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The Cognitive Mechanisms Underlying the Concept of سرعة (Speed) in Arabic

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Abstract
Despite the wide range of studies on how students' past knowledge influences their understanding of scientific terminology, few studies were conducted to compare non-scientific language with scientific language, or rather everyday language with scientific language, from a cognitive linguistic perspective. The present paper aims to determine the cognitive mechanisms, i.e., image schemas, conceptual metaphor, and conceptual metonymy, which underpin the conceptualisation of the Arabic term سرعة (speed), using a conceptual metaphor theory framework. Thus, the research question guiding this study is: What cognitive mechanisms underlie the concept of سرعة (speed) in Arabic? The findings of this study will shed light on how Arab speakers conceptualise this term, demonstrating their background knowledge of the term compared to its scientific meaning. The article adds to the growing body of cognitive linguistics research on the conceptual processes behind physics terms. The data was collected from the *Arabic Web Corpus* (*arTenTen*) using the *Sketch Engine*. The findings demonstrated that VERTICATLITY and SCALE schemas are the most dominant image schemas that anchor the conceptual meaning in Arab speakers' perceptions of the term under investigation and the discourse in which it is employed, as well as offer the concrete basis for conceptual metaphors. The conceptual metaphor CHANGE IS MOTION (LOCATION) was also shown to be active in motivating the conception of SPEED in Arabic.
Keywords: Arabic, conceptualisation, conceptual metaphor, image schemas, cognitive mechanisms, speed

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Introduction

According to most research on scientific language, presenting new scientific terminology to learners will be challenging if they have formed a distinct understanding of the concepts based on their daily use. For example, scientific terms like *motion*, *acceleration*, *velocity*, and *speed* are commonly used in everyday English. Therefore, before studying these terms in science classes, learners are already familiar with them. However, the meanings of the terms in science differ from their meanings in everyday use. Students' background knowledge, which is supposed to help them understand scientific concepts, may hamper their understanding. A learner's prior knowledge of words like *motion*, *acceleration*, *speed*, and *velocity* may not fit in an academic setting; it may limit their ability to learn more about these concepts. Carey (2000) says that the most significant impediment to understanding the curricular materials is not what a learner needs but what they have: surrogate conceptual schemes for comprehending the things addressed by the theories that educators attempt to present.

Previous research on the concepts of ACCELERATION, SPEED, and VELOCITY[1] revealed learners' confusion as they try to understand scientific concepts using their background knowledge (e.g., Trowbridge & McDermott, 1980, 1981; Jones, 1983). Because of the difficulties in balancing learners' existing knowledge with scientific knowledge through education, the situation is quite worrying for both educators and learners. In contrast to research on English scientific terminology, very few works are available on Arabic scientific terminology. Thus, more research on science terms, especially those that are also used in daily language, across languages is needed to establish distinctions between a student's past knowledge and science, as well as the language of modern science texts and its counterparts in other languages.

Using languages other than English to teach science creates a more complex challenge for students to grasp scientific concepts because the terms used to translate English scientific terms may have distinct meanings, causing students to misunderstand scientific concepts. Miscommunication and disorientation can emerge from the challenges in attaining translational equivalence and the probable destruction of the initial senses during translation, mainly if the bodily, social, and cultural backgrounds are diverse. Failure to recognise these distinctions may have ramifications for scientific terminology teaching and learning.

The current article aims to determine the cognitive mechanisms, namely image schemas, conceptual metaphor, and conceptual metonymy, which underlie conceptualising the Arabic term *سرعة* (speed). In light of this aim, the study's central research question is: What cognitive mechanisms underlie the concept of *سرعة* in Arabic? The findings on the cognitive mechanisms that underpin the conceptualisation of the term under investigation will offer new insight into the conceptualisation of this term by revealing the background knowledge of such a term as opposed to its scientific meaning. The current article contributes to the growing body of research in cognitive linguistics about the cognitive mechanisms underpinning physics terminology. It is part of the author's study, which contributed to our understanding of the disparities in physics terminology across languages and between daily language and scientific language.

Literature Review

Language is an ongoing challenge in science teaching across the globe. According to research, the gap between daily speech and scientific language is a barrier for students in both the

[1] In this article, lexical items such as *speed* are italicised, but concepts are denoted using caps, as in SPEED.

West and the rest of the globe (e.g., Carey, 2000; Ennaji, 2005; Strömdahl, 2007; Duit & Haeussler, 2012; Lahlou, 2018, 2019). In English, much research on students' misunderstandings of MOTION and related concepts like SPEED, VELOCITY, and ACCELERATION was undertaken (e.g., Trowbridge & McDermott, 1980, 1981; Jones, 1983; Fuchs, 2013; Yıldız, 2016). However, few studies have been published on learners' misconceptions of these concepts in Arabic.

Trowbridge and McDermott (1980) investigated college students' perception of *velocity*. They gathered data through interviews, asking students about basic motions observed. The findings revealed that students were unable to distinguish between *position* and *velocity*. In a following study, Trowbridge and McDermott (1981) examined college students' perception of acceleration, employing the same data collection method. The analysis of results showed that the University of Washington students of physics could not distinguish between *velocity* and *acceleration*. A related study by Jones (1983) aimed to determine learners' conceptions about *speed*, *velocity* and *acceleration*, employing Osborne and Gilbert's (1979) interview-about-events and interview-about-instances techniques. The findings showed that only one out of thirty students (11-16 years old) accurately defined *velocity*. Thirteen admitted to having no idea what the word meant, and the rest mistook it for *speed*. The students incorrectly believed that *velocity* was synonymous with *speed* and *acceleration*. Despite the difference between the interviewees in Trowbridge and McDermott (1980, 1981) and Jones (1983) in terms of age, as the former were older, the results were similar.

Another study by Yildiz (2016) used descriptive analysis to study how to improve the definitions of *distance-displacement* and *speed-velocity* quantities, their key features, and how the formulas are taught by using relevant examples and activities. The data was collected from documents, including definitions, concepts, and formulas about *distance*, *displacement*, *speed*, and *velocity*. The results showed that the interchangeable use of the distinct concepts of velocity and speed could be attributed to factors such as spoken language, inaccurate definitions and translations, a lack of knowledge of the basics of scalar and vector quantities, and the misconception that distance and displacement are the same quantities. The study suggested that the best way to teach speed and velocity would be to use clear, simple, and common examples to show the distinction between distance and displacement.

In contrast, despite research interest in this topic, very limited studies on SPEED in Arabic have been undertaken. Lahlou (2020), for instance, investigated the concept of ACCELERATION in Arabic and English using prototype theory, image schemas, and conceptual metaphors. The study aimed to identify the similarities and differences between the polysemy of Arabic تسارع and the polysemy of English *acceleration*, as well as the prototypes and cognitive factors behind their conceptualisations. The research used dictionaries to explore their meanings and the *ArabiCorpus* and the *British National Corpus* to investigate the senses and find the most frequent collocates and prototypes of these terms. According to the findings, the terms' polysemy and cognitive factors motivating their conceptualisation generally overlap. It was also discovered that Arab and English speakers confuse ACCELERATION with SPEED and misinterpret them in a scientific setting.

Similarly, Lahlou (2021) sought to identify the commonalities and differences between Arabic and French terms used in physics, including *temperature*, *inertia*, and *speed*. The study examined the physics terminology's polysemy and conceptual structure underlying it using Lakoff's (2008) Idealised Cognitive Models (ICMs). Focus group interviews were also used to explore Moroccan first-year university students' conceptualisations of the scientific terms under

investigation and see if changing the instruction medium from Arabic to French at the tertiary level affected the students' perception of the terms. The results showed similarities and dissimilarities between Arabic and French terms in polysemy, prototypes, metaphorical, and metonymic, meaning projections. It was also found that Moroccan students' conceptualisation of physics terms is influenced by linguistic differences between Arabic and French and their everyday language, typically a Moroccan dialect. In contrast to these studies, which compare the polysemy of physics terms between Arabic and English and between Arabic and French and how conceptual metaphor and metonymy motivate their sense expansion, the current study explores the cognitive mechanisms that underpin the Arabic concept of سرعة(SPEED).

As previously stated, students do not enter school as "blank slates" but rather with preconceived concepts based on their everyday experiences. When students are asked to explain scientific concepts, their answers deviate from the scientific viewpoint. Students' background knowledge may be the most serious impediment to grasping scientific concepts based on their cultural, social, and bodily experiences. Teaching scientific terminology should strive to connect everyday meanings of concepts with those of science to help students perform well in both contexts (Trumper, 1990; Duit & Haeussler, 2012). Thus, a method for studying students' misconceptions of scientific terms that incorporates learners' pre-existing knowledge is vital. To date, little cognitive linguistics research has been conducted on students' misunderstandings of the concept of MOTION.

Language is a cognitive mechanism that, among other mechanisms, assists people in deciphering reality and may impact their concepts (Evans, 2011). Language is used to communicate with others and learn about the world. People experience their surroundings and reality in various ways, resulting in a wide range of mental models or representations that provide common or conflicting perspectives of reality. Language mirrors reality as humans construe it (Cienki, 2007). A lexical unit is not a meaning container but an access point to the language user's background or encyclopaedic knowledge (Langacker, 1987; Kecskes, 2014). Language may use a variety of grammatical and semantic structures to refer to the same situation. For example, one language says *I am cold*, another says *I have a cold*, and yet another says *It is cold to me*. Though they refer to the same experience, the semantics of such expressions differ because they employ distinct images to frame the same conceptual content (Langacker, 1987). The mind of a language user construes experience using various conceptualisation processes such as metaphor, metonymy, and image schemas (Lakoff, 2008). Metaphors are represented in language because human thought processes are generally metaphorical. They are the fundamental schemes humans use to conceptualise their own experiences and the world around them (Gibbs, 1994).

An image schema is an abstract representation derived from one's daily interaction with and observation of their surroundings. It is embodied experience that gives rise to image schemas. For illustration, gravity ensures that things that are not supported fall to the ground, so one must bend down to pick up something that has fallen, gaze downwards for things dropped, and above for things moving upwards because the human vertical axis is asymmetric (Evans & Green, 2018). According to Lakoff (2008), image schemas primarily act as the basis for conceptual structure. Image schemas like PART-WHOLE, CONTAINER, UP-DOWN, and FRONT-BACK, for example, shape the experience and concept of SPACE. Some experiences are more directly mapped and understood metaphorically or metonymically based on image schemas in many

contexts. Such structures are preconceptual and arise from people's earliest bodily experiences (Barcelona, 2003; Lakoff, 1993; Johnson, 2013).

Metaphor is the primary mechanism by which an individual comprehends abstract concepts and reasons about them. It helps individuals learn a relatively abstract or inherently unstructured subject matter by relating it to a more concrete or, at the very least, more highly structured subject matter (Geeraerts, 2006). A metaphor is a common association of one domain with another. It is conceptual because metaphor motivation occurs at the conceptual level (Lakoff & Johnson, 2003). To use Johnson's (2008) examples, the expressions *The water went from hot to cold, The system is moving toward homeostasis, and The pizza is somewhere between warm and cold*, are understood in terms of CHANGE OF STATE IS MOVEMENT. In these examples, a change of state is understood as moving from one location to another. In other words, MOTION/CHANGE OF LOCATION (source domain) is metaphorically mapped onto CHANGE OF STATE (target domain).

Metonymy is the use of one entity to refer to another related to it (Lakoff & Johnson, 2003). To use Lakoff and Johnson's example, *strong bodies* in *We need a couple of strong bodies for our team* refers to strong people. Like metaphor, metonymy is a cognitive process that is conceptual, a mapping, conventionalised (that is, part of an individual's daily conceptual system), automatic, effortless and unconscious, and a means of extending language resources (Lakoff & Turner, 2009).

Given the above, the current study attempts to determine the cognitive mechanisms, i.e., image schemas, conceptual metaphor, and conceptual metonymy, which underlie the conceptualisation of the term سرعة (speed) in Arabic. This will provide an insight into Arab students' pre-existing knowledge of the term concerned and how it may conflict with its scientific meaning.

Method

The current article is descriptive qualitative research that draws on Conceptual Metaphor Theory (CMT) and corpus linguistics as a support tool to explore the conceptualisation of the Arabic term سرعة. Human communication requires conceptual metaphor because it develops an individual's understanding. The source domains used in conceptual metaphors are derived from people's sensory-motor and physical experiences that serve as a foundation for conceptualisation and reasoning (Lakoff, 2008; Johnson, 2008). They enable people to use metaphorical meanings that are directly linked to their bodily and sensory-motor experiences, allowing them to comprehend abstract concepts based on concrete concepts (Lakoff, 2008; Lakoff & Johnson, 2008; Kövecses, 2010, 2015). Language is a domain in which metaphor-based thinking is mirrored. Therefore, it provides access to such cognitive processes as image schemas, conceptual metaphor, and conceptual metonymy.

The *Arabic Web Corpus* (*arTenTen*) was chosen as the data source for this study to identify the linguistic forms used metaphorically and/or metonymically and investigate the conceptualisation processes (i.e., metaphor, metonymy, and image schemas) underlying the term سرعة. The data was collected from the *arTenTen*, a web-crawled Arabic corpus of 7,475,624,779 words. The use of سرعةin the *arTenTen* was investigated using *Sketch Engine*, a web-based Corpus Query System (CQS). Because the current study is concordance-based, only concordances involving the occurrence of the search word سرعة were investigated. The data set for the

investigation comprised 250 concordance lines randomly selected using the *Sketch Engine* sample tool.

In the lack of accurate automated identification of metaphor, the author manually examined the generated concordance lines to identify metaphorical and/or metonymic mappings for accuracy (Sardinha, 2008). A surface metaphor must include a vehicle term incongruous with the surrounding context or the meaning drawn from the co-text. Such incongruity can be resolved by some 'transfer of meaning' from the vehicle term (or source domain) to the topic (or target domain). The vehicle's meaning should be distinct from its core meaning (Cameron, 2003, 2008). In contrast, the entity that a metonymic expression represents acts as a point of reference, providing mental access to the desired target, that is, the entity being referred to (Langacker, 1993). This does not imply that metonymy merely serves as a reference point; it also provides understanding. Metonymy is a cognitive process in which one conceptual entity, the vehicle entity, provides mental access to another in the same domain, the target entity (Kövecses & Radden, 1998; Kövecses, 2010). Therefore, in contrast to metaphors, metonymies include mapping within a single domain and depend on contiguity between the two entities. The source domains whose elements are projected onto the domain of سرعة were also investigated to determine the role of embodiment in the formation of this concept and, as a result, to identify the image schemas underlying its conceptualisation.

Overall, the author first conducted a concordance search of the node word سرعة and selected 250 random samples generated by *Sketch Engine*'s 'random sample' function to determine the cognitive mechanisms that underpin its conceptualisation. The selected data set was then manually analysed to find the actual linguistic expressions, instantiating image schemas, conceptual metaphors, and/or conceptual metonymies. It is worth noting that the search word or node سرعة was examined by checking sentences before and after the concordance line to provide a more comprehensive data set on the linguistic expressions motivated by any cognitive mechanisms. This can only be feasible while reading long sections of text (Koller, 2006).

Results

The data gathered from the *Arabic Web Corpus* (*arTenTen*) through *Sketch Engine* revealed that VERTICALITY and SCALE schemas are prevalent throughout the concordance lines retrieved from the selected corpus. The findings also showed that, broadly, the conceptual metaphor CHANGE IS MOTION (LOCATION), that is, SPEED OF ACTION IS SPEED OF MOTION and SPEED OF PROGRESS IS SPEED OF MOTION TO A DESTINATION, motivates the conceptualisation of SPEED in Arabic. Furthermore, no expressions instantiating conceptual metonymy were found in the selected data.

The concordance lines analysed exhibited diverse collocations with the word *speed*, i.e., noun-adjective collocations, verb-noun collocations, noun-noun collocations, and adjective-noun collocations. Table one lists the most frequent examples of these collocations. Based on the data retrieved from the *arTenTen*, the most predominant image schemas that underlie the conceptualisation of the term سرعة in the corpus citations retrieved are the VERTICALITY and SCALE schemas. Examples one, five, six, fourteen, fifteen, nineteen, and twenty exhibit a vertical movement, showing the direction of UP. In examples one, five and six, the adjectives describe the degree or intensity greater than normal of the noun *speed* from bottom to top. Example twenty similarly describes speed as becoming more at a high rate, a speed change upward. Thus, it is

motivated by the AMOUNT IS VERTICALITY conceptual metaphor. In example fourteen, *speed* resembles lightning in the speed of movement. However, the fact that lightning can be above the ground, the clouds, and so on, showing vertical movement, though it can also be horizontal, may be underpinned by the VERTICALITY schema. In the same vein, in example fifteen, the comparison of the speed with that of a rocket shows the speed's intensity and the vertical movement.

In comparison, examples seven, eight, twelve, thirteen, sixteen, seventeen and eighteen show a "more" or "less" characteristic of Arabic speakers' experience, forming the source of the SCALE schema. In examples seven and eight, the noun *speed* is modified by the adjective *great*(*er*), describing the largeness in the degree of speed. In examples twelve and thirteen, *speed* is preceded by *amount*/*intensity*, showing its degree. However, in example twelve, the *amount* is downward, so it is motivated by the AMOUNT IS VERTICALITY conceptual metaphor. While examples sixteen and eighteen show a change downward, example seventeen shows a change upward. Nevertheless, these examples are motivated by the AMOUNT IS VERTICALITY conceptual metaphor. As noticed from the description above, in more than half of the examples, both concepts of amount/intensity and upward motion are activated. This finding is not unexpected given that, while VERTICALITY includes vertical orientation, other image schemas also heavily rely on it (Hedblom, 2020).

Table 1. *Collocations with speed*

Collocations	Examples		English Translation
Noun-Adjective Collocations	(1)	**سرعة** اعلى	higher **speed**
	(2)	**سرعة** جنونية	insane **speed**
	(3)	**سرعة** خارقة	extraordinary **speed**
	(4)	**سرعة** تاريخية (تقطع الانفاس)	historic **speed**
	(5)	**سرعة** فائقة	top **speed**
	(6)	**سرعة** عالية	high **speed**
	(7)	**سرعة** اكبر	greater **speed**
	(8)	**سرعة** كبيرة	great **speed**
	(9)	**سرعة** خاطفة	lightning **speed**
Adjective-Noun Collocations	(10)	اقصى **سرعة**	maximum **speed**
	(11)	اسرع **سرعة**	(the) fastest **speed**
Noun-Noun Collocations	(12)	تخفيف حدة **سرعة**	decrease in the (intensity of) **speed**
	(13)	مقدار**سرعة**	amount of **speed**
	(14)	**سرعة** البرق	lightning **speed**
	(15)	**سرعة** الصاروخ	rocket **speed**
Verb-Noun Collocation	(16)	يقلل من **سرعة**	to reduce the **speed** (of)
	(17)	تزيد من **سرعة**	increase the **speed** (of)
	(18)	خفف من **سرعة**	decrease the **speed** (of)
	(19)	مر بسرعة الصاروخ	passed at a rocket **speed**
Noun-Clause Collocation	(20)	سرعة تتزايد بشكل عالي	**speed** that increases at a high rate
	(21)	سرعة (تاريخية) تقطع الانفاس	(historic) breathtaking **speed**

Given the prominence of the VERTICALITY schema, followed by the SCALE schema, underpinning the conceptualisation of the term *سرعة*, there were many citations in which this image schema offered the concrete basis for conceptual metaphors. Table two provides some examples of these metaphors. The clause in example one is motivated by the PROGRESS IS FORWARD

MOTION conceptual metaphor. Tourism development is likened to a vehicle having wheels and must be pushed forward to proceed. Moving forward is metaphorically mapped onto the progress (of tourism development). However, this movement must be at the maximum (upper limit; the largest possible quantity) speed, which makes it oriented vertically with the maximum amount of speed upwards and value of cost downwards.

Example two depicts a country heading towards disintegration and possibly descending into civil war at high speed. SPEED OF PROGRESS IS SPEED OF MOTION TO A DESTINATION motivates this image. Given the phrase *at high speed*, the speed in example two is upward. Another conceptual metaphor that might have motivated this example is FINAL STATES ARE FINAL LOCATIONS, albeit these two conceptual metaphors are special cases of CHANGE IS MOTION. Similarly, example three indicates the dramatic increase in the degree of the crisis, which is supported by the VERTICALITY schema. Given the movement upward of flying, the sentence *the officials flew with joy* in example four is motivated by the conceptual structure UP IS GOOD, whose skeleton is constructed by VERTICALITY (Hedblom, 2020).

Table 2. *Image schema – UP-DOWN*

Image Schema		Examples	English Translation
UP-DOWN	(1)	...للدفع بعجلة التنمية السياحية الى الامام باقصى سرعة و ادنى تكلفة...	... to push forward the wheel of tourism development at the maximum speed and lowest cost...
	(2)	...يتجه بسرعة فائقة الى التفكك و ربما نحو حرب اهلية...	... it is heading toward disintegration and perhaps towards civil war at high speed...
	(3)	...حدة الازمة ارتفع بشكل كبير و بسرعة قياسية...	... the severity of the crisis has risen dramatically and at the highest speed...
	(4)	...طار المسئولون مرة اخرى فرحا...	...the officials flew again with joy...

As mentioned earlier, the conceptualisation of*سرعة* in Arabic is broadly motivated by the CHANGE IS MOTION (LOCATION) conceptual metaphor. The examples in Table Three show how this conceptual metaphor underlies the way the word *speed* is conceptualised in Arabic. For instance, examples one, two, and three are motivated by SPEED OF PROGRESS IS SPEED OF MOTION TO A DESTINATION, a sub-case of CHANGE IS MOTION (LOCATION). However, while examples one and three show a vertical speed intensity, example two exhibits a scale, as paths are metaphorically mapped onto scales in this context. In example four, leaders are described as leaving their principles behind when they reach power, taking themselves to power, money or prestige. This example exhibits another sub-case of the CHANGE IS MOTION (LOCATION) conceptual metaphor, i.e., SPEED OF ACTION IS SPEED OF MOTION.

Table 3. *Conceptual metaphor – CHANGE IS MOTION LOCATION*

Conceptual Metaphor		Examples	English Translation
Speed of Progress is Speed of Motion to a Destination	(1)	...الافكار الخبيثة التي ستكبر بسرعة ملتهمة عقول الناس لتلقي بهم في ظلمات التعاسة...	...the malicious ideas that will grow up rapidly devouring people's minds to throw them into the darkness of misery...
	(2)	...ان الاجيال السالفة (الكهول مثلا) راحت تلهث وراء سرعة الشباب لمجاراتهم, و السير معهم و بهم نحو مستقبل افضل.	...Earlier generations (for example, the elderly) were panting for young people's speed to keep up with them

			and to walk with them toward a better future.
	(3)	البلد وضعت لها عجلات لتسير عليها بسرعة فائقة الى مهاوي التشظى و الدمار...	The nation was given wheels to go at high speed into the abyss of fragmentation and destruction…
Speed of Action is Speed of Motion	(4)	...سرعة تحولهم عند اول اختبار لشهوة السلطة او المال او الجاه...	... the speed of their transformation at the first test of the lust for power, money or prestige...

Discussion

The VERTICATLITY and SCALE schemas are the most common image schemas that locate the conceptual meaning in Arab speakers' comprehension of the word *سرعة* and the discourse it is used in, as well as provide the concrete foundation for the aforementioned conceptual metaphors. As previously stated, the VERTICALITY schema can be said to play an important part in other image schemas. This is further supported in the current study, as both VERTICALITY and SCALE are activated in many of the examples discussed above. The SCALE schema construes a property quantitatively as more or less and qualitatively as degrees of intensity (Johnson, 2013). While the SCALE schema does not suggest a certain geometric orientation, the VERTICALITY schema includes an axis and a base, or the ground, as a reference point (Bourou, Schorlemmer, & Plaza, 2021). However, scalar quantity is normally understood in terms of the VERTICALITY schema in certain contexts. In other words, MORE is viewed as being oriented up, as in the case of the MORE IS UP conceptual metaphor (Johnson, 2013). People learn new words and how to arrange them in a line from one pole to the other. Young children can be taught concepts or terms like *speed*, which encompasses the manifold spanned by polarity. Once this is established, they may be introduced to some features of this concept, such as how it can be quantified and how, when discussing *speed*, we conceptualise it using the VERTICALITY schema, which implies that speed can be high, low, or somewhere in between (Fuchs, 2013).

Overall, the findings revealed that in daily discourse, Arab learners understand the concept of SPEED in terms of the SCALE and VERTICALITY schemas, in which speed is either high or low, indicating a vertical scale. As a result, it comes as no surprise that the SCALE and VERTICALITY schemas are interconnected in this context. VERTICALITY contributes to how Arab speakers conceptualise the concept of AMOUNT (Lahlou & Hajar, 2020). This suggests that Arab learners can associate the term speed with their past knowledge and assimilate/accommodate it successfully based on their embodied experience of speed. This is consistent with previous results (e.g., Lahlou, 2021). One of the striking findings of this study was that the first concept that struck the respondents' minds when they heard *سرعة* was the concept of SPEED, which they defined, for instance, as "the movement of a body from place to place" or "the distance travelled by a body in a certain period of time." The question that arises here is whether they know about the other associated components of *motion*, such as *velocity* and *acceleration*, and whether they can discern between them.

It is worth mentioning that the term *سرعة* is used in some scientific texts to refer to both the concept of SPEED and the concept of VELOCITY. Salah (2010), for example, argued that *سرعة* is employed to signify both *speed* and *velocity* in many translations. While the former refers to the speed of human-made objects like cars and machinery, the latter refers to natural phenomena such as light and sound. However, in most translations of scientific texts, *speed* is expressed as *السرعة القياسية* and *velocity* as *السرعة المتجهة* (Hewitt, Suchocki, & Hewitt, 2014). According to Lahlou

(2021), using these two compounds fails to separate the concepts of SPEED and VELOCITY because the noun *سرعة* is a component of both Arabic compounds. The compound constituents *القياسية* and *المتجهة* denote 'scalar' and 'vector', respectively, and are adjectives that classify the source word *سرعة*. In contrast to velocity, a vector, speed is a scalar quantity that has no direction. The compound noun *السرعة المتجهة* is therefore made up of inconsistent constituents, i.e., *سرعة* (speed, scale) and *متجهة* (vector). Such ambiguity may exacerbate students' difficulties while studying the many scientific concepts of MOTION, particularly SPEED and VELOCITY (e.g., Jones, 1983; Lahlou & Hajar, 2020; Lahlou, 2021). Thus, to avoid confusion, teachers should warn students about the difference between everyday language and scientific language, wrong definitions and translations, and a lack of understanding of the basics of quantities like scalar and vector quantities. They should use clear, straightforward, and common examples to show the distinction between these principles (Yildiz, 2016).

Conclusion

The current article sought to determine the cognitive mechanisms underlying the conceptualisation of the term *سرعة* (speed). The findings revealed that the most common image schemas that anchor the conceptual meaning in Arab speakers' comprehension of the term and the discourse in which it is used, as well as provide the concrete foundation for conceptual metaphors, are VERTICATLITY and SCALE schemas. The results also showed that the conceptual metaphor CHANGE IS MOTION (LOCATION) motivates the conceptualisation of SPEED in Arabic, i.e., SPEED OF ACTION IS SPEED OF MOTION and SPEED OF PROGRESS IS SPEED OF MOTION TO A DESTINATION. Arab students will be able to correlate the term *السرعة القياسية* (speed) presented in science class with their past knowledge and accommodate it successfully based on their embodied experience of speed. The second compound *السرعة المتجه* (velocity) will be challenging for students, given the confusion exerted by the source words. Being aware of the parallels and contrasts between students' knowledge of the term *سرعة* (including compounds deriving from it) and its scientific meaning will allow Arab teachers of science to explain the possible differences better and avoid students' inconsistent ways of comprehending scientific ideas. In addition to the implications for science curriculum design and instruction, the findings contribute to the increasing body of literature on universal and culture-specific language features by studying the semantic aspects of Arabic *سرعة* and cognitive mechanisms underpinning its conceptualisation. Finally, the current article contributes to the literature on image schemas and conceptual metaphors by taking the first step toward investigating the mechanisms involved in constructing the conception of *سرعة*.

About the Author

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