

SPEED and VELOCITY in Arabic and English: A Corpus-based Cognitive Linguistic Analysis

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Abstract

Current research shows that the gap between scientific knowledge and everyday knowledge may impede students' learning of science. The present study aims at investigating the terms denoting the concepts of SPEED and VELOCITY in Arabic and English in terms of meaning, prototypicality, conceptual metaphor and conceptual metonymy based on Lakoff's (1987) idealized cognitive models (ICMs). The data for analysis was extracted from Arabic and English dictionaries as well as corpora. The results show that Arabic سُرْعَة (speed) and English speed overlap and contrast in terms of meaning extension and its motivation, and overlap in prototype, SCALE. The dominance of SCALE in conceptualizing the terms may cause both Arabic and English speakers to confuse speed and velocity if they are not alerted to the difference between their prior knowledge and scientific meanings of the terms. These results have important implications for research in linguistics and science education.

Keywords: speed, velocity, prototype, idealized cognitive models, conceptual metaphor, conceptual metonymy

1. Introduction

It is often not possible to find meaning equivalence across languages because as part of human knowledge, language is gained through experience and very much influenced by a speaker's cultural background. In certain languages like the dialects of Tamazight, or Berber, spoken in North Africa, speakers use one word, *azegzaw*, to refer to both green and blue [1]. This is because “colour categories result from the world plus human biology plus a cognitive mechanism that has some of the characteristics of fuzzy set theory plus a culture-specific choice of which basic colour categories there are” [2]. In contrast, an object may have several names in other languages. In Classical Arabic, for example, the word *lion*¹ can be referred to as *أسد* (*asad*)², *ضِرْغَام* (*dirghām*), *لَيْث* (*layth*), *حَيْدَر* (*haydar*) and *سَبُع* (*sabu*). Some scholars of Arabic grammar like Ibn Hālawiya mentioned more than five hundred names for a lion [4]. Possessing a high number of words to refer to certain phenomena characterizes a culture's expertise in a particular knowledge or experience. According to Lakoff, “different people may have different domains of experience that are highly structured. Given a general conceptualizing capacity and a language capacity, they can conceptualize and name structured aspects of that domain of experience” [2].

The difficulty of achieving translation equivalence and the possible loss of the original meaning in the process of translation can lead to miscommunication and confusion, especially if the conceptualization experiences are different. The lack of understanding of these differences can negatively affect the process of learning and teaching, particularly in the field of science. The nature of this issue is complex and affects both non-western and western learners. However, research shows that this problem is more challenging in non-western countries because of the difference between learners' native language and the foreign language used as the medium of instruction, especially for science subjects. The difficulties that learners of science face due to differences in language is evidenced by a series of studies on learners' misconception of scientific terminology [5, 6, 7, 8, 9].

Arabic speakers, for instance, are first exposed to concepts in their first language. The use of the native language continues in school, and the second language (i.e., English or French) is introduced at later stages.

The knowledge they acquire about the second language during these different stages of learning does not necessarily prepare them to be aware of the differences between their pre-existing knowledge of words and their scientific meaning. This may result in their dependence on their prior knowledge of the words in science classes, and so may invariably cause learners to mix up their culture with “science culture” [10].

In the western context, learners experience similar, though less serious, challenges in understanding science due to the gap between their everyday speech and scientific terminology [11, 12]. A learner employs his or her pre-existing knowledge about words such as *nature*, *energy*, and *motion*, which they easily understand in their daily life. However, this understanding may hamper a learner’s capability to learn more about a concept as it does not fit in an academic context. Carey (2000), in this connection, says:

Now we understand that the main barrier to learning the curricular materials we so painstakingly developed is not what the student lacks, but what the student has, namely, alternative conceptual frameworks for understanding the phenomena covered by the theories we are trying to teach (Carey 2000:13-14).

Despite the growing body of literature on learners’ misconceptions of scientific terminology, there are limited studies on Arabic scientific terminology. Given the incongruity of the pre-existing knowledge in a physics classroom, previous studies on the concept of motion indicate that students generally mix up certain concepts of motion with others. For instance, first-year students of physics at the University of Washington confuse position and velocity [13], and velocity and acceleration [14]. Younger students, aged between 11 and 16 years, may even consider speed, velocity, and acceleration as the same [15]. This shows that the situation is more than alarming for both academics and students, especially with the difficulty to change the students’ background knowledge through instruction. More research on physics concepts is then required to identify the differences between a learner’s native language and the language employed as a medium of instruction for science and between their prior knowledge and science ideas.

Given the above-mentioned problem, it is necessary to identify the gaps between Arabic and English physics terminologies and between Arab and English learners’ pre-existing knowledge and the acceptable use of physics terms. To this end, the current paper examines two physics concepts: SPEED and VELOCITY in Arabic and English. More precisely, the paper compares the polysemy, prototypes and cognitive mechanisms (i.e., conceptual metaphor and conceptual metonymy) that motivate the conceptualization of Arabic *سُرْعَة* (*sur‘a*) with those of English *speed* and *velocity*.

It is worthy of note here that in many contexts, in Arabic, compared with English, *سُرْعَة* (*sur‘a*) denotes both *speed* and *velocity*, in other contexts, especially scientific contexts, it forms part of the compounds *السرعة القياسية* (*as-sur‘a l-qiyāsiya*) (*speed*) and *السرعة المتجهة* (*as-sur‘a l-muttajiha*) (*velocity*). In various translations, Salah [16], for instance, asserts that both *speed* and *velocity* mean *سُرْعَة* though the former is used to express the speed of man-made things like cars and machines while the latter is associated with natural phenomena like sound, light, and so forth. Within this situation, an Arabic user can only distinguish between *speed* and *velocity* in context given the complex polysemy of *سُرْعَة*. In many other translations, in contrast, *speed* is rendered as *السرعة القياسية* (*as-sur‘a l-qiyāsiya*) and *velocity* as *السرعة المتجهة* (*as-sur‘a l-muttajiha*), especially in scientific texts [17]. The use of these compound forms seem to distinguish between the different terms; however, the noun *السرعة* is a component in both coinages, *السرعة القياسية* (*as-sur‘a l-qiyāsiya*) and *السرعة المتجهة* (*as-sur‘a l-muttajiha*). The second components of the compounds are adjectives³, classifying the source word *سُرْعَة* (*sur‘a*). The adjectives *القياسية* means ‘scalar’ while *المتجهة* denotes ‘vector’. However, speed is invariably a scalar quantity and it is ignorant of direction while velocity is a vector. Thus, the compound *السرعة المتجهة* consists of two contradictory source words: *السرعة* (*speed, scale*) and *المتجهة* (*vector*). The use of the word *سرعة* in the compounds *السرعة القياسية* (*speed*) and *السرعة المتجهة* (*velocity*) may cause Arab learners to consider ‘velocity’ as an extended meaning of the word *سُرْعَة* (*sur‘a*) (*speed*). Therefore, the ambiguity of the word *سرعة* (*sur‘a*) may add to the difficulty that may arise in learning the two distinct scientific concepts, SPEED and VELOCITY, in Arabic.

Based on the above, the objectives of the current paper are:

1. To identify the differences and similarities between the polysemy of *سُرْعَة* (*sur'a*) and the polysemy of *speed* and *velocity*.
2. To identify the differences between the prototypical entities and factors that motivate the conceptualization of *سُرْعَة* (*sur'a*) and the prototypical entities and factors that motivate the conceptualization of *speed* and *velocity*.

The findings on the differences between the polysemy, prototypes and cognitive mechanisms of *سُرْعَة* (*sur'a*) and *speed* and *velocity* will provide new information on the conceptualization of these terms by exploring the prior knowledge of these terms and comparing it with the terms' scientific meanings. The findings of the analysis will not only contribute new knowledge on how the terms are conceptualized in Arabic and English contexts, but they will also provide information on whether there are any culturally motivated differences in the concepts that may negatively influence Arabic learners' understanding of the concepts of SPEED and VELOCITY.

2. Literature review

In cognitive linguistics, language is a cognitive mechanism among others which helps a person decipher reality and may have some influence on his or her concepts [18]. Language is a way in which humans communicate with other people and learn about their environment and socio-cultural reality. Other ways in which humans experience their environment consist of “sense-perceptory experience, proprioception, and subjective experiences including affect, the visceral sense and diverse cognitive evaluations and states” [18]. This gives rise to a rich variety of mental representations, giving reciprocal or competing ‘views’ of reality. Language encodes semantic structure, which may affect humans’ conceptualization and other cognitive processes like categorization through which humans make sense of experience and concepts. Categories are used in reasoning about entities like chairs, nations and emotions, in performing action, notably writing with a pencil is a type of motor activity, and in generating as well as making sense of an expression [2].

Language is also symbolic in nature given that it is based on the correspondence between semantic representation and phonological representation. It is almost directly anchored in humans’ experience, that is, in bodily, physical, social, and cultural experiences [19]. More importantly, human experience is intertwined with culture as “every experience takes place within a vast background of cultural presuppositions.... all experience is cultural through and through, that we experience our “world” in such a way that our culture is already present in the very experience itself” [20]. Given the symbolic nature of language, a word, thus, functions as an access point to a cognitive structure [21].

Cognitive linguistics studies reveal that people can understand the meanings of linguistic units relative to their background or encyclopedic knowledge that is grounded in their cultural, social and physical experience. Both linguistic knowledge and encyclopedic knowledge are activated in the process of understanding the meaning of a word as they are inextricably related. Several methods of analysis in cognitive linguistics represent the structured encyclopedic knowledge, which is completely connected with linguistic knowledge, namely frames by Fillmore [22, 23], cognitive domains by Langacker [21] and idealized cognitive models by Lakoff [2]. These constructs stem from a methodology that treats language as a communication system that reflects the world as humans construe it [24].

Humans’ knowledge of the world is organized by idealized cognitive models (ICMs). They function as mental reference points as they structure humans’ prior knowledge through which new phenomena are construed. They are “the yardstick by which we measure new objects and events” [25]. ICMs may give rise to prototype effects, and hence they enable a person to decide as well as to explicate whether a member of a category is prototypical or peripheral. As the cognitive models are idealized, that is, they derive from several common experiences [19], they may not exactly match all the cases in the world. The concept BACHELOR, for example, can be understood with recourse to the Marriage ICM that represents a community with a monogamous system and typical age of marriage, that is, youth and adulthood. This ICM, however, does not match a pope and therefore may deny some characteristics of the real world.

Polysemy, the main concern of the current paper, is viewed as categorization in cognitive linguistics. The related senses or members of a lexical unit or ‘radial category’ form a network, showing family resemblance. Nonetheless, one meaning or subcategory can be more prototypical than another and therefore is the source from which the other meanings are projected [2]. Meaning extensions are not random, rather they are motivated by the prototypical model and some general principles of extension. “The central model determines the possibilities for extension, together with the possible relations between the central model and the extension models” [2]. Thus, the extension of ICMs to form radial categories results in polysemy. This semantic projection is mostly motivated by metaphor, metonymy and image-schema transformation [2]. To use Lakoff’s (1987) example, ‘control’, a meaning or member of the category OVER, is metaphorically extended from another meaning of OVER, i.e., ‘above’.

While there have been studies on the concept of MOTION in English [13, 14,15], there is a paucity of literature on this concept in Arabic. Jones [15], for example, revealed that out of 30 students between the ages of 11 and 16, only one participant could define velocity correctly. Overall, the participants assumed that velocity is the same as speed and acceleration. Students’ prior knowledge, grounded in their cultural, social and bodily experience, is the main barrier to learning scientific concepts. An approach that includes the background knowledge in the research on learners’ misconceptions of scientific terminology is critically important. To date, learners’ misconception of MOTION is under-researched from a cognitive linguistic perspective.

Given the above, the current study employs three theoretical frameworks, namely the prototype theory [26, 27], ICMs [2], and conceptual metaphor and metonymy [20], in an attempt to unravel the conceptualization of the terms under study. Firstly, prototype theory is needed in the study as a framework for delineating the prototypical structure (or the prototypical and peripheral meanings) of *سُرْعَة* (*sur‘a*), *speed* and *velocity*. ICMs are then employed to describe the conceptual structure of the terms, including the ICM by-products: polysemy and prototype effects. The use of ICMs is necessary as the senses of a lexical item can be best explicated with recourse to a structured background of experience, beliefs, or practices that develop a kind of conceptual prerequisite for understanding the meaning [28]. Lastly, conceptual metaphor and metonymy analytical constructs are employed to identify the source of the semantic extensions and to depict the conceptual mappings [20] of SPEED and VELOCITY in Arabic and English.

3. Methodology

In the current paper, both Arabic and English dictionaries and corpora were employed to examine the polysemy of *سُرْعَة* (*sur‘a*), *speed* and *velocity*. This is because learners mostly consult dictionaries for definitions, senses, and/ or translations of scientific terms and corpora for the usage of words. The use of these reference sources offers extensive coverage of what may constitute a learner’s prior knowledge of the terms under study. To generate the first set of data on the meanings of *سُرْعَة* (*sur‘a*), *speed* and *velocity*, various Arabic and English dictionaries were surveyed to identify all the possible definitions and meanings of the two words. Following a comprehensive survey of various printed and digital dictionaries, six dictionaries were selected: two monolingual dictionaries and four bilingual dictionaries, as presented in Table 1. One Arabic-Arabic dictionary and one English-English dictionary were selected for the semantic analysis that needed to be carried out on the terms concerned in both Arabic and English. These dictionaries were selected because they are the most comprehensive. Three Arabic-English dictionaries and one English-Arabic dictionary were required to compare as well as contrast the Arabic terms to their English equivalents and to facilitate the translation of the Arabic examples used in the analysis of the terms concerned.

Table 1. Dictionaries referred to in the study of the meanings of the terms concerned

Arabic-Arabic	• <i>Mu'jam l-lugha l-'Arabiyya l-mu'āsira</i> [29]
English-English	• <i>Concise Oxford English Dictionary</i> [30]
Arabic-English	• <i>Arabic-English Lexicon</i> [31] • <i>The Hans Wehr Dictionary of Modern Written Arabic</i> [32] • <i>Al-Mawrid: A Modern Arabic-English Dictionary</i> [33]
English-Arabic	• <i>Al-Mawrid Al-Hadeeth: A Modern English-Arabic Dictionary</i> [34]

Next, to investigate the polysemy, the prototypes and cognitive mechanisms motivating the terms concerned, the *ArabiCorpus* (Arabic Corpus Search Tool) and the *British National Corpus (BNC)* were referred to. The data on *سُرْعَة* (*sur'a*) were collected from the *ArabiCorpus* (173.600.000 words), which generally consists of newspapers, pre-modern text, modern literature, and non-fiction. The data on *speed* and *velocity* were collected from the *BNC* (100.000.000), comprising spoken, fiction, magazines, newspapers and academic, and so on. Both the *ArabiCorpus* and the *BNC* are beyond the minimal size of a standard corpus, which must contain ten million words and over [35,36]. Moreover, the two corpora are largely equal in terms of language variety as they both consist of a considerable range of kinds of data, including newspapers, fiction, non-fiction, spoken and written varieties of language.

The rationale behind utilizing these corpora is their usefulness in discovering the various meanings based on up-to-date real examples of language and the frequency of occurring collocates [37, 38]. The frequency of occurrence of collocates of the terms concerned is employed to identify the most prototypical collocates and thus meanings of these terms. This is because linguistic frequency can help in finding prototypical members of a category in spite of the fact that it is not the source of prototypicality [39, 40].

To achieve the objectives of the study, three sets of data were generated for the analysis of the concepts of SPEED and VELOCITY. The first set of data essentially involves the polysemy of the terms denoting these concepts in Arabic and English. Once the semantic analysis was done, the prototypes motivating the terms under study needed to be examined. To this end, the data on the collocates of *سُرْعَة* (*sur'a*), *speed* and *velocity* were generated based on the *ArabiCorpus* and the *BNC*. The last level of analysis, that is, the metaphorical and metonymic analysis of the terms, is also informed by the data that emerged in the two corpora.

4. Results

The word *سُرْعَة* (*sur'a*) and its English equivalents *speed* and *velocity* consist of a simple network of polysemous senses. In the dictionary *Mu'jam al-Lugha al-'Arabiyya al-Mu'āsira* [29], *سُرْعَة* (*sur'a*) has three senses: 'speed (opposite to slowness)'/ 'rapidity', 'agility, presence (of mind, in a compound noun)' and 'credulity (of belief and credence, in a compound noun). In the *Concise Oxford Dictionary* [30], *speed* has four meanings. It denotes 'the rate at which something occurs', 'a gear', 'the light-gathering power of a camera lens', and 'an amphetamine drug'. *Velocity*, meanwhile, has only two senses, namely 'speed' and 'the speed of something in a particular direction'.

The terms *سُرْعَة* (*sur'a*), *speed* and *velocity* share the meaning 'quickness and rapidity'. Within the domain of physics, *سُرْعَة* (*sur'a*) is also similar to *speed* (i.e., 'the distance travelled by a moving object per unit of time) and to *velocity* (i.e., 'the speed of something in a particular direction'). Nevertheless, there are some differences among *سُرْعَة* (*sur'a*), *speed* and *velocity*. The category *سُرْعَة* (*sur'a*), unlike *speed* and *velocity*, denotes 'agility' and 'credulity'. Additionally, only the word *speed*, on the other hand, has the meaning of 'a gear', 'the light-gathering power or f-number of a camera lens', and an amphetamine drug'.

To identify the prototypes for *سُرْعَة* (*sur'a*), *speed* and *velocity*, the concordance sets of the three words in the *ArabiCorpus* and the *BNC* were generated, and the collocates of the terms were examined. The collocational analysis, as depicted in Figure 1, shows that the word *سُرْعَة* (*sur'a*) most commonly co-occurs with the words *مُعْتَدِلَة* (*mu'tadila*) (*moderate*), *كَبِيرَة* (*kabīra*) (*great*), *غَرْبِيَّة* (*garbiya*) (*westerly*), *فَائِقَة* (*fā'iqa*)

(*excessive*) and الرِّيح (r-riyāh) (*the winds*). The most common collocate of سُرعَة (sur'a) is مُعتدلة (mu'tadila) (*moderate*). In all the citations extracted from the corpus, the adjective *moderate* modifies the speed of the wind as all these concordance sets are in weather forecasts presented in newspapers. The adjective *westerly*, on the other hand, modifies the direction from which the wind comes. In this context, the adjective *moderate* is a scalar feature of speed as it shows the degree of the speed of the wind in motion, i.e., being within average limits. The second and fourth most frequent collocates of سُرعَة (sur'a), that is, *great* and *excessive*, are also scalar properties of speed. Therefore, the most frequent conceptualization associated with سُرعَة (sur'a) is SCALE.

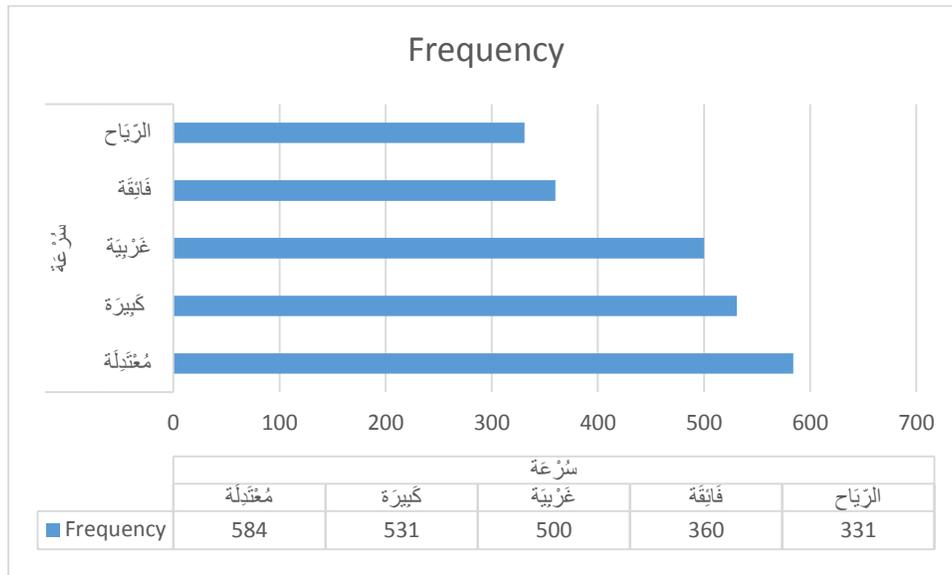


Figure 1. The Most Frequent Collocates of سُرعَة (sur'a)

The most common collocates of *speed*, as shown in Figure 2, are *high*, *top*, *limit*, *maximum* and *average*. Like the most common collocate of سُرعَة (sur'a), *high* is a sort of degree and so exhibits a position on a scale. Interestingly, all the subsequent most frequent collocates indicate a type of degree. This suggests that *speed* is typically conceptualized as a scalar quantity. In sum, the terms سُرعَة (sur'a) and *speed* share the same prototype, notably SCALE.

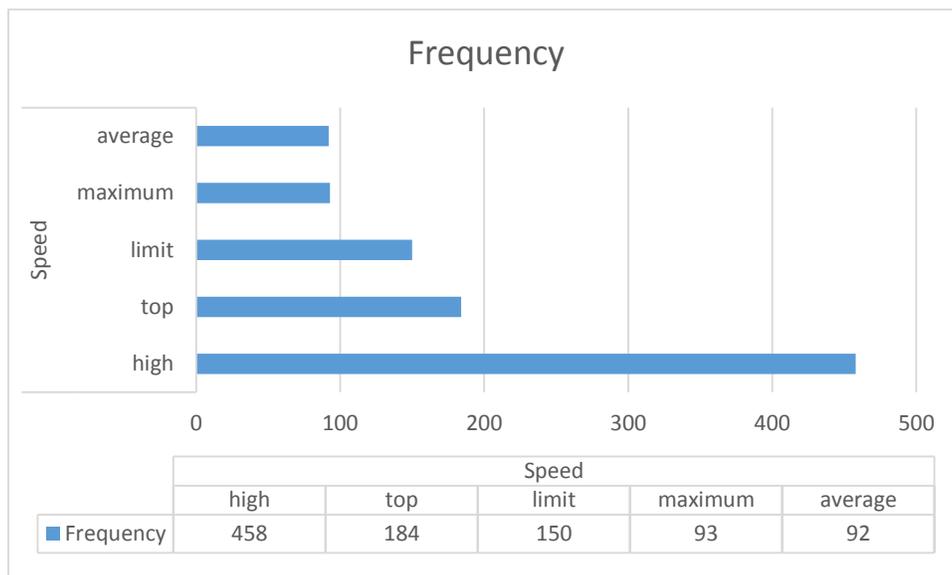


Figure 2. The Most Frequent Collocates of *speed*

Regarding the term *velocity*, in comparison, the data extracted from the corpus show that it frequently collocates with *light*, *profile*, *constant*, *circulation* and *mean* as depicted in Figure 3. These collocates indicate that *velocity* is predominantly used in scientific, technical and commercial domains. The most recurrent collocate of *velocity*, that is, *light*, suggests the quantity nature of velocity. The velocity of light denotes the magnitude of light (electromagnetic radiation) and the direction it is going. Therefore, *velocity* is generally conceived of as a vector quantity.

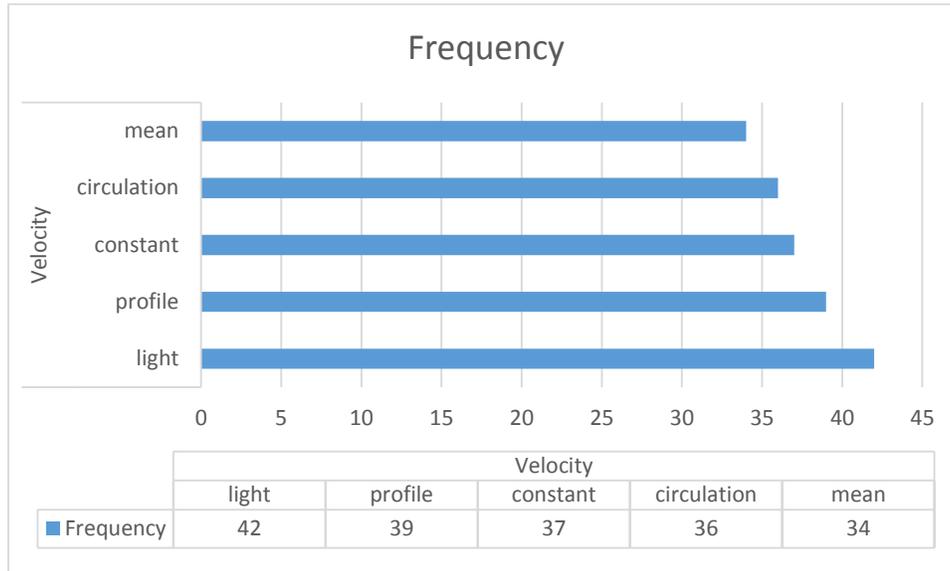


Figure 3. The Most Frequent Collocates of *velocity*

As pointed out earlier, *سرعة* (*sur‘a*) means ‘rapidity’, ‘agility’, or ‘credulity’. The meaning of the noun *سرعة* (*sur‘a*) is semantically projected from concrete (visible quickness) to abstract (agility and credulity).

Within the semantic network of *سرعة* (*sur‘a*), PHYSICAL PROPERTIES ARE MENTAL PROPERTIES metaphor is very active. First, in the second sense of *سرعة* (*sur‘a*): ‘agility’, *سرعة* (*sur‘a*) is used in the compound *سرعة البديهة* (*sur‘atu lbadīha*). The noun *بديهة* (*badīha*) means the ability of “extemporizing; or of uttering, or relating, things by means of the promptness of his intelligence” *An Arabic-English Lexicon* [31]. It is not only a faculty of improvising, but it is also an accurate utterance and performance. In this context, PHYSICAL QUICKNESS (source domain), which is a physical entity or quality, is mapped onto MENTAL QUICKNESS (target domain), which is a mental quality:

1. وكان الشيخ سيد صاحب مزاج مرح يأخذ الدنيا بالهدوء والنكتة وسرعة البديهة.⁴

wa kāna sh-shayḥu sayyid ṣāḥiba mazājin mariḥin ya’ḥuḍu d-dunyā bilḥudū’i wa n-nuktati wa sur‘ati lbadīha.

Sheikh Syed was a cheerful person who dealt with life with calm, humour and agility⁵.

It is worthy of note here that though English *speed* does not denote ‘agility’ as mentioned before, it can similarly be conceptualized with recourse to PHYSICAL PROPERTIES ARE MENTAL PROPERTIES metaphor:

2. In the physically gruelling sport of boxing where ‘brawn’ is said to rule, the most stringent demands are made upon mental agility, *speed* of thought, anticipation and sense of strategy...

Second, in the semantic projection of *سرعة* (*sur‘a*) to ‘credulity’ in the compound *سرعة تصديق* (*sur‘at taṣḍīq*), where *تصديق* means ‘believing’, PHYSICAL QUICKNESS (physical quality) (source domain) is mapped onto MENTAL QUICKNESS, which is a mental quality, that is, quickness and simplicity of believing (target domain):

3. ..وتبدت مظاهر اليأس في صور شتى، منها: سرعة تصديق كواذب الأخبار...
...wa tabaddat maẓāhiru lya'si fī ṣuwarin shattā, minhā: sur'at taṣdīqi kawāḍiba l'akhbār...
...the phenomenon of despair occurred in various forms, including credulity in believing false news...

The semantic expansion of *speed*, in contrast, is motivated by conceptual metonymy and metaphor. The meaning extension to 'gear' is motivated by MOTION FOR INSTRUMENT conceptual metonymy, or more precisely MOTION SCALE FOR VEHICLE MECHANISM metonymy as SPEED (the rate of movement) stands for GEAR (mechanism for transmitting movement, or rather instrument producing movement)⁶:

4. Would I get better fuel consumption by replacing this with a four-*speed* auto box and if so how can this be done?
5. Braking is done on the high *speed gears* [in compounds], not on the slower-turning output shafts, he explains.

To express the meaning of 'a gear box', compared with English, dictionaries generally use صُنْدُوقُ التُّرُوسِ (*ṣundūq t-turūs*) (*Mu'jam al-lughā al-'Arabiyya al-mu'āsira* [29]; *The Hans Wehr Dictionary of Modern Written Arabic* [32] or عُلْبَةُ التُّرُوسِ (*'ulbatu t-turūs*) [34]. However, the *ArabiCorpus* cites cases where gear is associated with SPEED:

6. ...الاقلاع المتكرر للسيارات الشاحنة التي تنوء بحمولة ثقيلة يؤدي الى تعطل علبة السرعة...
...al-iqlā'a l-mutakarrira lis-sayyārāti sh-shāhinati l-latī tanū'u biḥamūlatin ṭaqīlatin yu'addī ilā ta'aṭuli 'ulbati s-sur'a...
...the frequent departures of lorries carrying heavy loads cause the malfunction of the gear [speed] box...

In photography, the word *speed* also means 'the light-gathering power'. This sense is metaphorically extended as MOTION SCALE (the rate of movement or speed) (source domain) is mapped onto POWER (the amount of light that is let in through the lens, reaching the camera sensor) (target meaning). A fast lens lets in more light to the sensor, whereas a slow lens lets in less light. The speed of a camera lens, then, is conceptualized in terms of controlling exposure. It seems also that this semantic projection is motivated by MOTION SCALE FOR LENS SYSTEM RATIO metonymy. The 'light-gathering power' of a lens is conveyed in terms of its f-number. This number is a numerical measure of lens speed, that is, the ratio of the focal length to the diameter of a (camera) lens system. Thus, MOTION SCALE (the rate of movement) stands for FOCAL RATIO. The *BNC* cites a number of examples with this meaning:

7. ...it was very bright on the water and perhaps the film *speed* was too high.

Lastly, the meaning projection of *speed* to 'an amphetamine drug', a stimulant taken to treat sleep disorder and attention deficit disorder, can be explicated in terms of MOTION IS FORCE metaphor. This is because amphetamine temporarily speeds up the functions of the brain as well as the body, keeping one awake and increasing their energy; therefore, this substance exerts force on a patient's body.

8. She overdosed on some kind of *speed*.

English *velocity*, in contrast, has only one semantic extension: from 'speed of motion, or the rate at which something occurs', a concrete sense that can easily be measured, to an abstract meaning in the scientific domain. Though *velocity* and *speed* overlap in the meaning of 'the rate at which something happens', they are totally different concepts in scientific terminology. Unlike *velocity*, *speed* is a magnitude which informs about how rapidly an object is moving and does not tell anything about the direction of motion. Overall, *speed* is a scalar quantity, while *velocity* is a vector quantity.

5. Discussion

The polysemy of سُرْعَة (*sur'a*), *speed* and *velocity*, the structure of these radial categories and the cognitive mechanisms that govern the meaning extension of the categories were analysed in the current study to gain insight into the conceptualization of SPEED and VELOCITY in Arabic and English. The results of the three levels of analysis that were carried out suggest that the meaning expansion of سُرْعَة (*sur'a*) is mainly motivated by PHYSICAL PROPERTIES ARE MENTAL PROPERTIES conceptual metaphor. This contrasts

with the meaning projection of English *speed*, which is motivated by MOTION FOR INSTRUMENT conceptual metonymy, MOTION SCALE IS POWER conceptual metaphor and MOTION IS FORCE conceptual metaphor. The term *سُرْعَة* (*sur'a*) can be understood in relation to MOTION as in 'rapidity', PERSONALITY ATTRIBUTE/INTELLIGENCE as in 'agility' and PERSONALITY ATTRIBUTE/ TRUST as in 'credulity'. In comparison, the term *speed* can be understood with regard to the concept of MOTION as in 'rapidity', VEHICLE MECHANISM as in 'gear', POWER as in 'the light-gathering power' and FORCE as in 'an amphetamine drug'.

The results of the analysis also show that the polysemy or the radial subcategories of both categories *سُرْعَة* (*sur'a*) and *speed* are basically expanded from the central prototype PHYSICAL QUICKNESS or MOTION SCALE. This, in other words, means that the notion of the rate of movement is active in all the metaphorical and metonymical extensions of the terms under study. This postulate is substantiated by the data retrieved from the *ArabiCorpus* and the *BNC*, which demonstrate that the prototype of both *سُرْعَة* (*sur'a*) and *speed* is SCALE. This provides evidence for the overlapping conceptualization of SPEED and VELOCITY. People learn about motion through their interaction with the world around them. They see the movement of a bird as it takes off, flies and alights in a tree, the movement of a vehicle as it speeds up, slows down or stops, and so on and so forth. The most dominant perception of motion in everyday life is related to speed, or more specifically, the magnitude of how fast an object moves, rather than velocity that represents both the magnitude and direction of speed. For instance, when someone who is a layman of science or physics runs around a track, their main concern is most probably about the rate at which they cover a distance in an amount of time, and not displacement, and so on.

The analysis of the words in Arabic and English suggests that both Arabic and English learners face problems in understanding the concepts of SPEED and VELOCITY given the gap between their prior knowledge of the concepts concerned and their scientific denotations. Arabic speakers only use the lexical unit *سرعة* (*sur'a*) in association with rapidity and speed in everyday language and non-scientific language. The use of the compounds *السرعة القياسية* (*speed*) and *السرعة المتجه* (*velocity*) are only used in scientific contexts. In the same vein, the English lexical items *speed* and *velocity* are interchangeable in everyday speech as speed or rather the magnitude of how fast dominates in conceptualizing the concept of motion. In scientific language, on the contrary, speed is only one component of velocity, that is, magnitude, given that velocity involves the measure of both speed and direction. Consequently, both Arabic and English speakers conceptualize *speed* and *velocity* as a scale or the rate at which something occurs, which conflicts with the scientific meanings of *speed* and *velocity*. In this context, Arabic and English speakers' prior knowledge of these terms may distort their scientific meaning and so may lead to their confusion and failure to make progress in learning such concepts.

6. Conclusion

The results of the analysis suggest that Arabic *سُرْعَة* (*sur'a*) and English *speed* both converge and diverge. They also indicate that the concepts SPEED and VELOCITY overlap in both Arabic and English everyday and non-scientific language. Consequently, Arabic and English learners' prior knowledge of these terms is conceptualized in terms of SCALE. The findings of the current study support the postulate that students' conceptualization and understanding of words used in everyday language may not always be in consonance with those of scientific terms and so cause difficulty in learning the terms.

It is therefore recommended that academics and material developers explicitly elaborate on the differences between everyday speech and scientific terminology. This will not only alert students to the reality of the use of the words but also enrich their understanding of how language works in different contexts and domains. The focus, therefore, is not just on the scientific content but also on the approach to teaching science that is sympathetic to students' cognitive load and cultural background and understanding.

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