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Psychological Analysis of Subjective Motion: A Review

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Abstract

Over the last thirty years, much attention has been devoted to one specific issue – subjective motion. This article takes a retrospective look at the related studies on psychological analysis of subjective motion, which cover a wide variety of perspectives, including understanding tasks, drawing tasks, eye movement tasks, time and motion surveys, and neuroscience studies. These previous works can give important enlightenment to the field of motion studies.

Keywords

Subjective motion, psychological analysis.

1. Introduction

Dynamic predication of static spatial situations such as *The road zigzags into the forest* and *The mountain range goes from Canada to Mexico* have received great attention across diverse disciplines over the years, including theoretical and experimental works as well as comparative works. These sentences, which are called subjective motion sentences, do not involve any motion and change outside the representation; motion verbs in this type of sentences are used to express their antithesis – stasis.

Although subjective motion is mainly discussed within the field of linguistics, psychological works that have been undertaken to test the original theoretical observations and claims also advance our knowledge of subjective motion in recent years. As Gibbs (1996) proposes, doing experiments is one way to explore conceptual structure. Those linguistic observations and interpretations are informative and illuminating, yet conducting experiments can lead to deeper insights into language representation, comprehension and use. The present study provides an overview of psychological analysis on subjective motion.

It was not until the twenty-first century that behavior studies started testing claims that is associated with subjective motion, particularly whether they do involve a fleeting sense of motion. In recent years, more and more empirical studies are used to support the idea that mental simulation is involved in processing subjective motion. Methods used include narrative understanding tasks, drawing tasks, eye movement tasks, time and motion surveys, as well as neuroscience studies.

2. Narrative Comprehension Tasks

The constellation of work is started by Matlock – an important researcher who has devoted herself to the study of subjective motion (Matlock 2004a, 2004b, 2006, 2010). According to Matlock, "people mentally simulate all sorts of actions in everyday thought" (Matlock 2004a: 1389).

Matlock (ibid.) uses narrative comprehension tasks to test whether subjective motion interpretation includes any sort of implied motion. According to her, "if people mentally experience an implied sense of motion while processing [subjective] motion, then thinking about actual motion right beforehand should influence how that fleeting sense of motion

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unfolds in real time. Time to mentally process subjective motion sentences should vary if there are differences" (Matlock 2017: 481). Four reading experiments were conducted to investigate the process of subjective motion involves mentally simulated motion (ibid.). In the first two experiments, participants read stories about travel, focusing on the path along which the protagonist traveled (distance or speed), i.e., short versus long distance, and slow versus fast travel. The third experiment concentrates on the terrain through which the paths extend, i.e., easy versus difficult terrain. The results show that all the factors presented exert influence on the processing of subjective motion sentences such as *The highway runs through the valley*. In general, latencies would be shorter after participants had read about stories involving a path that conveys a short distance, fast movement, or an easy terrain. Subjective motion sentences in the three experiments are instances of what she terms as *Type 1 subjective motion*, in which the subject referent implies motion, say, is metonymically associated with motion. For example, in *This highway goes from Las Vegas to Los Angele*s, the noun *highway* is associated with driving, or in *The trail zigzags into the woods*, the noun *trail* is related with walking or hiking. However, in the last experiments, the subject referent in the subjective motion sentences is untraversable linear entity which has no association with motion, such as *fence*, as in *A fence follows from the property*, or *fault*, as in *The earthquake fault runs across the valley*. Results of the fourth experiment show that simulation is also included in this *Type 2 subjective motion*; people simulate not just movement but also *visual scanning* in comprehending subjective motion sentences (Matlock 2004b; see also Langacker 2001). Therefore, the four trails reveal consistent results for subjective motion: slower subjective motion decision times with long distance (versus short) and with cluttered terrains (versus uncluttered); these results suggest that comprehending subjective motion involves an implied sense of motion along path, i.e., people mentally re-enact movement they have read about while processing subjective motion.

3. Drawing Tasks

Similar results are obtained in experiments with drawings designed to get at people's conceptions of the static scenery (Matlock 2006). In other words, if mental simulation of movement or scanning is involved in the conceptual structure of subjective motion sentences, that information may be observable and reflected in the external representations of people's conceptions, in this case, spatial depictions or drawings. In a set of studies, participants read sentences about a spatial scene, and are asked to draw images to represent their comprehension of that sentence. In one experiment, participants draw pictures of comparable sentences such as *A birthmark runs between her ankle and knee* and *A birthmark is between her ankle and knee*, which have similar meanings and have figure that may or may not be long (e.g., pool, blackboard, tattoo, et cetera). The result shows a difference that the figure has a more elongated shape in the former case, which supports evidence for the view that people mentally simulate motion in comprehending subjective motion sentences. In the second experiment, participants are invited to draw pictures of similar pairs of sentences such as *The footpath goes along the creek* and *The footpath is next to the creek*, but this time, with inherently long figures, such as footpaths, roads, or sidewalks, et cetera. This study yields identical results. It is worth noting that Matlock (2017) further points out that the participants in the first experiment are asked to generate line drawings to represent their comprehension of *Type 2 subjective motion* sentences, since figures in this trail can be construed as short or long. For example, a tattoo can be a long entity, such as a sword or snake, or a short entity, such as a heart or an apple. On the other hand, the participants in the second experiment are asked to draw depictions of *Type 1 subjective motion* or comparable non-subjective sentences, in which the figures – traversable entities that associated with motion – are inherently long.

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Moreover, another experiment has participants draw arrows to represent their understanding of the traversable paths in subjective motion sentences that featured manner verbs with varying rates of speed – slow, fast or neutral (e.g., *creep*, *race*, *go*), for example, *The highway crawls through the grasslands* and *The highway races through the grasslands.* The result shows that for subjective motion sentences with fast motion verbs, the arrows in the drawings seem to be longer, thinner and less crooked.

4. Eye Movement Studies

The understanding of subjective motion has also been investigated in eye-tracking experiments. In a study by Matlock & Richardson (2004), participants view two-dimensional (vertical or horizontal) stationary depictions of spatial scenes while they hear either subjective motion sentences such as *The cord runs along the wall*, or non-subjective motion sentences, such as *The cord is on the wall.* The pictures of spatial scene are presented on a computer screen; while participants look at the pictures and listen to the sentences, their eye movements are recorded and measured. The data show that figurative language influences eye movements, in other words, participants spend more time inspecting figures with subjective motion sentences than without. Hence, longer gaze duration on regions suggests that subjective motion processing involves mentally simulated motion or scanning.

Later, in a follow-up study by Richardson & Matlock (2007), participants are first asked to listen to a terrain description (with vertical or horizontal path) referred to a region where movement would be conceptualized as easy or difficult. For instance, sentence *The valley was flat and smooth* is inferred as easy movement (with horizontal path), whereas *The valley was full of potholes* as difficult. Next, people hear a subjective motion sentence (e.g., *The road runs through the valley*) or a comparable non-subjective motion sentence (e.g., *The road is in the valley*). Afterwards, they view a static scene on the screen (e.g., *valley*) and eye movements are recorded. The major result is that with subjective motion sentence, participants spend more time inspecting path (e.g., *road*) and make more path scanning fixations when they have been primed with difficult terrain descriptions than with easy terrain descriptions; whereas there is no reliable difference for those non-subjective sentences. The result demonstrates that "[subjective] motion evokes a mental simulation of motion that is immediately integrated with visual processing, and hence figurative language can have a distinct effect on perception" (ibid: 129).

Taken together, these psychological works provide strong evidence to support the idea that mentally simulated motion is part of the conceptual structure of subjective motion sentences such as *The trail goes along the road*. Also, they serve as evidence that "language is structured the way it is because of the natural ability to simulate motion" (Matlock 2004a: 238).

5. Time and Motion Surveys

Other behavioral work has explored whether subjective motion is conceptualized like literal motion by looking at whether and how it would permit space-time construal. Over the years, many cognitive scientists have tested whether conceptions of time are influenced by conceptions of space. In one experiment by Boroditsky & Ramscar (2002), participants imagined themselves moving toward a physical object or a physical object moving toward them before answering this ambiguous question: *Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?* A Monday response to this query suggests "moving" the meeting two days further into the past (relative to Wednesday), and a Friday response suggests "moving" two days further into the future (relative to Wednesday). The results of the experiment indicated that the way participants conceptualized motion influenced how they reasoned about time. People were more likely to provide a Friday

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response after imagining themselves moving toward an object, but more likely to provide a Monday response after imagining the object moving toward them.

Following the study of Boroditsky & Ramscar (ibid.), Matlock, Ramscar & Boroditsky (2005) conduct a set of experiments, demonstrating that subjective motion also have an influence on the way people think or reason about time. In the first experiment, participants read a subjective motion sentence such as *The road runs along the coast*, or a comparable non-motion sentence such as *The road is next to the coast*, and then drew a picture to demonstrate their understanding of the sentence. Afterwards, they were required to answer the same ambiguous time question: *Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?* The result shows that thinking about subjective motion led to more Friday responses than Mondays, but thinking about non-subjective motion yielded equal likelihood of a Friday or Monday response.

The second experiment used the same procedure as the previous one, but varied only on the number of scan points along a path in subjective motion sentences (e.g., *Eight pine trees run along the edge of the driveway* versus *Eighty pine trees run along the edge of the driveway*). The result that larger number of scan points would lead to more Friday responses to the ambiguous question demonstrates magnitude effects for subjective motion.

Yet another experiment investigates whether subjective motion includes a crucial conceptual property of literal motion – direction. As well, the procedure was identical to the first experiment, but participants read either an ego-moving subjective motion sentence such as *The road goes all the way to New York*, or an object-moving subjective motion sentence *The road comes all the way from New York*. The result reveals that when people think about subjective motion going away from them, they were more likely to provide a Friday response, and vice versa.

All in all, this series of experiments suggest that subjective motion, like literal motion, is capable of influencing people's conceptions of time. Also, the results shed light on "how domains deriving structure from a single more experiential-based domain relate to each other" (ibid: 663). Particularly, it appears that one borrowing domain – time can be susceptible to the influence of another borrowing domain – subjective motion when those domains are linked through some experiential-based lending domain – literal motion. Furthermore, the results provide additional evidence that subjective motion involves mentally simulated motion, which is especially apparent in the second and the third experiments.

6. Neuroscience Studies

Neuroscience research has also provided strong evidence for the idea that the processing of subjective motion sentences is indeed linked to the conception of literal motion. Saygin et al. (2010) use fMRI to explore whether activation associated with MT+, which is sensitive to visual processing of motion, would arise with sentences that containing motion verbs which are used either literally or figuratively. Participants are presented audio-visually with three types of sentences: actual motion sentences such as *The wild horse crossed the barren field*, static sentences, i.e., non-motion sentences such as *The black horse stood in the barren field*, and subjective motion sentences such as T*he hiking trail crossed the barren field*. The main finding is that MT+ is activated significantly more for literal motion sentences than the other two sentence types, and subjective motion sentences activate MT+ more than those static sentences. The results demonstrate that although to a lesser extent, figurative uses of motion verbs engage neutral systems as well; that is to say, the brain areas that in relation with visual processing motion may underlie subjective motion processing. Therefore, Saygin et al. conclude that "behavioral studies have suggested that processing subjective motion entails a simulation

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process in motion processing mechanisms, and the modulation of MT+ by subjective motion sentences could reflect a neutral correlate of such a simulation" (ibid: 2487).

Similar results are obtained by Wallentin et al. (2005) in a study on the neuro-linguistic processing of Danish subjective motion sentences. The study investigates whether LPMT [1] activation to motion verbs is influenced by linguistic context. The result shows that there is no significant difference in LPMT activation between subjective and literal motion sentences, and it is speculated that the LPMT acticity in the subjective motion condition "reflects the fact that the hearer applies motion to the depicted scenario by scanning it egocentrically" (ibid: 649).

7. Conclusion

In conclusion, scores of research in psychology lend support to the early claims that subjective motion does involve a fleeting sense of motion. Like literal motion, it can be modulated by environmental factors; it has magnitude and direction, and can influence how people season about time. More generally, these studies contribute evidence to support the idea that language representation and use is grounded in our embodied experience with motion in the physical world.

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