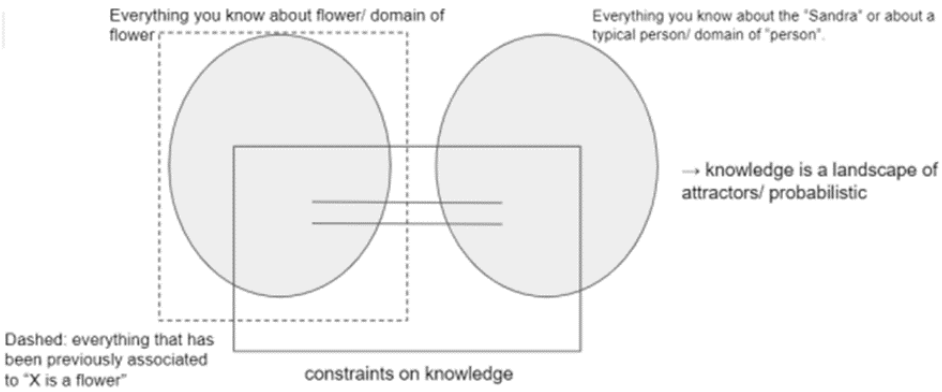

Figure 1. Metaphor processing

In a brief analysis that is meant to capture some aspects of metaphor comprehension, we start with the pairing of two concepts involved (vehicle and topic). People will not activate all the information they have on the concepts, and they will not produce all plausible mappings between the two concepts: the information available in the concepts are constrained by different variables. For example, if a person has recently heard (e.g., in a conversation) or frequently heard (e.g., as a member of a cultural group) some information about the topic of the metaphor, this information will be more salient: they will be more strongly active or more accessible in the concept. Moreover, some information about the vehicle will become more active than others, as a function of the topic (and what is salient in it). All information is dynamically activated, so even though some conceptual information may be highly active regardless of the context, if the context at time X is strong enough, it can weaken the strength of the usual variables (that tend to be strong in most contexts). What this means is that even though we may have a strong tendency to derive meaning X for a metaphor, there can be a context that biases the meaning so strongly in some other direction as to weaken or inhibit meaning X.

Within the concepts (vehicle and topic), the information that will be constrained and matched can be of different kinds. They are multidimensional: a) schemas, primary metaphors, frames, scenarios, etc.; b) attributes (e.g., beautiful, big, cruel, etc.); c) phenomenological schemas (e.g., mappings of visceral sensations); d) valence (positive, neutral, negative). We must consider that: a) any of these dimensions of meaning can be active, depending on the context; b) more than one dimension can be active, depending on the context; c) these dimensions can be probabilistically active, depending on the context (it is not an all or nothing switch). We must also consider that these constructs are useful for theorizing, but they are not exactly the same for everyone, since these dimensions of meaning are constructed depending on people's unique experiences — with some common overlaps, depending on their sharing of cultural and embodied similarities. Besides, we must understand how different variables in different timescales interact making it

possible for people to understand one another, but also to misunderstand one another. The variables (and their interactions) are discovered or tested in different experiments and can be observed in practice in our daily lives.

By taking the psycholinguistic literature into consideration (and some extrapolations that should be tested), metaphor processing starts by the pairing of two domains or concepts[3]. After pairing the concepts, some of their properties need to be matched. The properties that will get matched depend on different biases and the strengths of the biases, which are set contextually. We call those biases attractors. The notion that language processing is like traveling in a trajectory with many attractors exerting different forces helps us understand three facts about processing. First, the mind is not a dictionary in which one word evokes one full-blown meaning. Instead, processing is probabilistic, and meaning is accessed probabilistically, as explained by Gibbs and Santa Cruz (2012). Moreover, there are many attractors for one word's meaning, which gives it nuance and can include different aspects of one's subjective experience with that word (e.g., emotional valence, a sense of where to use the word, who to use it with, etc.), which is part of the meaning. Lastly, since processing is a pathway along many attractors, the pathway need not be always the same: starting from a different place can lead to different semantic experiences in different contexts.

We do not read minds; no one does. The difference between what we propose here (in line with Spivey, 2008), and what traditional cognitive linguistics proposes is that the traditional constructs of linguistics are generic. They are meant to capture a generalization for a given phenomenon (as if context and time did not exist). Here, we are presenting an idealization of an individual mind, not a generic one. Individual minds are bound by time, history, context, previous experiences, etc. They are not an abstraction, but we cannot know any individual mind, so we are going to create one based on the dynamic system's theory and empirical results.

Each mind at each moment is a landscape of attractors. Much more than we can represent here. Thus, our representation here is, of course, a simplification. Figure 2 represents an idealization of the processing of the metaphor "Sandra is a flower". At the moment we say "Sandra", there is a lot of salient contextual information about Sandra, especially if she is in front of us and has just said or done something interesting. This salient information constrains what will come up for the second concept probabilistically. The second part of the probabilistic constraints comes from our frequent or otherwise salient uses of this metaphor. In different contexts, different concepts may dominate

3 The approach to metaphors presented here is not supposed to make categorical claims. For example, up to this point, experiments suggest that metaphor processing starts by pairing two domains/concepts, but in the future, we might find out that other types of metaphor do not need pairing. Thus, the approach will be updated.

the processing. In this case, "delicate" is the dominant attractor in the landscape and it matches the contextual information, thus processing goes smoothly. In figure 2, concept 2 (Flower) is already affected by the previous processing of the same metaphor "X is a flower", thus it contains more information than a non-metaphoric concept of flower would contain (i.e., literal flowers are generally not said to be kind). Concept 1 is about the other term of the metaphor, in this case, "Sandra". We may know a lot or little about Sandra, and it should affect our landscape. In this idealization, we know by the context that Sandra is very delicate, very nice, somewhat kind, etc.

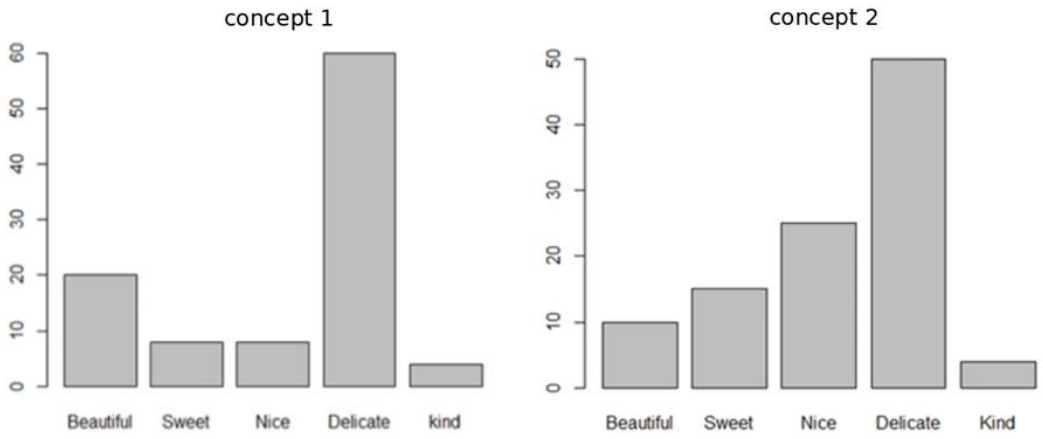

Figure 2. Idealized landscape: concept 1 (with some probabilistically salient properties) and concept 2 (with some probabilistically salient properties). Axis y represents the levels of activation of properties. Metaphor: "Sandra is a flower".

Remember that this is not a picture of what is happening in the mind. All theories are summarizing, condensing a complex multivariate world into simple equations, graphs, stories, metaphors. The world is more complex than we can grasp. Thus, the figures presented here could be broken down into different aspects and could show different parts and facets of cognition. We are choosing to emphasize some aspects that are derived from the results of experiments and which fit a new dynamic understanding of metaphor processing. Another important discussion that we are omitting (for now) is about the distinction between analogy and categorization in this model. The reason for that is that we are running further tests to understand the difference between the two. At this point, we consider the mechanism to be the same, and the difference in processing time shown in experiments to be due to repetition (i.e., reprocessing similar metaphors) and the strength of the biases that induce meaning.

There are two more things that are important to add. One is that all of this happens in flux, or in a continuum. The illustrations represent static and separated objects, but this is just for convenience. The other issue we would like to quickly address is how conceptual metaphors (Lakoff & Johnson 1980) are biases that constrain (probabilistically,

not deterministically) meaning. The experimental evidence on CMT shows some consistencies regarding CMT's role in memory (Nick Reid & Katz 2018) and in processing (Thibodeau & Durgin 2008) — for a more extensive discussion see (Siman 2022). This is not to mean that conceptual metaphors always constrain meaning (McGlone 1996; Miller et al. 2020), but that they do, probabilistically, in some conditions. More studies are needed if we want to specify the interactions that lead to a higher probability of using conceptual metaphors in meaning.

The approach that we briefly presented here is novel and under construction, differing from other approaches in that it is dynamic: the constraints that affect metaphors are multiple and probabilistic, allowing metaphors to have different meanings in different contexts. This approach can be contrasted, for example, with the classic version of Conceptual Metaphor Theory, which proposes that metaphors are processed by fixed, pre-established cross-domain mappings. This approach also differs from models that claim that the mappings occur because of previous similarities between the two concepts involved or from theories that focus on semantic concepts isolated from their contexts (Ortony 1979).

4. Implications for other theories

In the 19th century, John Stuart Mill classified psychology as an inexact science: just like meteorology, we could only predict what minds would do probabilistically. There's a high likelihood that it is going to rain tomorrow, but maybe it won't. If you know that your professor tends to smile when he starts the classes, you might predict that he will smile in the next class… but maybe his dog will die, or he will have a headache, or his boss will threaten to fire him: knowing that a person tends to behave in one way does not guarantee they will behave the same way next time. The same is true for metaphor processing. There are no universal rules that can predict metaphor meaning for all people in all contexts — there are only tendencies. Metaphor meaning is not an exact science (at least not yet).

When we understand this argument, we understand not only the worth of proposing a dynamic theory of metaphor meaning but also what is wrong with all categorical theories of meaning. Conceptual Metaphor Theory (CMT) has made both wrong and useful predictions, which we discuss in (Siman 2022). Just to make the point brief: there can be no single source of constraints on cross-domain mappings, no fixed set of cross-domain mappings that are valid in all contexts — which does not preclude CMT from being valid or partially valid in some conditions, or under some experimental constraints. Gibbs and Santa Cruz (2012), on one hand, and Kovecses (2017) on another, assume a somewhat dynamic position toward conceptual metaphor processing, but they restrain metaphor meaning to some constructs that are found in cognitive linguistics: primary metaphor, schemas, frames, etc. However, metaphor meaning can go beyond these constructs (e.g.,

attributes) (McGlone 1996; Siman et al. 2022). These theories also do not acknowledge how different factors may lead to different outcomes in metaphor processing (i.e., outcomes that are not predicted by CMT). They do offer important insights into how different constructs can be useful in discussing metaphor processing, but they are rather biased in terms of what aspects of meaning are worth theorizing about.

Steen's (2017) DMT divides processing into binary categories: deliberate metaphors are processed as analogies, whereas non-deliberate ones are processed as categorization. The problems with the theory arise at different levels. First, not all novel metaphors seem to be processed in the same way (Glucksberg 2008). Second, novel metaphors may be very much novel or they may rely on conventional metaphors (Siman 2022), thus novel and conventional metaphors might be a continuous category rather than a binary one (which should affect the distinction regarding deliberate and non-deliberate metaphors). Third, very often what seems to be deliberate carries with it a lot of unconscious processing (Bargh 2017; Gibbs 2011). But what is more relevant to our point is that DMT once again relies on metaphors having two universal meanings (either a lexical or an analogical one), as predictable as the laws of classical physics, which we know cannot be true. The theory can be further specified to claim that it does not care about the particular meanings of the metaphor, only that there are two independent processes to derive this meaning (lexical access and analogy), but still, the theory would lack the specifications of how meanings can be different, and the binary distinctions often turn out not to be binary.

Gentner and Bowdle's (2005) theory manages to get an important insight into how metaphor processing changes over time. But the theory fails to make sense of conceptual metaphors' role in metaphor processing, of the fact that some novel metaphors seem to be processed just as quickly as conventional ones (Glucksberg 2008), and of the fact that some metaphor processing seems to go beyond analogy (and categorization as resulting from analogy) (Siman 2022), as discussed in the previous section.

Gibbs's (1994) proposal that metaphors are processed contextually disregards Giora's (Peleg et al. 2001) findings about the role of salience in processing. Sometimes, the most salient meaning of the metaphor is accessed even when it is not contextually adequate. On the other hand, Giora's theory must be further tested considering that even highly salient meanings may fail to be accessed when other variables increase the salience of less salient meanings. This needs to be tested to understand if the salient meaning is inhibited or less active, but daily life experiences with this phenomenon abound: for example, a friend reported reading "amendoim sem pele" (skinless peanuts) as "amendoim sem Pelé" (Peanuts without Pelé) on the day that the famous soccer player Pelé died. His first interpretation was that the peanuts were mourning Pelé (the peanut brand could be paying tribute to Pelé), but he later realized that it was skinless. "Skinless peanuts" is the most frequent and meaningful interpretation for those signs, but Pelé was just too salient in our culture to be blocked.

The overall point is that all experimental findings shown are tendencies (instead of rules) in particular circumstances. The change in those circumstances can lead to different behavior or different interpretation of the metaphor. That is why metaphors are best seen as processed by the dynamic interaction between different factors, with dynamically shifting weights, in different time scales.

The approach to metaphors presented here is meant to put the puzzle together of what empirical findings are telling us about metaphor processing. It is often the case that this presentation leads to a question: what are the predictions this new approach to metaphors is making? As one might guess, we cannot make predictions of the kind generic theories do. We cannot claim "all metaphors will be processed in X way" because we are saying metaphor processing is the result of different variables interacting dynamically. What we can do, instead, is to use this approach to guide us into challenging generic claims, further inquiring into each result: what variables could change the result we got? We cannot know *a priori* what variable will affect the results, but we can look at the world and at science to hypothesize. We work on the principle that most things can change, and our goal is to understand under what conditions they change, knowing that variables can be in different time scales and have different strengths.

5. Why dynamic systems theory?

One could argue that it is widely recognized that meaning is subjective and context-dependent. However, the mechanics of contextual meaning are a subject of debate, as evidenced by the differing perspectives of Giora (2008) and Gibbs (1994), which we have addressed in this paper. Conceptual Metaphor Theory (CMT) scholars generally assume that the meaning of a metaphor is confined to certain constructs used in Cognitive Linguistics (e.g., primary metaphors, frames, etc.), while other theories either disregard conceptual metaphors altogether or only acknowledge their use in novel metaphors (Glucksberg & Mcglone 1999; Steen 2017), which may be an oversight (Thibodeau & Durgin 2008). Although it is commonly understood that meaning is individual, no coherent theory has emerged to explain the specific ways in which meaning is both individual and shared, and how the findings in the literature fit together. We propose one approach to making sense of these issues, which can be subject to discussion, refinement, and refutation.

Of course, all explanations are partial and provisory since our knowledge about the world is ever changing. One might wonder why propose a provisory theory that attempts to summarize our current knowledge about metaphors or why bother explaining when the explanation is incomplete and might be discarded a few years from now. Should we create theories with the only purpose of predicting new data? The fact is that theories, regardless of what they predict, end up telling us what is relevant (or irrelevant) in the world and how to tackle real problems. And we believe that the current theories dismiss important aspects of experience, lead to wrong decisions about how to tackle real

problems, and can, potentially be harmful as they ignore important variability between people (an issue that will be addressed in a different paper).

In psycholinguistics, theories serve the dual purpose of elucidating existing data and predicting new discoveries. Categorical theories or claims are valuable in that they can be supported or refuted by different experiments repeatedly, as seen in the "Metaphor Wars" (Gibbs 2017). On the other hand, a probabilistic theory appears to be an inadequate replacement for our trial-and-error approach. After all, if everything is probabilistic and dependent on the intricate interplay of factors, then nothing can ever be definitively ruled out! However, experiments do not conclusively invalidate theories (Meehl 1967). Moreover, human behavior is characterized by self-organization driven by multiple variables that do not operate deterministically in isolation, but rather interact in non-linear ways, resulting in a deterministic outcome. That is, categorical theories might be good for predictions but not realistic for explanations.

It is also important to realize that experiments artificially hold constant some variables as they change the one variable under investigation. For example, we may create equal texts and change only one metaphor as we investigate the metaphoric framing effect in the context of Covid-19. But in the wild we cannot tell people to hold still and not learn anything new about Covid, not be exposed to new metaphors, new texts with the same metaphor, new ideas, new challenges in their lives regarding Covid. There is no *ceteris paribus* in the wild. The world is dynamic; it is in a state of flux. This is another reason we should consider dynamic theories since it prevents us from making naïve claims about metaphors and society (or more generally about experiments and individuals or societies).

One of the uses we get from Dynamic Theories is a way to articulate what different sciences are showing us regarding different human facets. They explain why we encounter conflicting results and observe behaviors that manifest in certain contexts but not in others. This raises the question of falsifiability: What would convince a dynamic systems scientist to change their minds? Dynamic theories are refuted when scientific evidence demonstrates that behavior is not influenced by multiple variables in different timescales in a probabilistic manner. This would require a scientist to uncover a fundamental universal principle that accounts for all the seemingly disparate behaviors exhibited by individuals, rendering the explanation of dynamic variations unnecessary. From a dynamic systems perspective, however, the ideal of a universal theory is unattainable.

Alternatively, we could settle for an alternative theory that elucidates differences and adaptable behavior. Nonetheless, the history of science has taught us that novel theories explaining the same phenomenon come with both advantages and disadvantages compared to existing ones. The bottom line is that no theory is definitive, and we should employ them if they enhance our understanding and help us address real-world problems. One way to interpret our proposition in this paper is to view our theory as a temporary

placeholder for our accumulated knowledge about metaphors. It serves as a framework for organizing our understanding and thinking about the world.

Dynamic theories can be misconstrued as "theories that explain everything but end up explaining nothing." However, no theory can explain everything. Science continuously develops, revealing realms beyond our current grasp. Dynamic theories are just as partial as other theories. Holism should not be seen as a replacement for reductionism but rather as a complementary and partial approach that contributes to science (Ayers 1997). But how does it contribute to science? Considering other theories, the expectation is that we will make categorical predictions that can be tested. However, even categorical theories (in psychology and linguistics) do not specify the exact conditions when support is to be found.

Thus, if dynamic theories are claiming that behavior is the result of the dynamic interaction between different variables in different timescales, the only way we can predict behavior is by knowing all the variables that lead to an outcome for each person – which at this point is impossible. We can't predict behavior unless it is in a probabilistic way. And this is a fact for all theories, dynamic or not.

With that in mind, some predictions within Dynamic Systems studies involve understanding different phenomena as continuous rather than binary. For instance, Farmer et al. (2007) tracked the trajectory of mouse movements as individuals decided between two potential interpretations for garden path sentences. By capturing mouse movements, the authors revealed the gradual nature of people's thinking, influenced by linguistic and visual information processing biases. Nearly any phenomenon can exhibit continuity, ranging from metaphorical to literal language, from novel to conventional metaphors, and from abstract to concrete language. Identifying informative ways to test continuity can advance our understanding of cognition, particularly toward a non-symbolic/non-representationalist perspective (Spivey 2006).

Another important trend is to explain phenomena through a unified mechanism rather than multiple ones. For instance, instead of positing separate mechanisms for processing regular and irregular verbs, it is plausible that the same mechanism handles both cases (Joanisse & Seidenberg 2005; Rumelhart & McClelland 1985; Seidenberg & Plaut 2014). Similarly, rather than attributing different mechanisms to conventional and novel metaphors, it is likely that they operate under the same "mechanism". Our future objectives include designing experiments that shed light on how this may be possible. Therefore, if we can challenge prevailing beliefs and demonstrate, through experiments, the plausibility of an alternative explanation, it signifies a scientific advancement. When there are multiple plausible explanations for a phenomenon, there is more knowledge to be gained.

Researchers studying dynamic systems also approach the notion of fixed structures in the mind with skepticism. By altering the experimental conditions, we may discover

that what we think is a fixed cognitive structure is, in fact, a dynamic response to the task at hand. Significant modifications to the task can elicit different responses (Perone & Simmering 2017). In this paper, we have discussed how Giora's (2008) proposition, suggesting that metaphors are initially processed by accessing the lexicon, can be challenged through experiments showing that we can manipulate the salience of a less prominent meaning of a word contextually. This manipulation results in the less prominent meaning being accessed first, contradicting the notion that the "lexical" meaning must be accessed prior to contextual factors. Indeed, scientists have attempted to refute other theories by creating situations that defy their predictions. From a dynamic systems perspective, it is unnecessary for someone to predict something before demonstrating that the prediction does not hold in alternative contexts; this is done under the assumption that cognition is dynamic.

In essence, certain theories must undergo revisions when their predictions are found to be incorrect. Dynamic systems theories, on the other hand, are subject to change with each new finding, unless the discovery undermines crucial tenets of the theory (such as determinism, non-representationalism, dynamic adaptable behavior, etc.). While psycholinguists may not favor this style of theorizing, it is indispensable for professionals working in applied sciences (e.g., psychotherapists, physicians, linguists). Understanding how different variables impact individuals in varying ways, whether in symptom manifestation or meaning interpretation, is essential for comprehending individuals and societies, and for understanding that what may benefit one person or group might harm others (i.e., non-linearity).

6. Final considerations

To understand what a metaphor means, we must consider the multidimensional aspects of metaphor meaning: a) schemas, primary metaphors, frames, scenarios, etc.; b) attributes (e.g., beautiful, big, cruel, etc.); c) phenomenological schemas (e.g., mappings of visceral sensations); d) valence (positive, neutral, negative). We must consider that: a) any of these dimensions of meaning can be active, depending on the context; b) more than one dimension can be active, depending on the context; c) these dimensions can be probabilistically active, depending on the context (it is not an all or nothing switch). We must also consider that these constructs are useful for theorizing, but they are not exactly the same for everyone, since these dimensions of meaning are constructed depending on people's unique experiences, with some common overlaps, depending on their sharing of cultural and embodied similarities. Besides, we must understand how different variables in different timescales interact, making it possible for people to understand each other, but also to misunderstand each other. The variables (and their interactions) are discovered or tested in different experiments and can be observed in practice in our daily lives.

Scholars often express skepticism towards dynamic theories when it comes to predictions and falsifications, which we have discussed in this paper. However, we want to emphasize that scientific inquiries also delve into the nature of the mind, the process of interpretation (meaning-making and linguistic processing), and how we interpret findings in the existing literature. The theoretical framework proposed in this paper presents specific claims on these matters, which can be compared to what is already known in psycholinguistic literature and the broader field of humanities. Ultimately, we hope that our paper sparks a philosophical discussion on how to articulate our understanding of metaphor processing, the implications of conflicting findings, and how to approach individuals' discourse when we lack knowledge of their personal history leading to their statements.

By taking a broader perspective on science, we can observe that the problems encountered in one field are often found in many others. In essence, various disciplines grapple with the multidimensional nature of objects, such as diseases, cognition, and development. While traditional science focuses on generalizations, universal rules, and shared trends among many cases, applying science to real-life situations requires us to understand how the interaction of variables leads to non-linear differences. We cannot ignore the fact that people respond differently to the same stimulus in different contexts. Dynamic Systems approaches shed light on these variable interactions.

This paper makes the point that all experimental findings show tendencies (instead of rules) in particular contexts. The change in those contextual variables can lead to different behavior or different interpretation of metaphors. That is why metaphors are best seen as processed by the dynamic interaction between different factors, with dynamically shifting weights, in different time scales.

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