The influence of Prior Knowledge on Learning Scientific Terminology: A Corpus-based Cognitive Linguistic Study of ACCELERATION in Arabic and English

Hicham Lahlou
Department of English Language Studies, School of Humanities,
Universiti Sains Malaysia, Penang, Malaysia

Hajar Abdul Rahim
Department of English Language Studies, School of Humanities,
Universiti Sains Malaysia, Penang, Malaysia

Abstract
The current paper expands on previous work done on the influence of learners' language and pre-existing knowledge on understanding physics terminology by exploring the concept of ACCELERATION in Arabic and English. The study attempts to answer two questions: (1) what are the similarities and differences between the polysemy of Arabic تَسَارُع (tasāruʿ) (acceleration) and the polysemy of English *acceleration*, and (2) to what extent do prototypes and factors motivating the conceptualization of تَسَارُع (tasāruʿ) and the conceptualization of *acceleration* converge or diverge? To this end, Arabic and English dictionaries and corpora, the *ArabiCorpus* (Arabic Corpus Search Tool) and the *British National Corpus* (BNC), were employed. The dictionaries were surveyed to explore the various meanings of تَسَارُع (tasāruʿ) and *acceleration*, while the *ArabiCorpus* and the *BNC* were employed to investigate the senses and to identify the most frequent collocates and so the prototypes of these terms. The meaning extension of the terms is examined on the basis of the cognitive mechanisms which appear in the corpora. Theoretically, the paper is informed by the prototype theory (Rosch, 1973; 1975), image schemas (Johnson, 1987), and conceptual metaphor (Lakoff & Johnson, 1980/2003). The results show that تَسَارُع (tasāruʿ) (acceleration) and *acceleration* generally overlap in terms of polysemy, prototype, and images schemas as well as conceptual metaphor that organize the conceptualization of these terms. It was also found that both Arab and English speakers mix ACCELERATION up with SPEED and so misunderstand them in a scientific setting. The present findings have several implications for science curriculum design, education, and research on universal and culture-specific properties of language.
Keywords: acceleration, conceptual metaphor, image schemas, polysemy, prototype

Introduction

Learners' misconceptions of science terminology is a primary concern in science education worldwide. Current research in this area indicates that language, among others, is the primary source of learners' misunderstanding of scientific concepts (e.g., Whorf, 1956; Jones, 1983; Cobern, 1996; Aikenhead, 2001; Lahlou & Hajar, 2012; 2016; Lahlou, 2019). In the western context, the challenges in learning science stem mainly from the gaps between everyday speech and scientific terminology. In non-western countries, in contrast, the difficulties faced by learners are compounded by the differences between western and non-western languages as well as between everyday speech and scientific terminology.

Scientific terms that are also used in everyday language often present difficulties for learners. This is because learners' prior knowledge of the words, which is anchored in their bodily, social, and cultural background, often differs from the scientific understandings of the terms. Previous research on learners' misconceptions of scientific terms, like *speed*, *nature*, and *energy*[i], shows that there exists a considerable gap between learners' pre-existing knowledge of these terms and their scientific meaning (e.g., Jones, 1983; Cobern, 1996; Ng & Soo, 2006; Lahlou, in press). Learners' alternative conceptions that are inconsistent with scientific ideas invariably influence their learning of scientific concepts.

Despite the existing research into the influence of prior knowledge on the understanding of scientific notions, studies on the learning of key scientific terms across languages and cultures are still lacking. Besides, more research on the issue of learners' misconceptions of scientific terminology from a cognitive linguistics perspective is needed. In cognitive linguistics, language is not an autonomous cognitive faculty that is separated from non-linguistic cognitive abilities, but rather a cognitive ability which is grounded almost directly in experience, including bodily, physical, social, and cultural experiences (Ibarretxe-Antuñano, 2004). Learners' prior knowledge, rooted in their cultural, social, and bodily experience, is the main barrier to learning scientific concepts. Therefore, an approach that takes into consideration learners' prior knowledge in studying the misconceptions of scientific terminology will shed light on the issue from a cognitive linguistics perspective.

The current paper builds on earlier works on the impact of language, culture, and cognition on learners' conceptualization of physics terminology. The study focuses on a critical element of MOTION, that is, ACCELERATION, in Arabic and English. Trowbridge and McDermott (1981) found that learners confuse *velocity* with *acceleration*. Jones (1983) discovered that most learners assume that *speed*, *velocity*, and *acceleration* are the same. The learners' confusion over these crucial components of MOTION in these studies shows the seriousness of the problem and the urgent need for extensive research on the diverse physics terminology. Thus, it is essential to detect the differences between everyday speech and science terminology and between non-western physics terms and their western equivalents. The limited number of studies published on misunderstanding the concept of ACCELERATION and the lack of research on this issue in Arabic are the main motivation for this paper.

The main objective of the present study is to compare and contrast the conceptualization of تَسَارُع (tasāruʿ)[ii] with that of *acceleration*. More precisely, the current paper aims to address the following questions:

1. What are the similarities and differences between the polysemy of تَسَارُع (tasāruʿ) and the polysemy of *acceleration*?
2. To what extent do prototypes and factors motivating the conceptualization of تَسَارُع (tasāruʿ) and the conceptualization of *acceleration* converge or diverge?

The findings will have significant implications for science curriculum design and education. Also, they will contribute to the field of cognitive linguistics with new knowledge on the universal and culture-specific use of image schemas and conceptual metaphors in Arabic and English.

Theoretical Framework
Human beings learn about reality and communicate meanings, thoughts, and emotions through language. Therefore, language reflects the world as humans view it. In cognitive linguistics, language is considered as one of the cognitive mechanisms that help an individual decipher reality, and so it may have some influence on individuals' concepts (Evans, 2011). It is an integral part of other general cognitive faculties that permit mental processes like attention, reasoning, and memory. Language is symbolic in nature, but it is not arbitrarily structured. Instead, it is "motivated and grounded more or less directly in experience, in our bodily, physical, social, and cultural experiences" (Ibarretxe-Antuñano, 2004, p. 7). It is worthy of note that an individual's conceptual system is grounded in his or her direct physical experience, but such direct experience is intertwined with culture. Lakoff & Johnson (1980/2003) illustrates this in the following:

> Cultural assumptions, values, and attitudes are not a conceptual overlay which we may or may not place upon experience as we choose. It would be more correct to say that 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. (p. 58)

Within this framework, a lexical unit does not have meaning, but it contributes to the process of meaning construction, happening at the conceptual level.

> Words don't have 'meanings' in and of themselves. Rather meaning is a function of the utterance in which a word is embedded, and the complex processes of lexical concept integration,… they serve as points of access to larger-scale encyclopedic knowledge structures, which are potentially vast in scope. (Evans, 2006, pp. 492-493)

Thus, a lexeme is not a container of meaning but rather provides access to encyclopedic knowledge, which comprises a non-linguistic information network. This background knowledge is grounded in humans' physical, social, and cultural experiences. A lexical item is an access point to a cognitive structure. "The entity designated by a symbolic unit can...be thought of as a point of access to a [cognitive] network" (Langacker, 1987, p. 163).

From a cognitive linguistics perspective, image schemas and conceptual metaphors are underlying cognitive mechanisms that help structure humans' conceptual systems. An image schema can be defined as an abstract representation that comes from a person's regular interaction with and observation of the world around him or her. Image schemas seem to be the knowledge network that originates from pre-conceptual embodied experience. The image schema for the notion of force, for example, derives from humans' experience of acting upon other things or being acted upon by them. An individual experiences force once he or she goes in an unfamiliar dark room and hits the edge of the table, or overeats and feels the ingested food pressing outwards on their tightly stretched stomach (Johnson, 1987, p. 43). From early childhood, a concept is redescribed from perceptual experience through the process of perceptual meaning analysis, which gives rise to an image schema. So even though concepts are stable cognitive entities, they are modified by constant episodic and recurrent experiences (Evans, 2007, p. 31). Image schemas strongly support the idea that abstract reason involves two basic things: "(a) reason based on bodily experience, and (b) metaphorical projections from concrete to abstract domains" (Lakoff, 1987, p. 275).

In cognitive linguistics, metaphor is not only a device in poetics but also in ordinary language. Within Aristotle's theory of metaphor, metaphor is a device in rhetoric and poetics employed to convince. It is related to implicit comparison, in contrast to simile, which is associated with explicit comparison using *like* or *as*, as in 'Achilles is brave, like a lion'. In a corresponding example, 'Achilles is a lion', Achilles is identified with the attributes of a lion, like courage (Evans & Green, 2006, p. 293). The metaphor in this context is not based on physical resemblance but on cultural knowledge that views a lion as brave. This type of metaphor is known as resemblance metaphors (Grady, 1999, as cited in Evans & Green 2006, p. 293). Grady (1999) concludes that metaphors are anchored in experiential correlations and not in similarities. Lakoff and Johnson (1980/2003) state, "Grady showed that complex metaphors arise from primary metaphors that are directly grounded in the everyday experience that links our sensory-motor experience to the domain of our subjective judgments" (p. 255). For instance, the primary metaphor AFFECTION IS WARMTH is not grounded in similarities between affection and warmth, but in early humans' experience as children are held tightly by their parents, experiencing warmth, affection, and nurture (Johnson, 2010; Lakoff & Johnson, 1980/2003).

A metaphor is a conventional association of one domain with another domain. It is conceptual as the motivation for metaphor happens at the conceptual level (Lakoff & Johnson, 1980/2003). For example, in an everyday English expression like *We're at a crossroads*, love relationship is understood with reference to journeys; in other words, JOURNEYS (source domain) are metaphorically mapped onto LOVE (target domain).

Metaphor is prevalent in language, thought, and action as hypothesized by cognitive linguistics. Lakoff & Johnson (1980/2003) claim that humans' "ordinary conceptual system, in terms of which we think and act, is fundamentally metaphorical in nature" (p. 3). Therefore, metaphors are conceptual, while expressions that are metaphorical are only instantiations or linguistic realizations of conceptual metaphors (Lakoff & Johnson, 1980/2003). Conceptual

metaphor constructs human understanding, and the metaphor source domains are based on humans' bodily and sensory-motor experience, which develops into the source of conceptualization and reasoning (Johnson, 2008).

Methodology
Given the theoretical background to the study discussed above, the current research is informed by the prototype theory (Rosch, 1973; 1975), image schemas (Johnson, 1987), and conceptual metaphor (Lakoff & Johnson, 1980/2003). The prototype theory (Rosch, 1973; 1975) is used to find the most prototypical meanings of Arabic تَسَارُع (tasāruʿ) and English *acceleration*. Image schemas (Johnson, 1987) and conceptual metaphor (Lakoff & Johnson, 1980/2003) are used to discover the central cognitive mechanisms that help structure Arabic and English speakers' conceptualization of ACCELERATION.

To answer the research questions, a comparative analysis of the polysemy of the word تَسَارُع (tasāruʿ) and its English equivalent *acceleration* was conducted, using a set of selected Arabic and English dictionaries. Out of the many dictionaries that were surveyed, two main dictionaries were chosen for the semantic analysis of the terms, namely *Muʿjam al-Lugha al-ʿArabiyya al-Muʿāsira* (2008), and *Collins Cobuild English dictionary* (1987). Only these highly comprehensive dictionaries were chosen to avoid redundancy as the majority of the meanings are listed in all the dictionaries consulted. Furthermore, two comparable corpora were used: the *ArabiCorpus (Arabic Corpus Search Tool)* and the *British National Corpus* (*BNC*). The use of these corpora is pertinent to the objective of this paper because of two main reasons. First, corpora assist in discovering the various senses, including metaphorically extended meanings, and examples of lexical units on the basis of more up-to-date real examples of language. Second, they help in identifying the frequency of occurring collocates (Bowker & Pearson, 2002). Though linguistic frequency is not the source of prototypicality, it can assist in classifying the most prototypical meanings of lexical units. Linguistic occurrence can be utilized to identify typical members of a category (Geeraerts, 2006; Rosch, 1975).

The data on تَسَارُع (tasāruʿ) were collected from the *ArabiCorpus* (173.600.000 words), which mainly comprises newspapers, pre-modern text, modern literature, and non-fiction. The data on *acceleration* were collected from the *BNC* (100.000.000), consisting of spoken, fiction, magazines, newspapers, and academic, and so forth. The corpora are comparable because both of them are beyond the minimal size of a standard corpus, which needs to consist of ten million words and over (O'Keeffe et al., 2007; O'Keeffe & McCarthy, 2010). Moreover, the two corpora are similar in terms of language variety as they contain a considerable range of kinds of data, including newspapers, fiction, non-fiction, spoken and written types of language.

The data analysis consists of three main steps. First, Arabic and English dictionaries were surveyed to explore the diverse meanings of تَسَارُع (tasāruʿ) and *acceleration*. Second, the prototypes of these terms are categorized based on their frequency, which is retrieved from the *ArabiCorpus* and the *BNC*. Third, the meaning projection of the terms is examined on the basis of the cognitive mechanisms which appear in the corpora.

Findings and Discussion
The Polysemy of تَسَارُع *(tasāruʾ) and acceleration*
Acceleration is one of the most predominant themes and concepts in physics, especially in mechanics. The term has been translated as تَسَارُع(tasāruʾ) in Arabic. Both Arabic تَسَارُع(tasāruʾ) and English *acceleration* are polysemous. Morphologically, the word تَسَارُع(tasāruʾ) (acceleration) and سُرعَة (surʾa) (speed) have the same derivation. The noun تَسَارُع(tasāruʾ) may have originated from the verb تَسَارَع(tasāraʾa) or سَارَع(sāraʾa) (to hasten or move faster). The term تَسَارُع(tasāruʾ) has the meaning of 'the act of increasing the speed or moving faster' *Muʾjam al-lugha al-ʿArabiyya al-muʿāsira* (2008). In physics, it denotes 'speed increase or the rate of this increase' (*Al-Mawrid Al-Hadeeth: A Modern English-Arabic Dictionary*, 2013). The term *acceleration* similarly has the senses of 'the rate at which the speed of an object increases', 'the rate at which a vehicle can increase its speed' and 'the process of getting faster and faster' *Collins Cobuild English dictionary* (1987).

Based on the Arabic and English dictionaries as we as well as corpora, it seems then that تَسَارُع(tasāruʾ) and *acceleration* share all the meanings. Firstly, they denote 'the rate at which the speed of an object increases', or rather 'the rate at which the velocity of an object changes':

1. إن القوة المؤثرة على جسم ما تساوي كتلة ذلك الجسم مضروبة في تسارعه. [iii]
Inna l-quwwata l-muʾattirata ʿalā jismin mā tusāwī kutlatu dālika l-jismi maḍrūbatun fī tasāruʿih
The force acting on an object equals the mass of that object times its acceleration.

2. Now if we wish to use Newtonian mechanics we must relate velocity and *acceleration* to the same particle.
Secondly, they both mean 'the rate at which a vehicle can increase its speed':

3.
...يستخدم الثالث (low) في المنحدرات للجم دوران المحرك و المساهمة في خفض تسارع السيارة.

t-tālitu (low) fī l-munḥadarāti lilajmi dawarāni lmuḥarriki wa l-musāhamati fi yustaḥdamu

ḥafḍi tasāruʿi s-sayyāra

...the third (low) is used downhill to limit motor rotation and contribute to the reduction of car acceleration.

4. ...the practical desirabilities of a car, and the *acceleration* and performance and looks are very important...
Finally, they both have the meaning of 'the process of getting faster and faster, or an increase in the rate of a process or change':

5. ...من المفترض أن يرى حوالى 900 مليون من مواطني القارة الافريقية تسارعا ملحوظا في نمو دخلهم،
بفعل التغيرات الاقتصادية المرتقبة.
…mina l-muftaraḍi an yarā ḥawālay 900 milyūn min muwāṭinī l-qārrati l-ifrīqiyati
tasāruʿan malḥūẓan fī numuwwi daḫlihim, bifiʿli t-taġayyurāti l-iqtiṣādiyati l-murtaqaba.

… It is believed that about 900 million Africans see clear *acceleration* in their income growth due to the expected economic changes.

6. Corresponding to the dramatic *acceleration* in the stock of money was an equally dramatic *acceleration* in the rate of inflation.

The Prototypes of تَسَارُع (tasāruʿ) and acceleration
The concordance sets of تَسَارُع (tasāruʿ) and *acceleration*, generated from the *ArabiCorpus* and the *BNC*, were examined to identify their most frequent collocates and most prototypical meanings. As seen in Figure 1, the corpus-based collocational analysis shows that the most frequent collocates of تَسَارُع (tasāruʿ) are وَتِيرَة (watīra) (pace)[iv] (80), النُّمُو (al-nnumuw) (the growth) (63), الأَحْدَاث/(al-ʾaḥdath) (the events) (48), الحُكُومَة (al- ḥukūma) (the government) (47), and القَلْب(al-qalb) (the heart) (37).
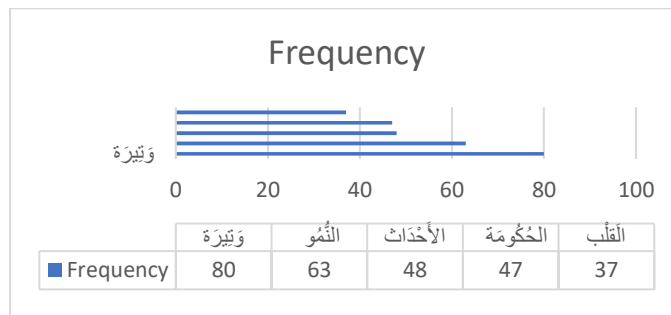

Figure 1 The Most Frequent Collocates of تَسَارُع

The most prototypical meaning of تَسَارُع (tasāruʿ), therefore, is 'an increase in the rate of a process or change'. Examples showing this sense in the corpus data extracted are associated with political, educational, scientific, and economic changes. The subsequent recurrent collocates: النُّمُو (al-nnumuw) (the growth), الأَحْدَاث (al-ʾaḥdāth) (the events), and الحُكُومَة (al- ḥukūma) (the government) support the afore-mentioned prototype as they all refer to an increase in economic growth, and political change as well as development. The fifth most frequent collocate القَلْب(al-qalb) (the heart), in comparison, shows the association of acceleration with the heart rate as the heart beats faster.

In comparison with تَسَارُع (tasāruʿ), the most recurrent collocates of *acceleration*, as highlighted in Figure 2, are *rate* (26), *deceleration* (20), *velocity* (18), *constant* (16) and *rapid* (15).
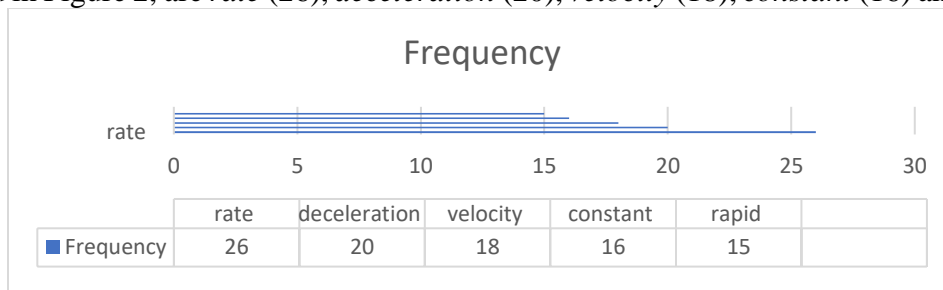

Figure 2 The Most Frequent Collocates of *acceleration*

In the context of the citations retrieved, the most frequent collocate of *acceleration*, *rate*, relates to scientific concepts like velocity, speed, and deceleration in some cases; in others, it is associated with economic, political and social changes. The following frequent collocates: *deceleration*, *velocity*, and *constant* are prevalent in the scientific domain. The fifth most recurrent collocate moderately relates to economic, political, and industrial development.

In sum, the most frequent collocate of تَسَارُع (tasāruʿ) is *pace*, showing that the most prototypical meaning of تَسَارُعis 'an increase in the rate of change'. In contrast, the most frequent collocate of *acceleration* is *rate*, indicating that the most prototypical meaning of *acceleration* is 'the rate of change or increase in velocity' in science and 'an increase in the rate of change' in non-scientific contexts. Despite the presence of the scientific denotation in the most recurrent collocate of *acceleration*, that is, *rate*, تَسَارُع(tasāruʿ) and *acceleration* have the same prototypical meaning in non-scientific language: 'an increase in the rate of change'. More importantly, given that the main concern of the present analysis is how the concept of ACCELERATION is conceptualized by Arabic and English speakers, comparing the use of the concept in everyday and non-scientific contexts with its use in a scientific setting is essential. Thus, the most prototypical meaning of *acceleration* in non-scientific language, 'an increase in the rate of change', is considered in the analysis as it better represents speakers' pre-existing knowledge of ACCELERATION.

The prototypicality of the sense of 'an increase in the rate of a process or change' suggests that Arab speakers conceptualize ACCELERATION as a matter of speeding up. This stems from their knowledge of the term تَسَارُع(tasāruʿ) in Standard Arabic, which they learned through literary texts, newspapers, and so on. The word تَسَارُع(tasāruʿ) is not used by Arab interlocutors in everyday life. Instead, the word سُرعَة(surʿa), from which the word تَسَارُع(tasāruʿ) is derived, is used in everyday speech. English speakers, similarly, relate the concept of ACCELERATION to increasing speed in everyday speech. More details on this conceptualization will be provided in a later subsection.

Image schemas
The data on the polysemy and prototypes of تَسَارُع(tasāruʿ) and *acceleration* show that they are both pervasively conceptualized in terms of SCALE schema in non-scientific contexts. Within this schema, they both seem to comprise an increase in the amount of speed. They can also be understood through VERTICALITY schema; in other words, comprehending تَسَارُع(tasāruʿ) and its English equivalent requires the activation of a schema which consists of *up* and *down* relations.

In everyday speech, speed is either high or low, representing a sort of vertical scale. It is not surprising then that there is an association between SCALE schema and VERTICALITY schema. In other words, VERTICALITY helps in structuring people's conceptualization of AMOUNT. The correlation of these structures is anchored in humans' experience (Johnson, 1987). The preconception of *acceleration*, in contrast, is framed by the upper end of the scale as it is only conceived as 'speeding up'. Arabic and English speakers seem to connect the concept of ACCELERATION with vertical scale. However, in everyday speech, VERTICALITY SCHEMA, which provides understanding of *acceleration*, only embodies an upward vertical motion, implying an

increase in speed, as shown in Figure 3. In this speed-time graph, acceleration is indicated by the line which has a slope directed upwards, showing that the object is speeding up.
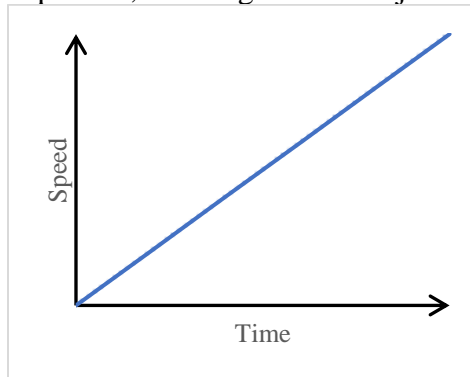

Figure 3 Preconception of *acceleration*

Arabic and English native speakers understand *acceleration* as 'high speed'. An Arabic speaker would automatically base his or her understanding of *acceleration* on سُرعَة(surʿa) (speed). This is because تَسَارُع(tasāruʿ) (acceleration) is usually used in Standard Arabic, very rarely in everyday speech, it is derived from the word سُرعَة(surʿa) (speed) as mentioned before, and it only denotes 'an increase of speed' in Standard Arabic. Given this, it would be very challenging for an Arabic interlocutor to view تَسَارُع(tasāruʿ) as negative acceleration (or deceleration). For instance, he or she may misunderstand example 3. In this instance, the low gear is used while driving down a hill to engage the engine braking and so to slow the car. Acceleration in this context is negative, i.e., deceleration or decrease in speed. This conflicts with an Arabic speaker's conceptualization of *acceleration* as speakers view it as positive, not negative. In a context like example 7, however, their background knowledge of *acceleration* would be useful. *Acceleration* in this example is positive as it denotes the rate of increase in the speed of the car as it overtakes another vehicle.

7.   ...وضعية السيارة، أي وزن حمولتها وسرعتها ونسبة *التسارع* عند التجاوز مثلاً...
…wadʿiyatu s-sayyāra, ay waznu ḥumūlatihā wa surʿatihā wa nisbatu t-tasāruʿi ʿinda t-tajāwuzi maṭalan
…The condition of the car, i.e., the weight of its load, its speed and rate of *acceleration* when overtaking, for example...

An English interlocutor similarly sees *acceleration* as positive, not negative. His or her pre-existing knowledge of *acceleration* can be useful in non-scientific contexts, as in example 4. In this instance, acceleration is positive as it refers to the fast speed of the car. Consequently, speakers confuse *acceleration* and *speed*, which is relevant in a non-scientific setting but irrelevant in science classes. That English speakers mix acceleration up with speed may be due to the use of the phrase *accelerator pedal* in a car (Jones, 1983, p.101). Jones (1983) came to this conclusion because, in his study of learners' understanding of speed, velocity and acceleration, many respondents perceived acceleration to be increased if the speed was increasing. For instance, in explaining a car speeding up, drawn on a card, learners supposed that increasing speed signified increasing acceleration, providing responses like "'going the same speed it's still got some

acceleration'… 'still got to keep foot on accelerator pedal to keep the same speed'" (Jones, 1983, p. 101).

The same postulate may apply to Arab speakers' conceptualization of ACCELERATION. First, a driver may press an accelerator or gas pedal with his or her foot to increase the speed of their car. As the accelerator relates to positive acceleration, so does any perception of acceleration in speakers' background knowledge; in other words, the difference between acceleration and speed is blurred, and acceleration is seen as speeding up only. Second, one of the significant features of a car that may be part of humans' communal experience of vehicles is being fast (Ungerer & Schmid 1996/2006). Thus, high speed constitutes the best member of ACCELERATION, which represents the category as a whole. More importantly, "fast moving things are generally more salient than slow moving things" (Croft, 2004, p. 171).

The pre-existing knowledge about the concept of ACCELERATION results in misunderstanding this concept in a scientific context. It is true that the meaning 'a speed increase' applies to science, but it constitutes only one aspect. In science, acceleration is a vector given that velocity is a vector quantity. It can be the outcome of a change in an object's velocity. This change can be manifested in speed increase, speed decrease, or direction change. Coming back to the example of car acceleration, a car can be accelerated by flooring the accelerator pedal, pressing the brakes, or turning the car. This perspective conflicts with an Arabic or English speaker's pre-conception that views acceleration as a positive rate of speed and a scalar quantity.

The SCALE schema and VERTICALITY schema do not only provide understanding of experience of *acceleration* in both Standard Arabic and English, but they also provide understanding of other experiences through their function as source domains in metaphor.

Conceptual Metaphor
The meaning of *acceleration*, 'an increase in the rate of a process or change', is mainly motivated by MORE IS UP conceptual metaphor. In example 5, for instance, QUANTITY, the target domain, is mapped onto VERTICALITY, the source domain; in other words, the increase in the amount of the income is understood metaphorically in terms of vertical scale. In the same vein, in example 6, the scale or increase in the amount of money stock is conceived metaphorically in terms of vertical scale. Also, the amount of growth in prices, the target domain, is structured as well as conceived metaphorically in terms of VERTICALITY schema (the source domain). Therefore, in both example 5 and example 6, VERTICALITY schema is applied to the domain of QUANTITY in the MORE IS UP metaphor. That is, the quantity is reasoned with the help of VERTICALITY schema. This perception is due to the frequent correlation between quantity and verticality in Arabic and English speakers' experience. "There are certain basic correlations of structures in our experience that give rise to metaphorical projections of this sort. When we add more of a substance to a pile or container, the level rises" (Johnson, 1987, p. 122).

Conclusion
The paper has several findings. First, تَسَارُع (tasāruʿ) and *acceleration* share all the senses. Second, they have the same prototypical meaning in non-scientific language, notwithstanding the overall dominance of the scientific meaning of *acceleration* as the scientific terminology does not form part of the pre-existing knowledge of speakers. Third, Arab and English speakers associate the concept of ACCELERATION with increasing speed in everyday speech. However, unlike *acceleration*, the word تَسَارُع (tasāruʿ) is not used in everyday speech, and so this association derives from its use in Standard Arabic, which is used in non-scientific subjects like Arabic, history and literature. Fourth, the data on the polysemy and prototypes of the terms reveal that both terms are widely conceptualized in terms of SCALE and VERTICALITY schemas in non-scientific contexts, including everyday settings. Finally, the most prototypical meaning of تَسَارُع (tasāruʿ) and *acceleration* is mostly motivated by MORE IS UP conceptual metaphor.

Taken together, these results suggest that the similarities far outweigh the differences between تَسَارُع (tasāruʿ) and *acceleration* and that both Arab and English interlocutors confuse *acceleration* with *speed*, misconceiving them in a scientific context. This provides new insights into learners' misconceptions of one of the essential components of MOTION, i.e., ACCELERATION, in Arabic and English. The present findings have important implications for science curriculum design and education. Being cognizant of the dissimilarities and their impact on learners' conceptualization of ACCELERATION helps educators better explain the possible differences, and so improve the learners' understanding of the concept. The findings also add to a growing body of literature on universal and culture-specific properties of language by examining the linguistic or rather semantic features of Arabic تَسَارُع (tasāruʿ) and English *acceleration*. Finally, the current paper contributes to the literature on image schemas and conceptual metaphor as it is the first step towards examining these mechanisms in structuring the conceptualization of تَسَارُع (tasāruʿ) in Arabic and comparing it with its English counterpart.

About the Authors
Hicham Lahlou, PhD is a Senior Lecturer in applied linguistics in the English Language Studies Department, School of Humanities, Universiti Sains Malaysia. His research interests lie within English linguistics, semantics, morphology, cognitive linguistics, corpus linguistics, and education. https://orcid.org/0000-0003-2796-9877

Hajar Abdul Rahim, PhD is a Professor of linguistics in the English Language Studies Department, School of Humanities, Universiti Sains Malaysia. Her current research interests include TESL, Corpus Linguistics, and Lexical Studies.

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[i] In this paper, lexical items are italicized, as in *acceleration*, meanings are placed in inverted commas, e.g., 'the act of increasing the speed', transliterated and translated words are placed in brackets, as in تَسَارُع(tasāruʿ) (acceleration), and concepts are denoted using small caps, as in ACCELERATION.

[ii] In this article, the Arabic words are transliterated under the recommended transliteration method used in academic studies of linguistics (Isaksson 2013).

[iii] Due to the absence of a scientific context where تَسَارُع(tasāruʿ) is used in the *ArabiCorpus*, Newton's second law of motion was given as an example.

[iv] The close equivalents in English provided here are based on the contexts of the citations retrieved from the corpora.