

# Varieties and Directions of Inter-Domain Influence in Metaphor

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## **Abstract**

We consider the varieties and directions of influence that the source and target domains involved in a conceptual metaphor can have on each other during the course of understanding metaphorical utterances based on the metaphor. Previous studies have been restricted both as to direction of influence and as to type of influence. They have been largely confined to the “forward” (source to target) direction of influence, and they have concentrated on the transfer of features or propositions and (to some extent) the highlighting of aspects of a domain. By contrast, this article stresses the importance both of other varieties of influence (e.g., transfer of queries and uncertainty effects) and of “reverse” influence (target to source). We seek to curb the natural tendency to think that, because metaphor involves an overall move from source to target, therefore all inter-domain influences in the course of understanding go in that direction. The bulk of the article explores the theoretical issues involved. These issues have arisen out of a reasoning-based approach to metaphor, seeking to make best use of information from metaphorical utterance, context, source and target domains, and known metaphorical mappings, by applying a complex overall reasoning process. The article briefly explains the thorough implementation of reverse influence in a computer program for metaphorical reasoning called ATT-Meta, although the theoretical considerations are relevant to all disciplines concerned with metaphor. We make some suggestions for further computational and psychological research on metaphor.

# 1 Introduction

This article arises out of an AI research project that is concerned with the processes involved during understanding of metaphorical language. The project has led to the development of a computer program called ATT-Meta. ATT-Meta performs types of reasoning that we claim are needed for metaphor understanding (Barnden, 1998, 2001a; Barnden *et al.*, 1994, 1996, 2002b; Barnden & Lee, 1999, 2001; Lee & Barnden, 2001a). The present article, however, reports theoretical considerations that, while generated by the development of ATT-Meta, are important independently of that program and are of potential interest to metaphor researchers in non-computational disciplines. These theoretical considerations are given additional substance by simulations using ATT-Meta (see Barnden *et al.*, 2002a, Barnden & Lee, 2001), but for reasons of space we only touch on ATT-Meta briefly in this article, in order to concentrate on the theoretical side.

We seek to curb the natural tendency to think that, because metaphor involves an overall move from source to target, therefore all inter-domain influences in the course of understanding go in that direction. Metaphor research almost always offers processing accounts in which the source domain has some sort of influence on the target domain, rather than the other way round. Typically, features or propositions arise in the target domain as a reflection of source-domain features or propositions that are gleaned from the metaphorical utterance. (We exclude those cases where the understander's mental lexicon directly supplies a target-domain meaning for the metaphorical word or phrase in question, in which case the source domain can be bypassed.) For example, in a possible approach to understanding the sentence "McEnroe killed Connors" (McEnroe and Connors being well-known tennis players), the source-domain proposition that McEnroe biologically-killed Connors is transferred to become the target-domain proposition that McEnroe defeated Connors. Such influence from source to target is explicit in some accounts, such as Structure Matching Theory (see, e.g., Falkenhainer, Forbus & Gentner, 1989), the artificial intelligence systems of Martin (1990), and theories based on feature-transfer. However, it is less explicit in categorization-based accounts such as those of Glucksberg (Glucksberg & Keysar, 1990; Glucksberg, 2001) and Way (1991). According to the Glucksberg & Keysar account, the sentence "My job is a jail" puts the job into a category **jail\*** that includes both the speaker's job and jails. Unless there is an existing, direct link from the word "jail" in the lexicon to the **jail\*** category, the latter category is presumably found or constructed partly through the influence exerted by aspects of the ordinary physical-jail category, such as constraint and unpleasantness.

We can take the source domain to be the domain of jails and the target domain to be the domain of jobs, say. There is therefore an influence from source domain to target domain, albeit indirectly.

We will view the feature-transfer and categorization cases of inter-domain influence as a special case of the proposition case, since attributing a feature or stating a categorization is just a special case of asserting a proposition. In keeping with common terminology in the field, we say that a source-domain proposition (e.g., that McEnroe biologically-killed Connors) has been transferred to become a target-domain proposition (e.g., that McEnroe defeated Connors). Proposition transfer, understood to encompass feature transfer and categorization, is by far the main type of influence that source domains have on target domains in discussions in the metaphorical literature. And, inter-domain influence in metaphor understanding is almost always considered to go from source to target, not the other way round. (Important exceptions are noted below.) The task of this article is to enrich this limited picture along two dimensions:

- A. to stress that there are important varieties of inter-domain influence that have largely been neglected in metaphor research
- B. to explore and stress the ways in which inter-domain influence can go in the target to source direction, i.e., the “reverse” direction to what is normally considered.

The dimensions are largely independent, in that the different types of influence can mostly go in either direction between source and target.

For definiteness, we will assume in this article that metaphorical language rests on conceptual metaphors in at least roughly the sense of Lakoff (1993). A conceptual metaphor consists of a mapping between a source domain and a target domain, where a mapping is a set of individual mapping links that put individual aspects (entities, properties, relations, etc.) of the two domains in correspondence with each other. However, our arguments below are significant for metaphor accounts in general, not just for ones resting on a Lakovian notion of conceptual metaphor. In any case, Lakoff and others make claims about conceptual metaphors that do not affect the present article, such as that many conceptual metaphors arise naturally from bodily experience. Also, we are not concerned about how entrenched the conceptual metaphors are in the mind of an understander – our considerations apply both to cases of discourse understanding where the conceptual

metaphors are already established in the understander and to cases of novel metaphor where the understander develops the metaphorical mappings from scratch during understanding.

The plan of rest of the article is as follows. Sections 2 and 3 discuss the dimensions A and B of influence variety and influence direction, respectively. Section 4 discusses the reverse transfer of queries, focus and expectation. Section 5 the reverse transfer of propositions, and Section 6 the case of reverse influences on the certainty levels of propositions. Section 7 links the considerations of previous sections to the ATT-Meta computer program, thereby indicating briefly how the theoretically supported processes can be realized in an actual system. Section 8 concludes.

## 2 The Influence-Variety Dimension

Here we look at dimension A in section 1 and thus to varieties of inter-domain influence that are different from proposition transfer (taken to include feature transfer and categorization as above). An important variety often mentioned in the literature—famously in the case of Max Black’s (1979) interaction theory—is that of an understander being led to focus on (i.e., highlight) particular aspects or structures of the target domain that reflect some aspects or structures of the source domain. Saying that “Mike is a wolf” after recounting his amorous exploits may not add much genuinely new information about Mike, but serve instead to focus the listener’s mind on some special qualities of those exploits.

While such highlighting is a well-known concept, there are other types of inter-domain influence that have barely been attended to. For instance, it is not often noted explicitly in metaphor research that questions, commands and other non-declarative types of utterance can be metaphorical. Just as one can state “The champion knocked the cream-puff out.” one can issue the command “Knock that cream-puff out!” Just as one can state “Mike is a wolf” or “McEnroe killed Connors.” one can ask “Is Mike a wolf?” or “Did McEnroe kill Connors?” One passage we have found is: “Have you arranged your ideas in a logical order? Does one idea lead naturally to the next? Does your essay ‘flow,’ or does it just jump around from one thing to the next?”(Hinton, 2002).

We will pursue here only the case of questions, rather than commands etc. A metaphorical question ultimately causes the understander to frame one or more mental queries about the target domain, such as:

Did McEnroe win the game with Connors? What is happening here is query transfer rather than proposition transfer. A mental query in source-domain terms (Did McEnroe biologically-kill Connors?) is derived from the metaphorical question. This is then transferred to become the mental target-domain query (Did McEnroe defeat Connors?).

Although query transfer is in many ways similar to proposition transfer, one needs to be cautious in assuming that existing metaphor-understanding theories that pay attention only to proposition transfer can straightforwardly be expanded to account for query transfer. For instance, if part of the theory is that the understander seeks an analogy between the body of source-domain information relevant to the sentence and a body of known facts in the target domain, then metaphorical questions pose a problem because what is at issue in the target domain is something that could well not be a fact. And of course metaphorical commands move yet further away from facts about the target domain.

A further type of inter-domain influence is certainty adjustment. A metaphorical utterance can boost or dampen the understander's degree of certainty in some target-domain proposition, rather than leading the understander to create the proposition from scratch. For instance, in the case of an utterance of "surgeons are butchers" the understander may already be entertaining the proposition that surgeons have a callous attitude towards the flesh they manipulate, perhaps because of statements already made in the discourse. But, if the understander has a high degree of certainty that butchers take a callous attitude to the flesh they manipulate, then the understander could now become more certain that surgeons are callous. Thus the source domain has exerted a positive certainty adjustment on the target domain.

There can be negative certainty adjustments as well. For instance, consider the sentence "It seems the company wants to push its workers' pension benefits in an upwards trajectory." Let us assume that the understander comes to the sentence with the belief that, in general, a company in the current economic climate would wish to worsen its workers' pension benefits. If the understander gives some credence to the sentence, she must, at the very least, reduce her certainty in this belief.

The notion of certainty adjustment is of special importance with respect to extended metaphor. If a substantial stretch of discourse intermittently talks about a target domain scenario by means of a particular conceptual metaphor (e.g., casting a sports match as a battle), the understander may incrementally build up a source domain scenario that metaphorically describes the target-domain scenario. As the source domain

scenario is built, it is likely that aspects of it that the understander is uncertain about, or has merely guessed about, become more certain. Such adjustments made to aspects of the source domain scenario that have already been put into correspondence with aspects of the target domain scenario need to be fed through to the target scenario, in order to keep the two scenarios as consistent with each other as possible.

The matter of certainty adjustment is just one way in which the issue of uncertainty is important for metaphor. As is well recognized, there are many types of uncertainty in metaphor understanding: e.g., uncertainty about what analogy or conceptual metaphor is in play, uncertainty about what aspects of the source domain are being exploited, and uncertainty inherent in inferential connections within both the source domain and the target domain (given that the domains involved in metaphor in mundane discourse are generally only common-sense domains of knowledge, involving much uncertainty). However, few treatments of metaphor provide a detailed handling of uncertainty of reasoning. The most salient exception other than our own work is Hobbs' abduction-based framework (Hobbs, 1990).

### **3 The Influence-Direction Dimension**

We now turn to dimension B in section 1, concerned with direction of influence. We have so far discussed proposition transfer, query transfer, focusing (highlighting) and certainty adjustment as being a matter of “forward” inter-domain influence: i.e., influence that the source domain has on the target domain. This reflects the almost exclusive attention in the metaphor literature on this direction of influence, and the intuition behind the use of the words “source” and “target.” The bias is seen most clearly in the case of proposition transfer, which is the main form of inter-domain influence that is investigated. The SMT framework (Gentner, 1983; Gentner, Falkenhainer & Skorstad, 1988; Falkenhainer, Forbus, & Gentner, 1989) for analogy and metaphor provides only a mechanism for proposition transfer in the forward direction. The ACME framework (Holyoak & Thagard, 1989) augmented to handle proposition transfer (Holyoak, Novick & Melz, 1994) only deals with transfer in the forward direction. In the AI area, most of the main accounts that provide for proposition transfer (e.g. Fass, 1997, Martin, 1990, Narayanan, 1997) deal only with the forwards direction. Indeed, as we will see, our observations about reverse proposition transfer are bound up with complex inference processes within the terms of the source domain, and very few detailed accounts of metaphor processing incorporate such inference, the main exceptions being our own work and that of Hobbs

(1990), and to a lesser extent Narayanan's and Martin's.

However, reverse proposition transfer and other types of reverse influence are occasionally discussed:

- Reverse influence features to an extent in interaction accounts (see, e.g., Black, 1979, Waggoner, 1990). The influence on the source domain is talked of as being a long-term one: e.g., understanding “men are foxes” could lead one to change one's long-term view of foxes as well as one's view of men. Similar long-term reverse influences have been discussed (Coulson, 1996, 2001; Grady, Oakley & Coulson, 1999) in the context of “blending theory” or “conceptual integration theory” (Fauconnier & Turner, 1998). Below, however, we will be not be interested particularly in long-term influences on the source domain (important though they may be), but only in ones occurring during understanding of a metaphorical utterance and whose prime purpose is indirectly in the service of understanding the target-domain scenario being described. That is, we allow the influences on the source-domain to have only short-term significance.
- Blending theory lends itself also to short-term target-to-source influences when applied to metaphor: in a blend space, there is a mixture of information derived from the target domain and information derived from the source domain. Under certain circumstances, the result of this can be viewed as the transfer of a target domain proposition into source domain terms, and the source-domain proposition that effectively results could be used in inference processes within the blend space that occur during understanding and are aimed only at providing new insights about the target.
- Hummel & Holyoak (1997) present their LISA model for analogy and briefly address a form of proposition transfer in the reverse direction.
- Hobbs (1990) presents a computational framework for metaphor understanding that allows a form of proposition and query transfer in the reverse direction, although the metaphor aspects of the framework have not been implemented in a computer program.
- Some metaphor and analogy theorists have proposed types of processing that can be regarded as reverse focusing effects or reverse query transfer (see below). Markman (1997) discusses analogical processing as being constrained towards establishing specified goals. This is related to reverse query transfer. The connectionist ACME system (Holyoak & Thagard, 1989; Holyoak, Novick & Melz,



1994) incorporates a mechanism that amounts to a limited type of reverse focusing/highlighting. In some connectionist and semantic-network accounts that rest on the spread of activation among networks of nodes, metaphor processing can result in activation spread within a subnetwork of source-domain nodes, where the spread is influenced by activation spread within a subnetwork of target-domain nodes. This amounts to a reverse focusing/highlighting effect, and appears in systems such as LISA (see above) and the Sapper system (Veale & O'Donoghue, 2000).

- Many authors have proposed that the discourse context surrounding a metaphorical utterance guides the process of selecting a metaphorical meaning for the utterance (e.g.: Cameron, 1999; Giora, 1997; Leezenberg, 1995; Ortony *et al.*, 1978; Peleg, Giora & Fein, 2001; Récanati, 1993; Stern, 2000; Waggoner, Palermo & Kirsch, 1997). As we will explain below, such guidance can be a matter of reverse influence.
- Any metaphor theory that involves finding something in a source domain to correspond to something in the target domain can be construed as performing a weak type of reverse influence. The influence is one of applying a selection process to the source domain.

However, the work above does not amount to a systematic investigation of reverse influence. Our goals in the article as regards such influence are to examine the phenomenon more systematically than in the past and to show that it is of more general and fundamental importance than has been recognized to date. We will argue that, even though the main influence in metaphor understanding is from source to target (see also Grady, Oakley & Coulson, 1999), there can be subsidiary, short-term influences from target to source that facilitate or enrich the forward influences and therefore help in the understanding of the target-domain scenario. The brunt of the remainder of this article is to show that all the main types of inter-domain influence discussed above (proposition transfer, query transfer, focusing/highlighting and certainty adjustment) can usefully go in the reverse direction as well as forwards.

First, a further word about blending theory. Our own approach to metaphor rests on a special computational environment we call the “pretence cocoon” or “pretence context” (Barnden & Lee, 1999; Barnden, 2001a; Lee & Barnden, 2001a). Pretence cocoons have much in common with the blend spaces proposed by blending theory. Therefore, we regard blending theory as supportive of the considerations in the present article. However, blending theory has not focused on query transfer or certainty adjustment (though these

concepts are compatible with the theory). More importantly, the phenomena that we describe in this article do not rely on any significant amount of blending as such, and therefore are matters to be treated potentially by all metaphor theorists, not just by blending theorists or ourselves. In addition, because we have implemented our own approach in a computer program, ATT-Meta, we have been obliged to make our approach much more specific and detailed than blending theory. We incorporate specific solutions to important problems that are at best handled sketchily in writings on blending theory. One such issue is the problem of resolving conflicts between different lines of reasoning, notably in the pretence context / blend space (Barnden, 2001a).

#### **4 Reverse Transfer of Queries, Focus and Expectation**

This section concerns the issue of transferring queries from target to source. We will concentrate here not on queries arising from natural language questions, but rather on queries arguably generated in the mind of the understander during the understanding of non-question utterances. However, the considerations are extensible to natural language questions.

Reverse transfer of queries is helpful because it is one way of exploiting context to guide metaphorical processing fruitfully. This is especially important given the well-known indeterminacy of the content of metaphorical utterances (see, e.g, Stern, 2000). Suppose discourse contains the sentence

(1) “John is a tank”

and the understander does not yet know any metaphorical sense of the word “tank” that could apply to people, and therefore has to consider another sense of the word to guide the process of metaphorical understanding. For brevity, let us confine our attention to the military-tank sense (as opposed to, say, the literal water-tank sense), and accordingly take the source domain to be, say, that of military combat. What is the understander to take (1) to be claiming about John?

One approach to understanding (1) would be blindly to take qualities of military tanks, such as size, heaviness, inexorableness, ability to withstand attack, and powerfulness, and transfer them in some form to apply potentially to John. The hope would be to find that one or more of these transferred qualities

could plausibly apply to him, or to find that they help explain why the sentence was uttered in the particular context at hand. This approach is assumed at least tacitly in much writing on metaphor. But the greater the number of qualities that could potentially be transferred the more wasteful the approach is, because it seeks to transfer qualities without having a handle in advance on their possible relevance to the discourse.

The converse approach is to examine the context surrounding the sentence, together with any existing knowledge about the situation being described, for issues that are raised there about John. After all, it is hardly likely that, in everyday discourse, (1) would be uttered in a context that gave no clue as to whether it was physical size, emotional inexorableness or whatever that was relevant. Suppose therefore that (1) were to appear in context as follows:

(1') “Most of my colleagues get dispirited when they’re criticized, but John’s a tank.”

The first clause here raises the issue of the ability to tolerate criticism. The word “but” suggests a connection of contrast between the propositions stated by the two clauses. The understander can therefore, on encountering (1'), internally pose a query such as:

(2a) **Is John able to tolerate criticism well?**

Let us assume for the sake of example that the understander, on noticing that a tank is a military object, and deploying prior knowledge of the “ARGUMENT AS WAR” conceptual metaphor (Lakoff & Johnson, 1980), has ready access to a mapping link between military attack-withstanding and criticism-tolerating. Then, on the basis of a target-domain query such as in (2a), the understander can internally pose a corresponding source-domain query such as:

(2b) **Is John able to withstand military attack well?**

Query (2b) is derived from (2a) by replacing criticism-tolerating by attack-withstanding, using the mapping link between these two notions in the reverse (i.e. target to source) direction. We therefore have a case of reverse query transfer. The source-domain query (2b) can then be answered within the source domain using the datum that John is a tank.

For our argument to carry through, it is not necessary for the context to raise the issue of toleration of criticism in quite such an explicit or precise fashion as the first clause of (1') does. Rather, we make the

general assumption that context provides relatively determinate information about what issue the utterer is addressing, at least in those cases where the metaphorical utterance itself is indeterminate about that. But in very difficult cases for the understander, context might (a) not raise the issue at all, or (b) only very implicitly raise it, or (c) raise many issues, so that it was not clear which one(s) the understander should address. However, the situation even in these cases is no worse for our account here than it is for metaphor theories which do not have any account at all of how context could help with metaphor understanding. Furthermore, under conditions such as (a–c), a human understander would presumably be unsure about what the metaphorical utterance was conveying. A further observation is that we do not need to assume that the issue-raising context arises before (1). It could occur afterwards, for instance if someone were to say “John is a tank. But most of my colleagues get dispirited when they’re verbally criticized.” A reasonable strategy for an understander, encountering a sentence whose meaning is not readily apparent, is to suspend judgement until succeeding context has been examined to some extent.

In referring to “query transfer” we are extending the traditional notion of transfer in analogy or metaphor in a natural way. In a traditional account, if on the source domain side there were a proposition about something tolerating military attack well, and on the basis of this a proposition about that thing (or a corresponding) thing tolerating criticism well were constructed, then we would have a case of proposition transfer. What has happened is that a proposition in the terms of one domain has been translated into a proposition terms of the other. It is in the “forwards” direction because the translation is from an item stated in source domain terms to one stated in target-domain terms. Equally, the move from (2a) to (2b) is a translation of a query (which is of course just an interrogative version of a proposition) that is in the terms of one domain into a query in the terms of another, and is thus a transfer. It is in the “reverse” direction because it involves a translation from target-domain terms to source-domain terms.

We have used invented tank examples in order to isolate the issues of interest, but similar examples can readily be found in real discourse. Consider the following one, casting someone metaphorically as a rock:

- (3) Okay. My husband has always been very involved with the children, although he works a lot of hours. He spent more time than he usually does with them. Obviously, I wasn’t around, or I was sick, but he was a rock. [Found at: <http://www.acscsn.org/global/pdfs/151.pdf>, accessed 19 June 2003. In this and some following examples italics (underlining in MS) indicate metaphorical

subsegments.]

In (3), it is reasonable to take the phrase “I wasn’t around” to mean “I was away somewhere” (e.g. at the hospital), and therefore to imply that the wife was not consistently with the children, and “I was sick” to imply the same thing more indirectly. This implication, together with the “but” could raise a target-domain query **Was the husband consistently present with the children?** Assuming that the understander subscribes to some conceptual metaphor of PERSON AS ROCK, the query **Was the husband [now viewed as a rock] consistently present with the children?** could arise in the source domain. We assume here that conceptual metaphors map over temporal qualities such as that denoted by the word “consistently” and matters such as presence. General knowledge about rocks, in this case that rocks consistently maintain their position, would then give a positive source-domain answer to the query **Was the husband [–as–rock] consistently present with the children?** This answer would then carry over as a positive answer to the target-domain query **Was the husband consistently present with the children?**

There are several further things to say about (3)—which is actually a very complex example. The part of (3) before the word “Obviously” strongly implies that the husband spent a lot of time with the children. Thus, the positive answer to the target-domain query just discussed could serve to raise the certainty of the proposition that he did spend a lot of time with the children, rather than to create that proposition. If so, we also have an example of forward certainty adjustment.

Secondly, the context also points out that the wife could at times be sick: it contains the sentence “Obviously I wasn’t around, or I was sick, but he was a rock.” Just as the “I wasn’t around” and the “but” could reasonably lead the understander to pose the query about the husband being present, the “I was sick” and the “but” could reasonably lead the understander to pose the target-domain query **Was the husband not sick?** It is more difficult in this case to see a reverse transfer of the query. But that does not harm our general argument – we do not claim that all queries that arise in metaphorical-discourse understanding can be answered by metaphorical processing involving inter-domain transfer. We claim only that there is an opportunistic process whereby target-domain queries that arise in discourse processing and that happen to be susceptible to inter-domain transfer lead to reverse-transfer actions.

There is another complication in this example. After segment (3) the passage goes on to talk about the husband providing solace to the woman. This is another way in which the husband could be perceived

as a rock (assuming a suitable metaphorical mapping). The above account is only about one plausible metaphorical contribution of the word “rock.”

Consider now the following example, which is part of the description of a film:

- (4) But when his son dies in an accident on one of those very Sundays when he is tending to a patient, the good doctor’s life slowly begins to unravel. His wife and daughter are inconsolable but he is a rock – at least on the surface. They weep into their pillows and each other’s arms but he must be alone. [Found at: [http://www.philly.com/mld/philly/entertainment/movies/video\\_dvd/4263526.htm](http://www.philly.com/mld/philly/entertainment/movies/video_dvd/4263526.htm), accessed 19 June 2003.]

Here, the context surrounding the segment “he is a rock” could give rise to the implication that **the wife and daughter expressed much emotion** and thence to the target-domain query **did the husband not express much emotion?** because of the word “but” after “inconsolable.” Assume in this case that the understander’s knowledge of “PERSON AS ROCK” includes a mapping link between physical immobility of rocks and lack of emotional expression by people. The understander could then, by reverse transfer, create a source-domain query such as **was the husband [-as-rock] physically immobile?** This would be answered affirmatively in the source domain, so that the target-domain query (**did the husband not express much emotion?**) would also be answered affirmatively.

The desirability of reverse query transfer also arises in some examples we have encountered that do not involve metaphor in copular form (A is B). Consider the following passage from a magazine article (Gross, 1994):

- (5) In the far reaches of her mind, Anne knew Kyle was having an affair, but ‘to acknowledge the betrayal would mean I’d have to take a stand. I’d never be able to go back to what I was familiar with,’ she says. Not until eight months had passed and she finally checked the phone bill did Anne confront the reality of her husband’s deception.

In our view this discourse chunk involves the conceptual metaphors of “MIND AS PHYSICAL SPACE” and of “IDEAS AS PHYSICAL OBJECTS.” On this basis Barnden and Lee (2001) discuss the understanding of the segment “In the far reaches of her mind, Anne knew Kyle was having an affair[.]” They state that

the meaning of this is that Anne only had a very low degree of conscious awareness of the idea that Kyle was having an affair. They argue that the segment “to acknowledge the betrayal” that follows the segment, together with the “but,” can readily give rise to a target-domain query such as **To what degree was Anne consciously aware of her husband’s betrayal?** We paraphrase this as

**(6a) To what degree was Anne able to operate in a conscious mental way on the idea of Kyle having an affair?**

Let us assume that “IDEAS AS PHYSICAL OBJECTS” maps physical operation on ideas, by the agent’s conscious self, to conscious mental operation on them by the agent. On this basis, (6a) can be reverse-transferred to create the query

**(6b) To what degree was Anne’s conscious self able to operate physically on the idea of Kyle having an affair?**

This query then guides the understanding, within the source domain, of the significance of the qualifier

(6c) “In the far reaches of her mind”

in (5). This qualifier indicates indirectly a very low level of ability by Anne’s conscious self to operate physically on the idea. This answer to (6b) is forward-transferred to the target domain to become the conclusion that Anne only had a very low degree of ability to operate in a conscious mental way on the idea. This conclusion is the answer to query (6a).

The reason the qualifier (6c) indicates a very low level of ability by Anne’s conscious self to operate physically on the idea is as follows. In applications of “MIND AS PHYSICAL SPACE,” the conscious self of the person is implicitly viewed as being a person located in a main part of the physical space, presumably distant from “far reaches.” This distance in turn implies a very low degree of ability of the conscious self to physically interact with the idea. The process of reasoning here, which is fully implemented in the ATT-Meta system, is described in more detail in Barnden & Lee (2001).

Although we have analysed the examples in this section in terms of query transfer, at least some of them could also be analyzed in terms of reverse focusing transfer or reverse expectation transfer. Consider again

sentence (1)—“John is a tank”— in a discourse context where the issue being attended to is people’s ability to tolerate criticism. We could rename this issue as a current “focus” of the discussion, or by saying that the discourse sets up an “expectation” that this issue will continue to be addressed. Then, we can think in terms of reverse-transferring this focus or expectation to the source domain via the linking between withstanding physical attack and tolerating criticism, to become a focus on, or expectation about, withstanding physical attack in the source domain. This focus or expectation then leads the understander to use the information in the source domain that John is a tank and that tanks are good at withstanding physical attack.

## 5 Reverse Proposition Transfer and Metaphorization of the Literal

Our next type of reverse influence partly arises from a proposal about how to treat (discourse-)extended metaphor, in the sense of the continual use of a particular conceptual metaphor throughout some substantial, multi-sentence discourse segment. The proposal is that the combination of information from different parts of the discourse segment is, in many cases, best done in the source domain rather than the target domain. In essence, we claim that it is often profitable to convert non-metaphorical, information-providing sentences (or sub-sentential units such as clauses) of the discourse into metaphorical terms during understanding. This is “metaphorization,” and rests on reverse transfer of propositions. Under this proposal, metaphorical sentences (etc.) conspire with each other and with non-metaphorical sentences to create an overall source-domain scenario. Forward transfers can then operate on parts of this scenario, to create target-domain propositions.

Thus, we are questioning an assumption that the vast majority of the literature on metaphor makes, at least tacitly, namely that each individual metaphorical sentence (etc.) needs separately to be understood in target domain terms. This assumption implies that integration of information all happens in the target domain, as shown in Figure 1. In this figure and our discussion as a whole we concentrate on metaphorical sentences that are not “sidelined.” We say that a metaphorical expression (or, more precisely, its metaphoricity) is sidelined if the understander’s lexical entries for the words or phrases involved allows the target-domain meaning to be worked out without going via the source domain. Thus, the sentence “McEnroe killed Connors” would be sidelined if there is a lexical entry for the word “kill” that directly provides a sports-defeat meaning.<sup>1</sup> Thus, we are only attending to metaphorical expressions whose understanding

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<sup>1</sup>Some authors may be tempted to talk in terms of “dead” metaphor here, but this would be tendentious as there is nothing to prevent a route to the sports-defeat meaning also being available via the biological sense of killing.



**(NON-SIDELINED)  
METAPHORICAL SENTENCES etc.**

**LITERAL SENTENCES etc.**

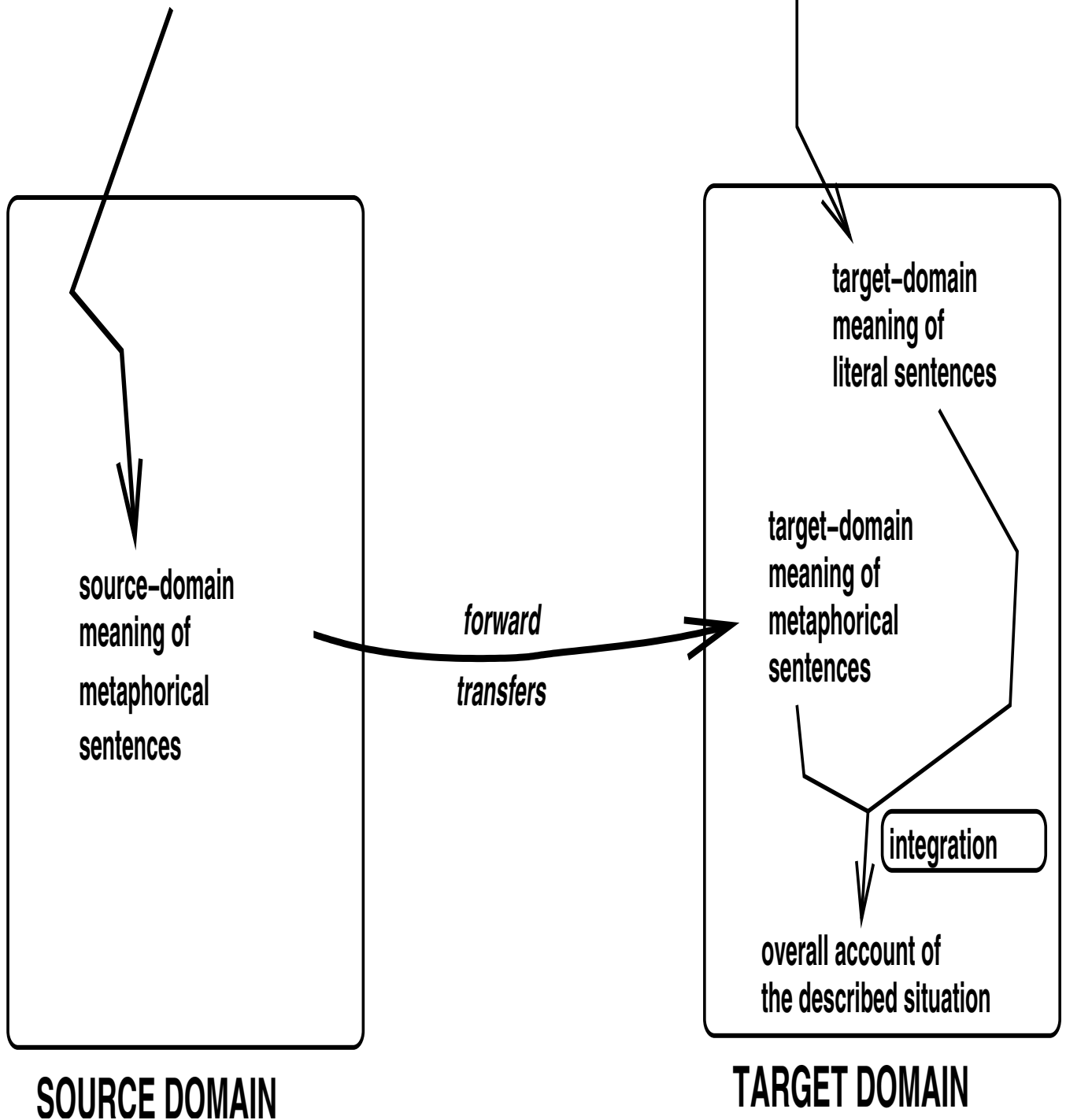


Figure 1: Traditional approach to coherence, not using metaphORIZATION. See text for the meaning of “sidelined.” Sidelined metaphorical expressions are not shown but would be included in the figure along with the literal sentences.

does require use of the source domain.

We argue that, in contrast to the integration method of Figure 1 that is traditionally assumed, with integrations happening in the target domain, the metaphORIZATION-based method suggested in Figure 2, where integration happens in the source domain, is more beneficial under some conditions. (We continue with the simplification of talking only in terms of sentences rather than also including sub-sentential units.)

An example that shows the benefits of metaphORIZATION is the following:

(7) I tried not to run down Phil too much - I felt bad enough as it was, what with screwing his girlfriend and all. But it became unavoidable, because when Jackie expressed doubts about him, I had to nurture those doubts as if they were tiny, sickly kittens, until eventually they became sturdy, healthy grievances, with their own cat-flaps which allowed them to wander in and out of our conversation at will. (Hornby, 1995: p.12.)

This uses the conceptual metaphor of “IDEAS AS LIVING BEINGS.” This is common in mundane discourse about mental states (see for instance the examples in our metaphor databank: Barnden, n.d.), but here the metaphor is elaborated for comic and/or ironic effect. It is intuitively natural, in reading the passage, to build in one’s mind a scenario of the sickly kittens becoming healthy animals (kittens or adult cats), which are metaphorically identified with the grievances. Now, it is of course natural in the domain of cats to think of kittens growing and to consider cases where a sickly kitten gets better. However, nothing in the source domain parts of (7) (the italicized parts) says that the particular sickly kittens do in fact get better or do continue to grow rather than die. The fact that the source-domain kittens in our example do get better comes from the target domain proposition that the doubts do develop (into the grievances—see the segment “until eventually they became ... grievances”), combined with the source-domain information that the grievances-as-cats are sturdy and healthy. Thus, the target-domain proposition that the doubts become grievances is reverse-transferred to become the source-domain proposition that the sickly kittens develop into something else. What this something else is—sturdy, healthy cats—is of course given by the source domain.

The impetus for us to analyze the example in terms of reverse influence, rather than to seek to rely exclusively on forward influence, is strengthened by the mention of the cat flaps. Our view (further discussed in Barnden et al., 1996; Barnden, 1998; Barnden & Lee, 2001) is that to understand the passage there is no

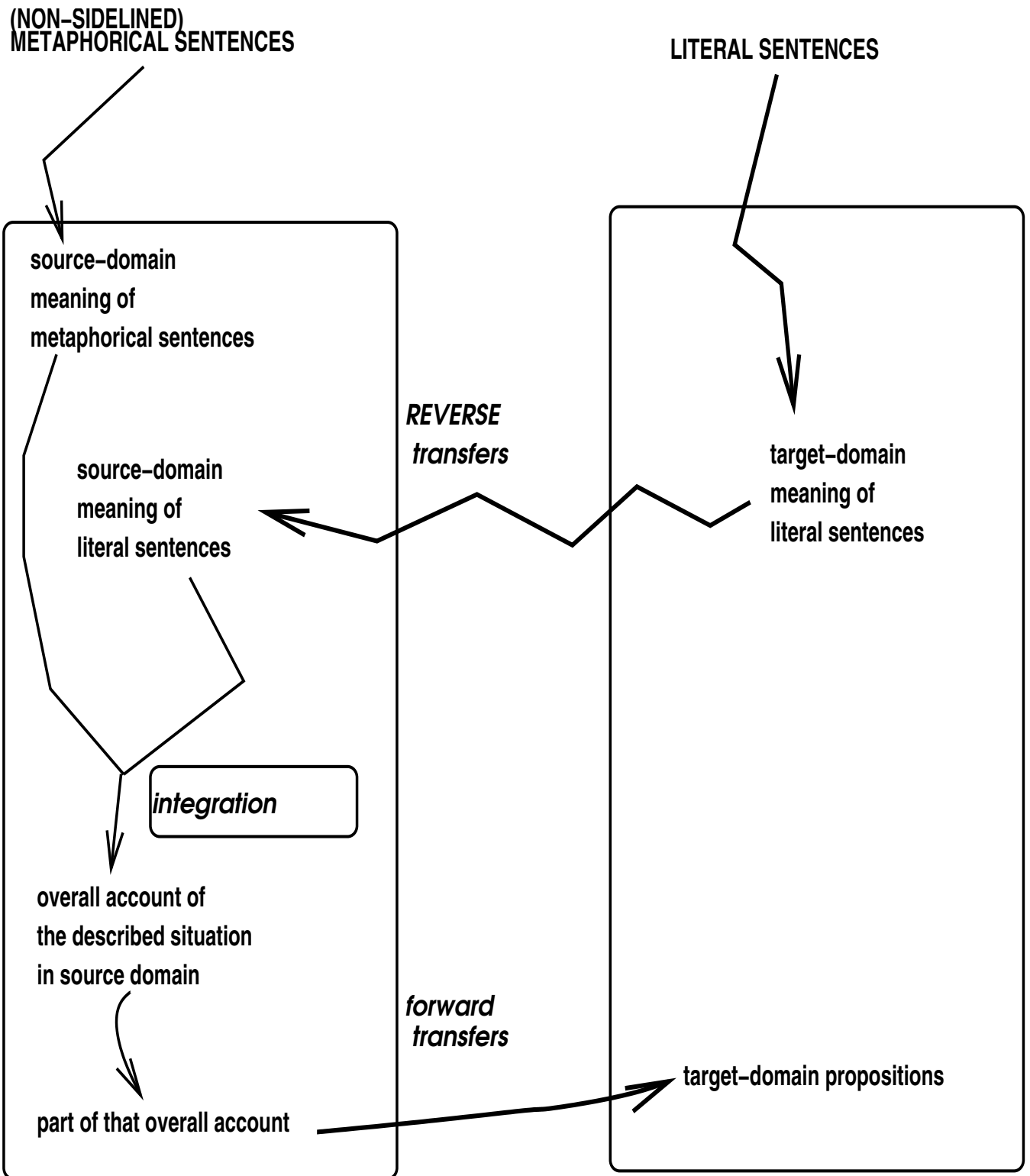


Figure 2: Metaphorization-based approach to coherence.

need to worry about what it is in conversation that can be likened to cat flaps. Likewise, there is no need to consider what it is about real grievances that could correspond to cats doing anything “at will,” given that grievances in reality have no will. Rather, the cat flaps and the at-will merely serve to suggest the source-domain inference that the cats go in and out of the house without further deliberate action by the owners. The conversation is implicitly identified with the house, with the house-owners being the conversants. Assuming that the lack of deliberate action can be transferred to the target domain, the message in that domain is that the conversation switches between back and forth between involving and not involving grievances, with these switches happening without deliberate actions by the conversants. At no stage do the cat-flaps or the at-will-ness of the cats’ movements need to be mapped.

Our analysis of the passage suggests that it is a mistake to think that, if there is an extended use of a metaphor across a stretch of discourse, then target-domain information has to be derived from each metaphorical patch in the stretch. Generally, only limited information needs to be transferred from source to target. Therefore it is not only fruitful, but also more economical, to metaphorsize intervening literal segments (in the present example, the interrupted segment “until eventually they became [...] grievances”) than to literalize the metaphorical ones (such as the mention of cat flaps). The extent to which this is true will depend partly on the relative numbers of literal and metaphorical segments and on the difficulty of finding target-domain interpretations for the metaphorical ones.

Indeed, quite apart from the question of whether it would or would not be useful to find target-domain correspondents for the cat-flaps and the at-will-ness, it would be quite difficult to do so. In Barnden et al. (1996), Barnden (1998, 2001b) and Barnden & Lee (2001) we give additional illustrations of such difficulty and of our strategy of avoiding the transference of everything into target-domain terms.

The following example, from Plato’s Theaetetus, shows that reverse proposition transfer can be useful for a somewhat different reason:

(8) And the greatest thing in my art is this: to be able to test, by every means, whether it’s an imitation and a falsehood that the young man’s intellect is giving birth to, or something genuine and true. Because I have, in common with midwives, the following characteristic: I’m unproductive of wisdom ... (Plato, 1973: segment 150c).

Here Socrates is speaking, and has been talking about himself being like a midwife (a metaphor that has been discussed in detail by Kittay, 1989, and Holyoak & Thagard, 1989). Our concern is with the sentence starting with “Because.” How is the understander to cope with this?

One possible interpretation is that Socrates is saying that both he and midwives are unproductive of wisdom. And, of course, one might claim that midwives are indeed generally unproductive of wisdom (of the intellectual, philosophical sort). However, this interpretation would not link well to the rest of Theaetetus, in which it is central that Socrates’ practice of helping his students produce ideas, rather than producing them himself, is metaphorically likened to a midwife helping other women produce babies, rather than producing them herself. Thus, the more appropriate interpretation is that Socrates is saying that he is unproductive of wisdom just as a midwife is unproductive of babies (or, more precisely, the role of Socrates is not to produce wisdom just as the role of midwives is not to produce babies).<sup>2</sup>

The key observation now is that, given that the conceptual metaphor of “TEACHERS AS MIDWIVES” is already in play in the discourse, the fact that ideas correspond to babies is thereby already in focus. Assuming the understander takes wisdom to be a body of ideas, the understander can reverse-transfer the proposition that Socrates is unproductive of wisdom to become the source-domain proposition that he is unproductive of babies. The understander can then take the actually-meant “common feature” to be baby-unproductiveness, in the terms of the source domain.

It is more difficult to see how to find a “common feature” using only forward proposition-transfers or other forward influences. How is the understander to know that the quality of midwives to pick on is their unproductiveness of babies? To be sure, the understander could be guided by the notion of unproductiveness, and thus search for ways in which midwives are unproductive. Note, however, that this is itself a matter of a reverse focusing influence starting from Socrates’ real-life unproductiveness (of wisdom). But, it is not enough for this influence to occur, even if midwives’ unproductiveness of babies is already salient in the understander’s mind. This is because, in the source domain, midwives are also unproductive of the the sort of abstruse philosophical wisdom that is important in Theaetetus. The understander is then faced between choosing between two forms of unproductiveness.

Another example that we have found to demonstrate the benefits of metaphorization is discourse segment

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<sup>2</sup>We might say that the phrase “common” in “common feature” is itself being used metaphorically.

(5) above about Kyle’s affair. We observed in section 4 that the metaphorical subsegment

(9a) “In the far reaches of her mind”

serves to imply that Anne had a very low degree of ability to operate in a conscious mental way on the idea of of Kyle’s having an affair. The crucial point, in the source-domain reasoning, was the large physical distance between the idea and Anne’s conscious self in the geography of her mind. Now, the subsegment

(9b) Not until eight months had passed and she finally checked the phone bill did Anne confront

is explicable on the basis that Kyle’s betrayal coming to her consciousness required considerable, deliberate mental effort on Anne’s part. Also, the use of the word “acknowledge” in the subsegment

(9c) to acknowledge the betrayal would mean

fits well with the notion that the coming to consciousness would require a deliberate act by Anne. How does the effort and deliberateness implied by (9b,c) link to (9a), if at all? The target-domain information from (9a) is that Anne has very low conscious awareness of Kyle’s affair. But just because somebody has very low conscious awareness of something X does not generally imply that its coming to consciousness is a deliberate, effortful act on the part of that person. After all, the consciousness of X could be weak merely because, for instance, the person happens to be momentarily distracted by something else, with no implication that switching attention back to X would need a deliberate, effortful act. So, if a coherent view of the discourse were sought within the target domain by the traditional method of Figure 1, there would be little support from (9a) for the deliberation and effort suggested by (9b,c).

In contrast, by seeking a coherent view of the discourse within the source domain by the metaphorization-based method of Figure 2, coherence is established more naturally and strongly. The confrontation and acknowledgment in (9b,c) can be metaphorized (reverse-transferred) to become an act by Anne’s conscious self of interacting with the affair idea.<sup>3</sup> Given the large physical distance of the idea from Anne’s conscious self, in the source-domain scenario, the conscious self must presumably travel to the far reaches of the mind-space to interact with the idea. This requires deliberate effort by Anne’s conscious self because of

<sup>3</sup>For simplicity we assume that the understander’s lexicon directly provides a target-domain sense for the word “confront,” even though one could argue that this word is being used metaphorically.

the physical distance between it and the affair idea. We therefore have a strong natural basis for coherence between (9a) on the one hand and (9b,c) on the other.

Most existing accounts of metaphor, in not properly dealing with the role of metaphorical utterances in extended discourse, leave one with the impression that the traditional method of Figure 1 would have to be used. But it is highly impoverished compared to the metaphORIZATION-based method of Figure 2, as it does not fully access the richness of the source-domain scenario. This lack of access is important when the source domain scenario does not have a complete, equally rich and extensive parallel in the target domain. For instance, in the Anne/Kyle example our knowledge about physical objects and space is richer and more definite than our non-metaphor-based knowledge of how the mind works. That this lack of parallelism is common in metaphor is argued further in (Barnden *et al.*, 1996; Barnden & Lee, 2001), but is also linked to common themes in metaphor research such as the relative unparaphrasability of many metaphorical utterances (see, e.g., Goodman, 1979; Katz, 1996; Stern, 2000; Waggoner, 1990) and the relative familiarity, richness and accessibility of source domains as opposed to target domains (see, e.g., Lakoff, 1993).

Even if the metaphorical mapping did capture all the richness of facts in the source domain, that might still not be enough for a non-metaphORIZATION approach to match a metaphORIZATION one. This is because of the need that often arises for reasoning within the terms of the source domain (Barnden *et al.*, 1996; Barnden, 2001a,b; Lee & Barnden, 2001a). We have seen some such reasoning in the Anne/Kyle example. MetaphORIZATION can exploit methods of reasoning peculiar to the source domain, given that, as Lakoff (1993) and others have pointed out, one benefit of metaphor is to allow the resources of the source domain to be brought to bear. For instance, spatial/diagrammatic reasoning (see, e.g., Johnson-Laird, 1983) might be used to good effect in a source domain that prominently featured physical space and objects. MetaphORIZATION allows such a reasoning method to be used indirectly to illuminate the target domain without needing to have an analog of the method couched directly in target-domain terms.

Also, it has been shown (see, e.g., Johnson-Laird, 1983:pp.29–34) that the familiarity of subject matter can affect the facility of people's reasoning even if the pattern of reasoning is kept constant. This gives source-domain reasoning a further advantage, to the extent that the understander is more familiar with the source domain than with the target domain.

In summary, we have shown that for the purposes of establishing coherence between subsegments of a

discourse that uses a conceptual metaphor *M* intermittently, it can be useful to seek coherence within the source domain of *M*, and for this purpose the metaphorization of subsegments that do not use *M* can be useful. This is in opposition to the method that is normally if tacitly assumed, of converting metaphorical subsegments into terms of the target domain and seeking an overall, coherent scenario there. Finally, although this section has concentrated on metaphorization of declarative discourse segments, there is no reason to exclude metaphorization of other types of segments, notably interrogative ones.

However, it is beyond the scope of this article to explain how an understander is to know when and when not try metaphorization. One complication is that that a body of discourse may use several different metaphors in close proximity, a matter of interest to the authors because of Lee and Barnden's (2001a) work on mixed metaphor. Our purpose here is merely to show its potential usefulness and, below, to indicate that it can be computationally realized.

## **6 Reverse Transfer of (Un)certainty**

We will argue in this section that within-target effects on the certainty of a target-domain proposition that corresponds to a source-domain proposition should be transferred back to the source-domain proposition. This is so even when it was the target proposition that was created from the source one and not the other way round. Behind the discussion below there lies a guiding principle that levels of uncertainty of target-domain and source-domain propositions that correspond to each other should themselves be aligned as much as possible. However, we do not exclude the possibility that sufficiently strong influences within the two domains can force the certainty levels to be disparate.

Although we claim that that both increases and decreases of the certainty of a target proposition should be transferred back to a corresponding source source-domain proposition if there is one, we will concentrate on the case of increases, for the sake of brevity. However, in Barnden *et al.* (2002a) we give an example of ATT-Meta working on the case of decreases.

Consider again (7). We now give an alternative analysis, recognizing that different understanders, or the same understander under different conditions, may treat a given example in different ways in detail, given that the type of processing we are discussing is complex. In section 5 we analyzed (7) as involving reverse



transfer of the proposition that the doubts developed into grievances, to get the source-domain proposition that the sick kittens developed into something else. This something else can be inferred to be healthy cats, according to source-domain information also provided by the discourse together with general knowledge about the source domain. So, altogether, we asserted that the target-domain proposition can be reverse transferred to help create the source-domain proposition that the sick kittens developed into healthy cats.

However, there is a variant of this analysis, as follows. See Figure 3. Purely from general knowledge about nurturing in the source domain, the understander could, with some substantial degree of uncertainty, infer that the sick kittens developed into healthy cats, since this is a plausible outcome of the nurturing under normal circumstances. The understander could do a forward transfer on this tentative proposition, getting an uncertain target-domain proposition that the doubts developed into something. However, the discourse states that the doubts did develop into something (the grievances). Therefore, the target-domain proposition now gets raised certainty (and the “something” is specified to be the grievances). This raise can then be reverse-transferred into the source domain, as shown in Figure 3. Overall, then, rather than the target-domain proposition that the doubts developed into grievances helping to lead to the creation of the proposition that the sick kittens developed into healthy cats, we could suggest that the target-domain proposition merely raises the degree of certainty of that source-domain proposition.

This source-domain proposition (that the kittens developed into healthy cats) is important for supporting the remainder of the source-domain scenario put forward by the passage. The higher the certainty that the kittens developed into healthy cats, the higher the certainty that the eventual healthy cats actually used cat-flaps at will to get into and out of the implied house. Then, with this cat-flap-usage aspect of the scenario firmly supported, the way is clear for doing a forward transfer to get the target-domain conclusion that grievances continually arose in the conversation without deliberate action by the conversants. If the passage had merely said “I had to nurture those doubts as if they were tiny, sickly kittens, until eventually they were able to use their own cat-flaps to wander at will ...” there would have been more doubt about the degree of use of the cat-flaps because there would have been more doubt as to whether the kittens or older cats were still sick or not.

To abstract from the particular example, the central point is that adjustments to the certainty of target-domain propositions can lead to adjustments in the certainty of corresponding source-domain propositions.

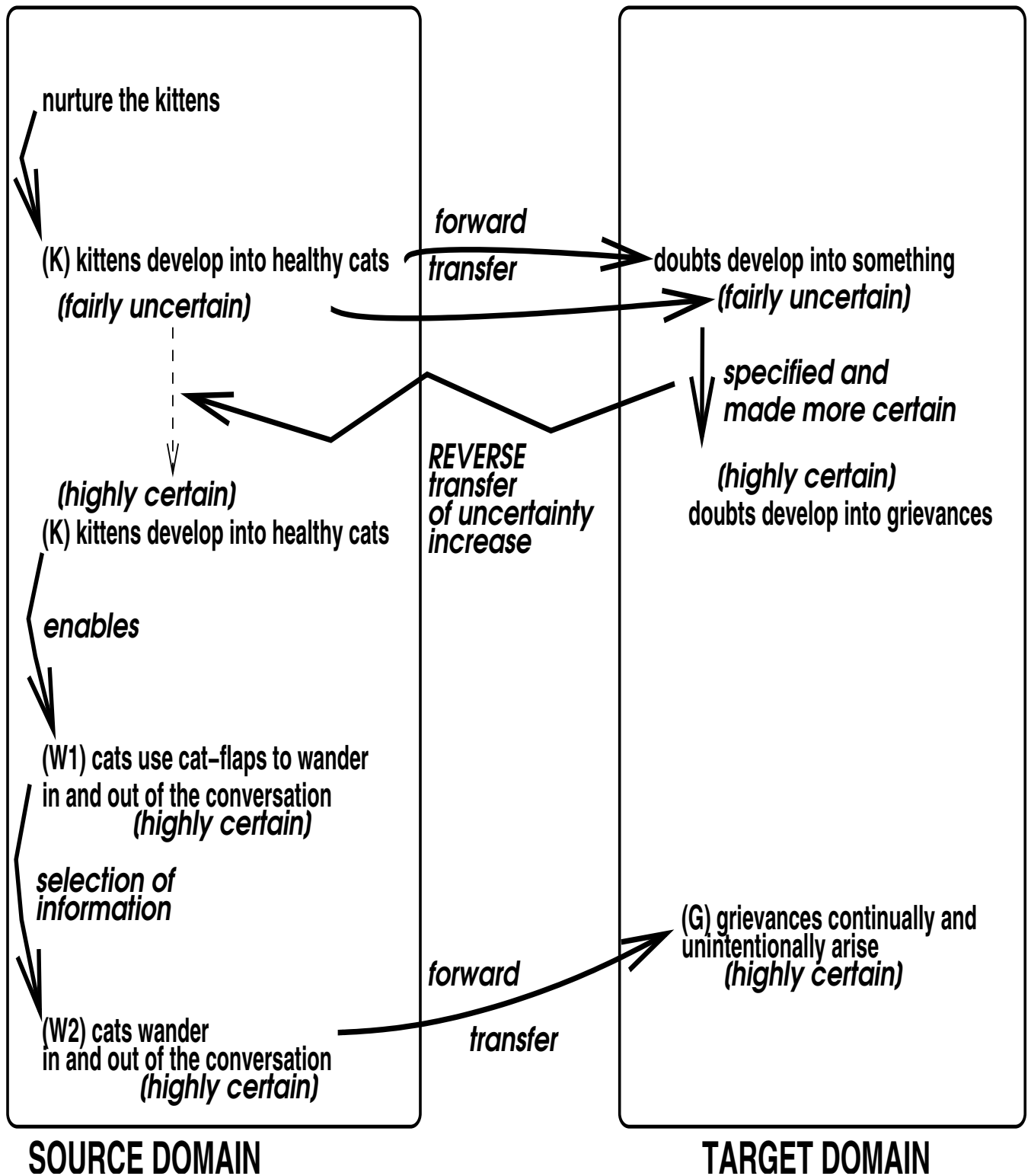


Figure 3: Showing forward and reverse transfer of certainty information. The enhanced certainty on the source domain side allows high certainty to propositions W1 and W2, and therefore, by forward transfer, to proposition G.

The adjustments to the latter propositions can feed through to provide certainty adjustments to further source-domain propositions supported by them. These adjustments can then feed through by forward transfer to affect corresponding target-domain propositions.

Not all cases of reverse proposition transfer can be re-analyzed in terms of reverse certainty adjustment. Whether they can be depends on the extent to which the source-domain propositions that could be created by reverse transfer could also arise independently by reasoning within the source domain, and also on the order with which different parts of the discourse are processed.

## 7 The ATT-Meta System

The theoretical considerations of this paper arose naturally out of our development of the ATT-Meta system (Barnden, 1998, 2001a; Barnden & Lee, 1999, 2001; Lee & Barnden, 2001a,b), which performs reasoning in aid of metaphor understanding. ATT-Meta can effect all the types of forward and reverse influence that this article describes, though it is naturally constrained in its details by the limitations of the representational and reasoning devices that AI is currently able to supply. Barnden *et al.* (2002a) provide a detailed account of runs of ATT-Meta that perform reasoning needed in specific metaphor examples that involve the varieties of reverse influence discussed here. In addition, reverse query transfer is important in all our other simulations, and reverse proposition transfer and reverse certainty influences are important in some. The present section briefly sketches the nature of the system and summarizes how it achieves the types of reverse influence discussed in previous sections.

ATT-Meta's reasoning is entirely query-directed. Query-directed reasoning, also called goal-directed reasoning, is a powerful technique, much used in AI (see, e.g., Russell & Norvig, 2002). In this form of reasoning, the process of reasoning starts with a query—an internally or externally presented question as to whether something holds. Queries are compared to known propositions and/or used to generate further queries by some means. In a rule-based system, queries are compared to the result parts of rules, and then new queries arise from the condition parts. For example, in the case of a rule that says if someone is a student then he or she is presumably poor, a query as to whether John is poor would give rise to a subquery as to whether John is a student.

Reverse query transfer in ATT-Meta is merely an application to metaphor understanding of the general technique of query-directed reasoning. By way of illustration, we look now at how ATT-Meta handles the sentence

“In the far reaches of her mind, Anne knew Kyle was having an affair.”

This is slightly adapted from (5). We assume ATT-Meta is given knowledge of conceptual metaphors “MIND AS PHYSICAL SPACE” and “IDEAS AS PHYSICAL OBJECTS.” We also assume that “far reaches” only has a spatial sense for the system and that the notion is not mapped to the mental domain by any conceptual metaphor known to the system. The most important mapping link is the following, and is part of ATT-Meta’s knowledge of “IDEAS AS PHYSICAL OBJECTS”:

(10) degree of (in)ability to operate physically on an idea, in the source domain (physical objects), maps to degree of (in)ability to operate in a conscious mental way on the idea, in the target domain (someone’s mind).

In the example as we run it using the program, the program is given an initial target-domain query (IQ) that is, roughly speaking, of the form **To what exact degree is Anne able to consciously operate mentally on the idea that Kyle had an affair?** This query is reverse-transferred via (10) to become a query of form **To what degree is Anne’s conscious self able to operate physically on the idea?** ATT-Meta can reason, using the source-domain information gleaned from the mention of “far reaches” in the utterance and from common-sense knowledge about physical spaces and objects, that this degree of physical operability is very low. This is because the far reaches of a physical region are very distant from the main part of the region, and Anne’s conscious self is taken in ATT-Meta’s conceptual metaphor “MIND AS PHYSICAL SPACE” to be in that main part. Once this very low degree is established in the source domain, it is forward-transferred via (10) to give a very low degree as the answer to the initial query (IQ). The program’s reasoning for this example is treated in much more detail in Barnden & Lee (2001). A variety of other examples are also computationally treated in that report and in other reports cited in it.

Both ATT-Meta’s long-term knowledge of individual domains and its knowledge of conceptual metaphors is couched in terms of IF-THEN rules. One crucial rule about the domain of physical objects and space can be glossed in English as follows:

**IF a physical object is not physically accessible to a person to some degree D**

**THEN presumably the person cannot physically operate on the object to degree D.**

The “presumably” annotation makes this rule a default rule: even if the rule’s condition is established with complete certainty, the system only presumes (i.e., takes as a default) the result side of the rule. The rule also illustrates that ATT-Meta can handle degrees to which states of affairs can hold. There is a small set of qualitative degrees going from “very low” up to “absolute.” Our observation from working on many examples of metaphor is that matters of degree are often important. A range of specific examples can be found in Barnden (2001b,c).

A given metaphorical mapping link such as (10) is implicit in a set of transfer rules<sup>4</sup> capturing the two different directions of transfer that the link could in principle support and also the two different polarities (ability versus inability in (10)). For instance, the above link is implicit in the following set of rules:

(11a)

**IF an idea is being viewed as a physical object**

**AND a person X’s conscious self is being viewed as being able to operate physically on the idea to at least degree D**

**THEN presumably in reality X can mentally operate consciously on the idea to degree at least D.**

(11b)

**IF and idea is being viewed as a physical object**

**AND in reality person X can mentally operate consciously on the idea to at least degree D**

**THEN presumably X’s conscious self is being viewed as being able to operate physically on the idea to degree at least D.**

(11c)

**IF an idea is being viewed as a physical object**

**AND a person X’s conscious self is being viewed as NOT being able to operate physically on the idea to degree D**

**THEN presumably in reality X canNOT mentally operate consciously on the idea to degree D.**

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<sup>4</sup>We have elsewhere called such rules conversion rules.

(11d)

**IF and idea is being viewed as a physical object**

**AND in reality person X canNOT mentally operate consciously on the idea to degree D**

**THEN presumably X's conscious self is being viewed as NOT being able to operate physically on the idea to degree D.**

Rules (11a,c) would be used for forward transfer of propositions about X's conscious self operating physically on ideas, whereas(11b,d) would be used for reverse transfer of propositions about X operating mentally on ideas.

In addition, and to make the above description of reasoning about Anne more precise, the query (IQ) in target-domain terms about the exact degree D of ability of Anne to mentally operate consciously on the Kyle-affair idea leads the system to query the value D such that (i) Anne has that ability to at least degree D and (ii) Anne does not have that ability to the next degree above D. These subqueries (i) and (ii) are reverse-transferred via (11a) and (11c) respectively to become subqueries in the source domain about Anne's ability to operate physically on the idea. Note carefully that such reverse query-transfer occurs by backchaining over forward transfer rules such as (11a,c).

The system can also perform forward transfer of source-domain sub-queries that arise in the course of reasoning within the source-domain, by backchaining over reverse transfer rules such as (11b,d). Such forward-transfer of source-domain queries could also easily be applied to handle metaphorical questions in discourse, although we have not yet implemented this in the program.

The system's metaphor-based reasoning is thoroughly integrated into a general-purpose framework for uncertain reasoning using qualitative uncertainty measures. ATT-Meta's reasoning in source-domain terms and in target-domain terms is generally uncertain. Rules and propositions are annotated with qualitative certainty levels (cf. the "presumably" qualifiers above). There is a heuristic conflict-resolution mechanism that attempts to adjudicate between conflicting arguments, by considering their relative specificity. As a result of conflict-resolution, the certainty of one or more propositions is downgraded. Reasoning leaves behind a record of dependency links between propositions, so certainty-up/downgrading of a proposition often leads to up/downgrading of propositions dependent on it.

This certainty adjustment applies not only to reasoning within domains but also to reasoning that crosses between domains (via transfer rules). Because mapping links are generally clothed in reverse-transfer rules such as (11b,d) as well as in forward-transfer rules such as (11a,c), ATT-Meta performs reverse transfer of certainty up/downgrades when reverse-transferable target-domain propositions are up/downgraded. Because of the extensive within-source reasoning that ATT-Meta often performs, up/downgrades within the source domain can lead to other up/downgrades in that domain, and hence to up/downgrades in the target domain by virtue of forward transfer via rules such as (11a,c). Thus, patterns of influence such as shown in Figure 3 are achievable, and are described in more detail in Barnden *et al.* (2002a).

## 8 Conclusions

Our main conclusions are that (a) inter-domain influences in metaphor can go in both directions, and the direction of influence is (largely) a separate matter from the type of influence; (b) reverse (i.e., target to source) influences of several distinctly different types are desirable in metaphorical discourse understanding; and (c) in particular, metaphORIZATION of literal utterances can be desirable. In sum, we seek to curb the natural tendency to think that because metaphor involves an overall move from source to target, therefore all inter-domain influences in the course of understanding go in that direction.

These conclusions arise from our reasoning-based approach to metaphor understanding, which tries to make maximal use of available information and reasoning possibilities. Clues from the context and from the metaphorical utterance itself are combined with prior information the understander has about the source and target domains. Generally, some reasoning is carried out in the source domain and some in the target, while some is a matter of using metaphorical mapping links to perform forward or reverse acts of inter-domain influence.

Reverse influences involving propositions, queries and certainty adjustments are supported in a routine way by the ATT-Meta system, as we have shown in our reports of computer runs elsewhere (e.g. Barnden *et al.*, 2002a). We would also claim that the way the theoretical considerations of this article have flowed from the task of constructing a computer program for metaphorical reasoning is a good example of how computational modelling can lead to broader insights.

Although we have, for definiteness, couched our considerations in terms of mappings, the crucial considerations carry over to other accounts that do not focus on mappings. All accounts of how to treat (non-sidelined) metaphoricity must ultimately involve some notion of flow of information, emphasis, etc. from one domain to another, irrespective of whether the flow is explicitly cast as travelling along links.

It is worth observing that, although our concern in this article is with reverse influences for the purpose of understanding, it is clear that a mechanism for generating metaphorical language would rely centrally on reverse influences. It would often need to take information expressed internally in target-domain terms and translate it into source-domain terms for the purposes of the generated utterances. Thus, although we may appear to be adding a new type of processing, it is a type that would be needed by a language-using agent for other purposes anyway.

Apart from our own ATT-Meta approach, the approach that comes closest to dealing with our considerations on reverse influence is the application to metaphor of “blending” theory (Fauconnier & Turner, 1998; Coulson & Matlock, 2001). A central point of blending theory, as applied to metaphor (Grady *et al.*, 1999), is that the blend space mixes together information, reasoning patterns, etc. drawn from the target domain with information, reasoning patterns, etc. from the source domain. In particular, such matters as the reverse transfer of target-domain propositions should fit in with blending theory, even though transfers do not happen directly between the target and source domains—rather, what we are calling reverse transfer would become a matter of introducing into the blend space some information that is couched in terms of concepts from the source domain but is created from a proposition in the target domain. However, the phenomena we have talked about in this paper do not actually rely on any significant blending for their handling: they rely entirely either on reasoning that is performed within the terms of the source domain or on reasoning performed within the terms of the target domain. If these examples were treated by blending theory, the blend space would be an uninteresting one in not containing reasoning that treated the various entities as having some mix of target-domain qualities and source-domain qualities. For instance, in the cat-flap example (7) some entities in the blend space would be both grievances and cats—and yet the required effects would be obtained by reasoning about them purely as cats. The point of reverse-transferring the proposition that the doubts developed into something is precisely so that they can be treated as cats, not at all as doubts. In addition, blending theory has no implementation on the scale of ATT-Meta, and we are unaware of blending theory placing emphasis on query transfer or having a treatment of inter-domain certainty influences.



In sum, a small number of detailed approaches, listed in the Introduction, are beginning to allow reverse influences such as those discussed in this article. However, the topic has previously seen little detailed theoretical analysis or computational realization before our own studies, and little if any psychological experimentation. It is a fertile ground for future study.

We have some suggestions for further work on metaphor, arising partly out of this article. We suggest that future psychological and computer models of metaphor should pay more detailed attention to uncertainty, to what actually is contributed by metaphorical utterances to understanding of the encompassing discourse, to extended metaphorical discourse rather than single utterances, and to the details of reasoning needed in metaphor understanding. As regards psychological experimentation that might be done, we would point firstly to the need for more experiments that are aimed at teasing out exactly how the contextual guidance of metaphorical understanding works, rather than just the existence of such guidance. A second area for experimentation would be to test our metaphORIZATION conjecture (in section 5), perhaps by using the technique of determining the extent to which source-domain concepts versus target-domain concepts are accessed during the understanding of suitable passages.

A matter we have not had room to investigate in this article is the asymmetry of metaphor and how it is affected by the considerations here. We will address this elsewhere, but have made a start in Barnden (2001d).

## **Acknowledgments**

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## References

- Barnden, J.A. (1998). Combining uncertain belief reasoning and uncertain metaphor-based reasoning. In M.A Gernsbacher & S.J. Derry (Eds), Procs. Twentieth Annual Meeting of the Cognitive Science Society, pp.114–119. Mahwah, N.J.: Lawrence Erlbaum.
- Barnden, J.A. (2001a). Uncertainty and conflict handling in the ATT-Meta context-based system for metaphorical reasoning. In V. Akman, P. Bouquet, R. Thomason & R.A. Young (Eds), Procs. Third International Conference on Modeling and Using Context, pp.15–29. Lecture Notes in Artificial Intelligence, Vol. 2116. Berlin: Springer.
- Barnden, J.A. (2001b). Application of the ATT-Meta metaphor-understanding approach to selected examples from Goatly. Technical Report CSRP–01–01, School of Computer Science, The University of Birmingham, U.K.
- Barnden, J.A. (2001c). Application of the ATT-Meta metaphor-understanding approach to various examples in the ATT-Meta project databank. Technical Report CSRP–01–02, School of Computer Science, The University of Birmingham, U.K.
- Barnden, J.A. (2001d). The utility of reversed transfers in metaphor. In J.D. Moore & K. Stenning (Eds), Procs. Twenty-Third Annual Meeting of the Cognitive Science Society, pp.57–62. Mahwah, N.J.: Lawrence Erlbaum.
- Barnden, J.A. (n.d.). ATT-Meta Project Databank.  
<http://www.cs.bham.ac.uk/~jab/ATT-Meta/Databank>.
- Barnden, J.A., Glasbey, S.R., Lee, M.G. & Wallington, A.M. (2002a). Application of the ATT-Meta metaphor-understanding system to examples of the metaphorical view of TEACHERS AS MIDWIVES. Technical Report CSRP–02–10, School of Computer Science, The University of Birmingham, U.K.
- Barnden, J.A., Glasbey, S.R., Lee, M.G. & Wallington, A.M. (2002b). Reasoning in metaphor understanding: The ATT-Meta approach and system. In Shu-Chuan Tseng (Ed) Procs. 19th International Conference on Computational Linguistics, pp.1188–1193. San Francisco: Morgan Kaufman.

- Barnden, J.A., Helmreich, S., Iverson, E. & Stein, G.C. (1994). An integrated implementation of simulative, uncertain and metaphorical reasoning about mental states. In J. Doyle, E. Sandewall & P. Torasso (Eds), Principles of Knowledge Representation and Reasoning: Proceedings of the Fourth International Conference, pp.27–38. San Mateo, CA: Morgan Kaufmann.
- Barnden, J.A., Helmreich, S., Iverson, E., & Stein, G.C. (1996). Artificial intelligence and metaphors of mind: within-vehicle reasoning and its benefits. Metaphor and Symbolic Activity, 11(2), 101–123.
- Barnden, J.A., & Lee, M.G. (1999). An implemented context system that combines belief reasoning, metaphor-based reasoning and uncertainty handling. In P. Bouquet, P. Brezillon & L. Serafini (Eds), Second International and Interdisciplinary Conference on Modeling and Using Context, pp.28–41. Lecture Notes in Artificial Intelligence, Vol. 1688. Berlin: Springer.
- Barnden, J.A., & Lee, M.G. (2001). Understanding usages of conceptual metaphors: An approach and artificial intelligence system. Tech. Rep. CSRP-01-05, School of Computer Sci., University of Birmingham, UK.
- Black, M. (1979). More about metaphor. In A. Ortony (Ed.), Metaphor and Thought. Cambridge, UK: Cambridge University Press.
- Cameron, L. (1999). Operationalising ‘metaphor’ for applied linguistic research. In L. Cameron & G. Low (Eds), Researching and Applying Metaphor, pp.1–28. Cambridge, U.K.: Cambridge University Press.
- Coulson, S. (2001). Semantic leaps: the role of frame-shifting and conceptual blending in meaning construction. Cambridge, UK: Cambridge University Press.
- Coulson, S. (1996). Menedez Brothers Virus: Blended spaces and internet humor. In A.E. Goldberg (Ed.), Conceptual Structure, Discourse and Language, pp.67–81. Stanford, CA: CSLI Publications.
- Coulson, S. & Matlock, T. (2001). Metaphor and the space structuring model. Metaphor and Symbol, 16(3&4), 295–316.
- Falkenhainer, B., Forbus, K.D., & Gentner, D. (1989). The Structure-Mapping Engine: algorithm and examples. Artificial Intelligence, 41(1), 1–63.

- Fass, D. (1997). Processing metaphor and metonymy. Greenwich, Connecticut: Ablex.
- Fauconnier, G. & Turner, M. (1998). Conceptual integration networks. Cognitive Science, 22(2), 133–187.
- Gentner, D. (1983). Structure-mapping: a theoretical framework for analogy. Cognitive Science, 7(2), 95–119.
- Gentner, D., Falkenhainer, B., & Skorstad, J. (1988). Viewing metaphor as analogy. In D.H. Helman (Ed.), Analogical reasoning. Dordrecht: Kluwer.
- Giora, R. (1997). Understanding figurative and literal language: The graded salience hypothesis. Cognitive Linguistics, 8(3), 183–206.
- Glucksberg, S. (2001). Understanding figurative language. Oxford University Press.
- Glucksberg, S. & Keysar, B. (1990). Understanding metaphorical comparisons: beyond similarity. Psychological Review, 97(1), 3–18.
- Goodman, N. (1979). Afterthoughts on metaphor: Metaphor as moonlighting. In S. Sacks (Ed.), On Metaphor, pp.175–180. U. Chicago Press.
- Grady, J.E., Oakley, T & Coulson, S. (1999). Blending and metaphor. In R.W. Gibbs, Jr. & G.J. Steen (Eds), Metaphor in Cognitive Linguistics, pp.101–124. Amsterdam/Philadelphia: John Benjamins.
- Gross, L. (1994). Facing up to the dreadful dangers of denial. Cosmopolitan, 216(3), USA ed.
- Hinton, R. (2002). English 22E — English 10: Second Semester — a learning guide. Independent Study Program, School of Continuing Studies, Indiana University, Indiana, USA.  
([http://www.indiana.edu/~scs/hs/hs\\_pdf/eng22e.pdf](http://www.indiana.edu/~scs/hs/hs_pdf/eng22e.pdf) accessed on 19 June 2003.)
- Hobbs, J.R. (1990). Literature and cognition. CSLI Lecture Notes, No. 21, Stanford University.
- Holyoak, K.J., Novick, L.R. & Melz, E.R. (1994). Component processes in analogical transfer: mapping, pattern completion, and adaptation. In K.J. Holyoak & J.A. Barnden (Eds), Advances in Connectionist and Neural Computation Theory, Vol. 2. pp.113–180 Norwood, N.J.: Ablex Publishing Corp.

- Holyoak, K.J. & Thagard, P. (1989). Analogical mapping by constraint satisfaction. Cognitive Science, 13(3), 295–355.
- Hornby, N. (1995). High fidelity. Penguin Books.
- Hummel, J., & Holyoak, K. (1997). Distributed representation of structure: A theory of analogical access and mapping. Psychological Review, 104(3), 427–466.
- Johnson-Laird, P.N. (1983). Mental models: towards a cognitive science of language, inference and consciousness. Cambridge, MA: Harvard University Press.
- Katz, A.N. (1996). Experimental psycholinguistics and figurative language: Circa 1995. Metaphor and Symbolic Activity, 11(1), 17–37.
- Kittay, E.F. (1989). Metaphor: its cognitive force and linguistic structure. (Paperback ed.) Oxford, UK: Clarendon Press.
- Lakoff, G. (1993). The contemporary theory of metaphor. In A. Ortony (Ed.), Metaphor and Thought, 2nd ed. Cambridge, UK: Cambridge University Press.
- Lakoff, G. & Johnson, M. (1980). Metaphors we live by. Chicago: University of Chicago Press.
- Lee, M.G., & Barnden, J.A. (2001a). Reasoning about mixed metaphors with an implemented AI system. Metaphor and Symbol, 16(1&2), 29–42.
- Lee, M.G. & Barnden, J.A. (2001b). Mental metaphors from the Master Metaphor List: Empirical examples and the application of the ATT-Meta system. Technical Report CSRP-01-03, School of Computer Science, The University of Birmingham, UK.
- Leezenberg, M. (1995). Contexts of metaphor. ILLC Dissertation Series, 1995-17, Institute for Language, Logic and Computation, University of Amsterdam, The Netherlands.
- Markman, A.B. (1997). Constraints on analogical inference. Cognitive Science, 21(4), 373–418.
- Martin, J.H. (1990). A computational model of metaphor interpretation. San Diego, CA: Academic Press.

- Narayanan, S. (1997). KARMA: Knowledge-based action representations for metaphor and aspect. Ph.D. thesis, Computer Science Division, EECS Department, University of California, Berkeley, August 1997.
- Ortony, A., Schallert, D., Reynolds, R. & Antos, S. (1978). Interpreting metaphors and idioms: Some effects of context on comprehension. J. Verbal Learning and Verbal Behavior, 17, 465–477.
- Peleg, O, Giora, R. & Fein, O. (2001). Salience and context effects: Two are better than one. Metaphor and Symbol, 16(3&4), 173–192.
- Plato (1973). Theaetetus / translated (from the Greek) with notes by John McDowell. Oxford: Clarendon Press.
- Récanati, F. (1993). The alleged priority of literal interpretation. Cognitive Science, 19(2), 207–232.
- Russell, S. & Norvig, P. (2002). Artificial intelligence: A modern approach. Englewood Cliffs, N.J.: Prentice-Hall.
- Stern, J. (2000). Metaphor in context. Cambridge, MA and London, UK: Bradford Books, MIT Press.
- Veale, T. & O’Donoghue, D. (2000). Computation and blending. Cognitive Linguistics, 11(3–4), 253–281.
- Waggoner, J.E. (1990). Interaction theories of metaphor: psychological perspectives. Metaphor and Symbolic Activity, 5(2), 91–108.
- Waggoner, J.E., Palermo, D.S. & Kirsch, S.J. (1997). Bouncing bubbles can pop: Contextual sensitivity in children’s metaphor comprehension. Metaphor and Symbol, 12(4), 217–229.
- Way, E.C. (1991). Knowledge representation and metaphor. Dordrecht: Kluwer.