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Normative ratings for 536 action-related sentences in Spanish

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ABSTRACT
Familiarity, emotionality, motor activity, memorability, and vividness of visual imagery ratings, on 7-point scales, were collected for 536 Spanish action-related sentences, including a corpus of 439 phrases originally normed in Swedish, German, and Croatian (Arar & Molander, 1996; Molander & Arar, 1998; Molander, Arar, Mavrinac, & Janig, 1999) and 97 new sentences describing actions usually performed using different body postures and face or hand movements. These norms constitute the only available set of ratings for action sentences in Spanish including those dimensions to date, and they allow for the design of studies aimed at empirically exploring the relationship between action, language, and cognition with well-controlled materials in Spanish-speaking samples of participants.

Keywords: action sentences; cognition; enactment effects; ratings; Spanish norms

Most theoretical approaches in cognitive psychology have paid little attention to action and motor control, which might be contradictory given the interest of these dimensions for the study of behavior. This fact was highlighted by Rosenbaum (2005), who characterized motor control as the Cinderella of psychology. A notable exception is the embodied cognition (EC) theoretical framework, a perspective which posits that cognition is based on bodily and neural systems of perception, action, and emotion within a physical and social interaction environment (Glenberg, 2015). According to EC, the motor system and action itself play a crucial role in cognitive processes such as language comprehension and memory.

Glenberg and Robertson (1999, 2000) argued that action is a fundamental element for meaning construction and for language comprehension, because the construction of the meaning of a sentence depends on the possible actions that an individual can carry out in a given context. According to the simulation theory, which constitutes a central principle in EC, language comprehension implies constructing sensorimotor simulations of the events described in sentences, which involves the activation of the brain's systems of perception, action, and emotion, the same ones that are activated in a real situation (e.g., Glenberg, 2011). For example, Glenberg and Kaschak (2002) found that comprehending a sentence that implies action away or toward the body interferes with making a semantic judgment that requires responding with an action in the opposite direction (the *action-sentence compatibility effect*). This finding constitutes important empirical evidence in support of the hypothesis that language comprehension is based on simulation processes, in which the same neural systems involved in real action are activated.

Similarly, some studies have shown that engaging the motor system during encoding leads to better memory when the movement performed is compatible with the content of the material to be recalled (e.g., D'Argembeau, Lepper, & Van der Linden, 2008; Förster & Strack, 1997). As far as memory is concerned, Glenberg (1997) proposed that memory evolved at the service of perception and action, and argued that memory is formed by embodied representations, which are based on patterns of action, to facilitate our interaction with the environment. From an empirical perspective, it seems that action itself has a direct influence on memory (for an overview, see Madan & Singhal, 2012). One of the most remarkable examples is a well-known mnemonic phenomenon, namely, the enactment effect. Initially studied by Engelkamp and Krumnacker (1980), Saltz and Donnenwerth-Nolan (1981), and Cohen (1981), the enactment effect reflects the fact that memory for action-related phrases is better when the subject physically performs the action, in comparison with nonenacted processing of phrases. In the basic paradigm, the participants in the experimental condition are instructed to perform actions like "cut the paper" (subject-performed tasks; SPTs) and the participants in the control condition only have to read or hear the sentences (verbal tasks; VTs). Then, in a posterior free recall test, those participants who performed the actions generally obtain better memory results than those who only read or heard the sentences stating the same actions. A variation of this paradigm includes an extra experimental condition in which the participants see the experimenter perform the actions (experimenter-performed tasks), instead of performing them by themselves. Experimenter-performed tasks also have a positive impact on recall, although it is usually lower than the effect of SPTs.

Numerous replications and variations of this paradigm have shown the consistency of the enactment effect (sometimes also called SPTs effect) and its importance for the study of memory for actions, and several explanations have been proposed for this phenomenon, as reviewed in Molander and Arar (1998). According to Madan and Singhal (2012), these explanations are based on two main ideas: (a) SPTs give rise to richer and more elaborative representations compared to VTs; and (b) SPTs physically engage the motor system during the

encoding phase to a degree that VTs do not. The latter idea is aligned with positions such as those embraced by Macedonia and Knösche (2011), who suggest that enactment reinforces the connections to embodied features of the word that are present in its semantic representation, and that, alternatively, enactment can be used as a way of embodying any kind of verbal information (e.g., adding a gesture to an abstract word can enrich its representation by attaching a motor trace to it). Beyond mere encoding effects, recent evidence suggests that enactment can also have positive consequences for retrieval, making enacted memories more resistant to the interfering effects posed by dual tasks at the time of the test (Wammes & Fernandes, 2017).

It is important to note that the enactment effect has proven to be relevant for different applied purposes. For instance, it has been considered as an effective learning strategy for students (see Fiorella & Mayer, 2015), so much so that intervention programs based on the involvement of physical action during reading have been developed to enhance children's reading comprehension. A notable case is the Moved by Reading program (Glenberg, 2011; Glenberg, Goldberg, & Zhu, 2011; Glenberg, Gutierrez, Levin, Japuntich, & Kaschak, 2004), which demonstrated that both physical and imagined manipulation of concrete objects leads to better memory and comprehension of text. More recently, Kaschak, Connor, and Dombek (2017) have developed a comparable intervention program called Enacted Reading Comprehension, which uses hand and arm gestures to represent abstract concepts in order to improve the comprehension of abstract content texts. In addition, Macedonia and Knösche (2011) found that gesturing is also useful to enhance word learning in a foreign language. Furthermore, some authors have shown how the enactment effect in a SPTs paradigm can yield benefits for patients with memory-related clinical conditions, such as dementia of the Alzheimer type (e.g., Hutton, Sheppard, Rusted, & Ratner, 1996) or transient global amnesia (Hainselin et al., 2014).

Studying enactment effects requires the use of carefully constructed verbal materials, usually sentences describing actions, carefully chosen so that they are adequate for the specific research questions under considerations. This implies, therefore, that a complete description of the properties of the sentences is necessary for researchers to be able to implement particular manipulations and to control other variables with known mnemonic value, such as familiarity or emotionality. Most normative studies of verbal materials provide information for single words or pairs of words (for a review, see Proctor & Vu, 1999; Vaughan, 2004). However, the number of normative studies using sentences as stimuli is much lower. Addressing this need, in their seminal study, Molander and Arar (1998) obtained ratings for 439 action-related Swedish sentences, providing also their translations into English (e.g., "to bite an apple" and "to fly a kite"), in the dimensions of familiarity, emotionality, motor activity, and memorability. Their set of stimuli included, among others, all the sentences used by Cohen (1981), which were considered particularly important as they have been used by many experimenters. Likewise, there are also ratings available for this set of 439 sentences in German (Molander, Arar, Mavrinac, & Janig, 1999) and Croatian (Arar & Molander, 1996), and a selection of 166 sentences were normed in Portuguese

(Freitas & Albuquerque, 2007). Widely accepted as reference materials, these norms have already been used by several researchers to study enactment effects and memory for action phrases (e.g., Feyereisen, 2009; Kubik, Söderlund, Nilsson, & Jönsson, 2014), and also in other lines of research using the enactment effect paradigm to study different topics such as developmental amnesia (Brandt, Gardiner, Vargha-Khadem, Baddeley, & Mishkin, 2006; Gardiner, Brandt, Vargha-Khadem, Baddeley, & Mishkin, 2006). However, to our knowledge, there are no similar norms for action sentences in the Spanish language.

For this reason, the purpose of this study was to collect ratings and provide normative data for a broad set of widely used action sentences, making possible the future design of empirical studies with well-controlled action-related materials in Spanish. In addition, the availability of these norms in several languages, including Spanish, will be useful for the development of cross-linguistic research projects. Specifically, this kind of normative studies will make it possible for researchers to analyze action-related cognitive processes from a broader perspective, taking into account possible differences and similarities at linguistic and cultural levels. In this sense, it is expected that embodied cognition theories, which grant a fundamental role to action in explaining cognition, will benefit greatly from the availability of this type of norms.

As an example of a potentially important issue that reflects disparities between languages, it is interesting to note that languages vary in the way they encode motion path. Germanic languages, such as English and Swedish, are satellite-framed languages. This means that motion verbs mostly use particles to reflect the path of motion (e.g., *go out*) and usually describe manner of motion. In contrast, Romance languages, such as Spanish, are verb framed. That is, in this type of languages, verbs mostly encode motion path within themselves (e.g., *salir*) and do not include manner of motion information or they express it in an optional alternative way (e.g., *salir corriendo*; Talmy, 1991). In relation to this, Perry, Perlman, and Lupyan (2015) showed that Spanish verbs have a lower degree of iconicity (i.e., resemblance between words' sound and their meaning) than English verbs. These authors suggest that this is because Spanish verbs, as pertaining to a verb-framed language, tend to describe manner of movement less expressively. This type of specific characteristics of languages may need to be considered when designing experiments in the context of embodied cognition, because they might facilitate or interfere in the formation of sensorimotor simulations of the events described in a given sentence. Thus, cross-linguistic studies can also serve to help describe how the idiosyncratic peculiarities of languages affect cognitive processes such as language processing and memory, as well as shed some light on the intrinsic influence of verbal materials on the effects studied in a variety of psychology experiments.

The four dimensions rated in Molander and Arar's (1998) study were familiarity, emotionality, motor activity, and memorability. Familiarity is defined by these authors in terms of the frequency of occurrence, that is, the ratings express how familiar or frequent an action is in anyone's own experience, and it has been shown to have a considerable influence on memory of SPTs and VTs. For instance, Knopf (1991) showed that free recall of actions is enhanced when

encoding highly familiar items in both SPTs and VTs, and that performance in recognition tasks is better for unfamiliar actions in VTs (see Knopf & Neidhardt, 1989). Emotionality, in this case, reflects the intensity of the emotion elicited by an action, regardless of the kind of emotion concerned, and must also be taken into account when designing memory experiments, because several studies have demonstrated the relation between emotional arousal and memory enhancement for both positive and negative emotional stimuli, compared to neutral stimuli (for a review, see Hamann, 2001). In addition, research on sentence-comprehension processes has shown that using emotionally loaded phrases can be of great help in identifying basic muscular activity patterns involved in the understanding of emotional messages (Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2010). Motor activity, as its name suggests, is a dimension that represents the amount of motor activity that an action implies, and it seems to be an important variable for studying enactment effects, because the main difference between SPTs and VTs is the action performance itself. Consequently, it is expected that higher degrees of motor activity lead to better performance in recall tests. This is consistent with a study by Cohen and Bryant (1991), who found that longer SPTs were recalled better than shorter ones. The amount of motor activity conveyed by verbal statements has also been shown to be a relevant indicator of the language-processing abilities in patients who experience difficulties when planning and executing movements (Herrera, Rodríguez-Ferreiro, & Cuetos, 2012). Finally, memorability is described as the estimated ease with which an action can be remembered over time. More specifically, participants assigned to this dimension had to rate how easily they would remember an action if they were to perform it. It is considered that this variable can provide additional information about the probability of remembering a certain item. Moreover, as suggested by Molander and Arar (1998), this variable may be particularly interesting for studying metamemory for actions (Cohen, 1988; see also Carroll, Mazzoni, Andrews, & Pocock, 1999).

It is then clear that the aforementioned variables not only modulate cognitive processes such as language comprehension and memory in a general way but also play a specific modulating role in memory for action events. Therefore, to achieve optimal scientific validity, these variables should be taken into consideration when studying the enactment effect in a SPT paradigm, as well as other effects related to action, memory, and cognition. In this sense, the ratings provided in the present study allow for the possibility of controlling and manipulating these variables in experimental procedures.

In addition to the four dimensions studied by Molander and Arar (1998), in the present study, we also collected ratings for a new variable, namely, vividness of visual imagery (Marks, 1973), which describes the extent to which an action can be imagined creating a vivid and realistic mental image. In 1973, Marks developed the Vividness of Visual Imagery Questionnaire (VVIQ),[1] an instrument to measure individual differences in the vividness of experienced visual imagery, and demonstrated that participants scoring higher in this subjective dimension were more accurate in the recall of pictures than those who scored lower. Moreover, vividness of visual imagery has also been studied as a property of the stimuli. For example, Tulving, McNulty, and Ozier (1965) obtained vividness

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ratings for 82 words using a 7-point scale, defining vividness as "the ease with which you can picture something in your mind" (p. 243). In addition, they used the words as learning materials to conduct an experiment in which they found that words scoring higher in vividness were learned more readily than words with lower vividness scores. Thus, although vividness of mental imagery can vary across subjects, it also varies across stimuli, and it has a potential impact on cognitive processing. For this reason, we considered it to be another important variable that probably needs to be controlled when studying processing and memory for action events, especially in VTs, where participants do not have access to real visual perception of the actions.

The corpus of stimuli in this study includes the 439 phrases of the study by Molander and Arar (1998), which were translated into Spanish. As in Molander and Arar's (1998) study, the present stimuli set included 10 item pairs in which basic phrases were compared to more complex phrases that included an adverbial extension (e.g., "to turn a key" and "to turn a key hesitantly"). Moreover, and given the growing interest of many researchers in studying how different aspects of cognition such as perception, language, and memory are shaped by our body and its sensorimotor interactions with the world (i.e., EC theory), we decided to include in the study two sets of new sentences that complement our corpus of stimuli, with the aim of facilitating future research on some issues studied by this theoretical approach. One set included 64 sentences describing actions that are usually performed in one of the four most common human body postures: lying, sitting, standing, and walking. Our body posture determines to a large extent the way we interact with our environment and the kind of actions that we can perform. Furthermore, as a number of studies have revealed, body posture also affects different aspects of human cognition. For example, Dijkstra, Kaschak, and Zwaan (2007) found that body posture facilitated the retrieval of autobiographical memories when those memories implied a body position that was congruent with the position adopted by the participants during retrieval, in comparison with an incongruent-posture condition. Other studies have shown how body posture can also affect emotions (Duclos et al., 1989), task persistence (Riskind & Gotay, 1982), self-evaluation (Briñol, Petty, & Wagner, 2009), or quantitative estimates (Eerland, Guadalupe, & Zwaan, 2011). The other set contained 33 sentences that described specific face or hand movements, not included in the original set provided by Molander and Arar (1998). We believe that the availability of ratings in different dimensions for sentences describing actions associated with concrete body postures or describing face or hand movements will allow cognitive researchers to conduct specific experimental manipulations and will therefore contribute to ease future research in these areas.

METHOD

Participants

A total of 389 undergraduate students at the Universities of Salamanca and La Laguna, both in Spain, participated voluntarily in the study, which required rating

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responses using a computer. The participants signed an informed consent form and received course credit for their participation. All data from 22 participants were discarded due to inadequate performance in the rating task, applying at least one of two criteria: 20 or more trials in a row with the same response, or 30 or more responses made in less than 1 s. Thus, the final sample included 367 participants, 290 female, with a mean age of 20.0 years ($SD = 2.7$; range = 17–40 years). All participants were native speakers of Spanish.

Stimuli

The 439 sentences of Molander and Arar's (1998) study were translated into Spanish by the authors,[2] who are fluent speakers of English as a second language, with the assistance of a native English speaker who was fluent in Spanish. In addition, 97 new sentences, created by the authors, were included in the study. Of these, 64 describe actions that are usually performed in specific body postures, namely, lying (e.g., "to lie on the grass"), sitting ("to play chess"), standing ("to fry an egg"), or walking ("to wander around the garden"); 17 described face movements ("to raise the eyebrows" or "to make a sad face"); and 16 described hand movements ("to rub hands" or "to make a fist").

Procedure

All data were collected using Online Ratings of Visual Stimuli open-source software (OR-Vis; Hirschfeld, Bien, de Vries, Lüttmann, & Schwall, 2010). Five separate tasks were created, corresponding to each of the five different dimensions included in the study, and each participant was randomly assigned to one of the tasks, with the only restriction of maintaining a similar proportion of male and female participants across tasks. A 7-point scale, where 1 corresponded to the lowest value and 7 corresponded to the highest value, was used to rate the dimensions. Each participant rated 268 sentences, half of the total, which were randomly selected in each case.[3] Each target sentence was rated by an average of 32 participants, with a minimum of 27 valid observations for each sentence.

The data collection was done in group sessions of 10 to 25 participants at a time, using individual computers. The participants were required to provide demographic information, to read carefully the instructions of the task on the computer screen, and to perform four practice examples. The instructions for the familiarity, emotionality, motor activity, and memorability rating tasks were obtained from Molander and Arar (1998) and translated into Spanish. Minor changes were introduced in these instructions to adapt them to the computer-based rating tool. The exact and complete instructions in Spanish used in the present study are available in the online-only Supplementary Materials (Rating_instructions.pdf).

In the case of familiarity, the English translation of the specific Spanish instructions was as follows: "One of the dimensions along which actions can vary is familiarity. Some actions are very frequent, and a majority of people have experienced them many times; others are hardly experienced by anyone. This task

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contains phrases related to actions. Your task is to rate the frequency of each of the actions described by the phrases, that is, to rate how familiar or how frequent each action is according to your own experience. Your ratings should express how often you have performed, observed, or thought about each action."

The English translation of the Spanish instructions for the emotionality dimension was as follows: "One of the dimensions along which actions can vary is emotionality. Some actions may arouse strong positive or negative feelings in you, whereas other actions give rise to weak feelings or no feelings at all. This task contains phrases related to actions. Your task is to rate the emotionality of each of the actions described by the phrases, that is, to rate the degree to which an action arouses feelings. Thus, it is the intensity of the emotion that is relevant, not the kind of emotion."

The English translation of the Spanish instructions for the motor activity dimension was as follows: "One of the dimensions along which action can vary is in amount of motor activity. Performing some actions involves a large amount of motor activity, whereas performing other actions involves very little motor activity. This task contains phrases related to actions. Your task is to rate the amount of motor activity of each action described by the phrases, that is, how much you have to move an object or your body in order to carry out the action."

For the memorability dimension, the English translation of the specific Spanish instructions was as follows: "One of the dimensions along which action can vary is in memorability. Some actions may be very easy to remember and recall after a while; others may be very hard to remember and recall. This task contains phrases related to actions. Your task is to rate the memorability of each action described by the phrases, that is, to rate how easily you would remember an action if you were to perform it."

The instructions for the vividness of visual imagery rating task, newly used in this study, were adapted from the Spanish adaptation of the revised version of the VVIQ (VVIQ-2; Beato, Díez, Pinho, & Rodrigues Simões, 2006), and the English translation of the specific Spanish instructions was as follows: "One of the dimensions along which actions can vary is the vividness of the visual imagery that we form in our mind when we think about those actions. Some actions generate very vivid visual images in our mind, whereas others generate images with little vividness. This task contains a number of action phrases. Your task is to rate the vividness of each of the images of actions denoted by the phrases, that is, to rate how vivid the visual image formed in your mind is for each action."

Common to all tasks were instructions on how to do the ratings using a 7-point scale, some examples of concrete actions for which extreme scores could be expected on each scale (except for memorability and vividness tasks, where no examples were provided), and a short practice exercise in which participants were asked to actually apply the scale to rate 4 sentences used as examples. After reading the instructions and practicing with the examples, the participants started the rating task, in which the 268 sentences were presented in a random order on the computer screen. In each trial, a target sentence was presented in the center of the computer screen and a 7-point rating scale was displayed below. Two labels were shown at the extremes of the scale to remind the participants of the

scale values. The responses were entered by selecting a single number on the scale, via mouse click. The participants were asked to work at their own pace, responding quickly but as accurately as possible. The total duration of the task was between 30 and 45 min.

RESULTS AND DISCUSSION

The complete set of ratings for the 536 action-related sentences is available in the online-only Supplementary Materials (SpanishActionSentences.xlsx). The file includes a column listing the 536 Spanish sentences, with a twin column listing their English translation. In adjacent columns, for each sentence, the mean rating (e.g., *familiarity_m*) and the corresponding standard deviation (e.g., *familiarity_sd*) for each dimension are provided. The first 439 sentences correspond to those from Molander and Arar's (1998) study, and they have been listed with the same ID number to allow comparisons. Sentences numbered from 440 to 503 correspond to actions usually performed in different body postures: lying (440–455), sitting (456–471), standing (472–487), and walking (488–503). Finally, the last 33 sentences correspond to face movements (504–520) and hand movements (521–536).

As is shown in Figure 1, the distributions were quite similar to those reported by Molander and Arar (1998) for the dimensions shared with that seminal study. Familiarity, emotionality, motor activity, and memorability were positively skewed, and ratings were fairly well distributed along the 7-point scales (see also Table 1), except for the memorability dimension, in which the average scores

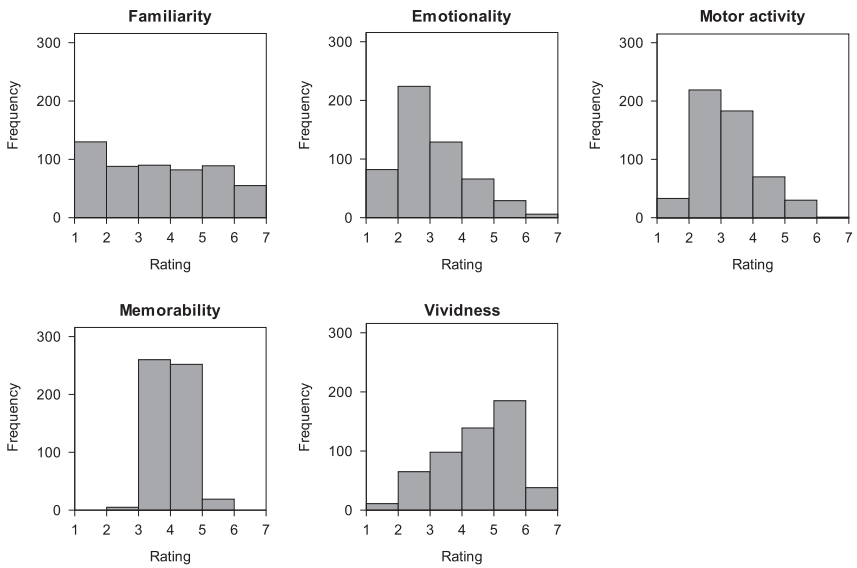

Figure 1. Distributions of the mean ratings for each dimension.

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Table 1. *Mean, standard deviation, and range of ratings for each dimension*

	Familiarity	Emotionality	Motor activity	Memorability	Vividness
M (All)	3.61	3.02	3.22	4.01	4.48
M (Men)	3.74	3.09	3.21	3.91	4.61
M (Women)	3.58	3.01	3.22	4.04	4.44
SD All	1.72	1.09	0.95	0.52	1.18
Range All	1–7	1.35–6.59	1.06–6.11	2.83–5.81	1.60–6.63
Skewness All	0.18	0.86	0.67	0.56	–0.53
Kurtosis All	–1.21	0.15	0.29	0.30	–0.67

Table 2. *Examples of the stimuli at both extremes of the rating scale in each dimension*

Dimension	Lowest item	Highest item
Familiarity	to hug a cactus	to swallow
Emotionality	to put a folder down	to laugh
Motor activity	to sleep in a bed	to build a partition
Memorability	to rotate a sugar bowl	to drive a carriage
Vividness	to juggle with pills	to laugh

were concentrated in the center of the distribution, showing a smaller rating range and hardly any extreme scores (see Table 2 for translated examples of sentences at both extremes of each rating scale). Vividness ratings also represented values along the complete range of the scale, with a negatively skewed distribution. Overall, small differences were found between the mean scores of men and women (see Table 1), and Wilcoxon signed-rank tests showed that the differences between men and women on average mean ratings were significant for the dimensions of familiarity ($Z = –5.386$, $p < .001$, $d = –0.01$, 95% confidence interval; CI [–0.21, 0.02]), emotionality ($Z = –2.197$, $p = .028$, $d = –0.07$, 95% CI [–0.19, 0.05]), memorability ($Z = –3.931$, $p < .001$, $d = 0.18$, 95% CI [0.06, 0.30]), and vividness ($Z = –5.211$, $p < .001$, $d = –0.14$, 95% CI [–0.26, –0.02]), suggesting that men and women tend to rate these dimensions differently, although to a moderate extent, as denoted by the negligible effect sizes.[4]

To assess the reliability of the norms, for each dimension, participant scores were randomly divided into two subgroups, with the only restriction that the two groups were comparable in terms of mean age and in their distribution of men and women. In each dimension, Spearman's correlations were calculated between the mean ratings of the items in both subgroups. The correlations were high and significant for familiarity ($r_s = .96$), emotionality ($r_s = .85$), motor activity ($r_s = .90$), and vividness ($r_s = .85$), all $ps < .001$, indicating very good reliability. In contrast, a moderate correlation was found for memorability ($r_s = .48$,

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$p < .001$). For completeness, intraclass correlation indexes were calculated for each rated dimension (two-way random-effects model, absolute agreement). Intraclass correlation values were high for familiarity, emotionality, motor activity, and vividness (.98, .95, .96, and .93, respectively), and moderate for memorability (.62). These results are similar to those obtained by Molander and Arar (1998) and seem to indicate that the memorability dimension might be more difficult to rate or less precisely defined than the rest of the dimensions.

As explained above, the present stimuli set contains 10 items, which, in addition to its basic format, were also included with adverbial extensions (e.g., "to turn a key" and "to turn a key hesitantly"). Means and standard deviations for this subset of sentences in both formats are presented in Table 3. The Pearson correlations between the basic format and the adverbially extended sentences were high and significant for familiarity ($r = .86$, $p = .001$), emotionality ($r = .92$, $p < .001$), and motor activity ($r = .88$, $p = .001$), and moderate and not significant for memorability ($r = .51$, $p = .13$) and vividness ($r = .57$, $p = .09$). These results might suggest that adding an adverbial extension to a sentence does not alter significantly the relative difference between items in familiarity, emotionality, and motor activity, although the reduced sample of comparisons do not allow firm conclusions. We conducted additional paired-samples t tests to compare the average ratings between the 10 sentences with and without adverbial extensions. The differences were significant for familiarity, $t\ (9) = 3.926$, $p = .003$, $d = 0.90$, 95% CI [–0.08, 1.89], and vividness, $t\ (9) = 4.171$, $p = .002$, $d = 1.23$, 95% CI [0.21, 2.26], and not significant for emotionality, $t\ (9) = –1.429$, $p = .187$, $d = –0.21$, 95% CI [–1.16, 0.73], motor activity, $t\ (9) = –1.216$, $p = .255$, $d = –0.19$, 95% CI [–1.13, 0.75], or memorability, $t\ (9) = 0.549$, $p = .596$, $d = –0.18$, 95% CI [–0.76, 1.12]. As in Molander and Arar's (1998) study, the differences observed in the familiarity dimension revealed that the sentences with an adverbial extension led to lower ratings ($M = 3.50$) than the sentences in the basic format ($M = 3.91$). This result is consistent with a study by Nilsson, Nyberg, Nouri, and Rönnlund (1995), who reported that enriched action sentences (e.g., "wave your hands as a conductor") tended to be rated as less familiar than the same sentences presented in a basic format (e.g., "wave your hands"). Similarly, the sentences with an adverbial extension gave rise to lower ratings ($M = 4.39$) than the basic sentences ($M = 5.37$) in the vividness dimension, which

Table 3. *Means and standard deviations for the 10 sentences presented with and without adverbial extensions*

	Familiarity		Emotionality		Motor activity		Memorability		Vividness	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Basic format	4.91	1.94	3.32	1.54	3.30	1.01	4.17	0.42	5.37	0.75
Adverbially extended	3.50	1.08	3.61	1.17	3.50	1.00	4.07	0.64	4.39	0.83

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suggests that constructing a vivid mental image of an action is more difficult when the action is more sophisticated or more specific, and probably less familiar. In this sense, it must be kept in mind that the correlation between familiarity and vividness dimensions was very high in our study ($r_s = .92$, $p < .01$), as explained below.

An estimation of validity was obtained by running Spearman's correlations between each dimension in the present set of Spanish sentences and the corresponding scores in the 439 sentences shared with Molander and Arar (1998). All correlations were positive and significant (all ps $< .01$). The correlations were high for familiarity ($r_s = .86$), emotionality ($r_s = .78$), and motor activity ($r_s = .83$), and moderate for memorability ($r_s = .42$). A possible explanation for this lower correlation is that the memorability dimension, as suggested above, might be less precisely defined and consequently might be more difficult to rate than the rest of the dimensions, partly because the rating instructions for this dimension did not include concrete examples, in contrast to familiarity, emotionality, and motor activity dimensions, and also because the estimation of the memorability of actions might be an inherently difficult task compared to the rating of the other dimensions. As a result, the memorability dimension might have led to a possible central tendency bias, with average scores concentrated in the center of the distribution (see Figure 1).

The complete set of intercorrelations among the five rated dimensions is presented in Table 4. The most notable result was a high correlation between familiarity and vividness ($r_s = .92$, $p < .01$), suggesting that highly familiar or frequent actions tend to elicit a more vivid mental image. Although this correlation was very high, it can be argued that these dimensions are relatively independent, as they differ in their overall mean ratings (see Table 1) and in their distributions of the mean ratings (see Figure 1). Vividness ratings tended to be higher than familiarity ratings, and the distribution of the mean ratings of the vividness dimension was negatively skewed, in contrast with the distribution of the familiarity dimension, which was positively skewed. In addition, these two dimensions correlated differently with the rest of the dimensions. For example, emotionality correlated significantly with vividness ($r_s = .13$, $p < .01$) but not with familiarity ($r_s = -.001$, $p = .99$), and memorability correlated negatively with familiarity ($r_s = -.07$, $p = .11$) but positively with vividness ($r_s = .07$, $p = .10$). Motor activity correlated negatively with both familiarity ($r_s = -.40$, $p < .01$) and

Table 4. *Intercorrelations (Spearman) among dimensions for all the 536 items*

	Emotionality	Motor activity	Memorability	Vividness
Familiarity	–.001	–.40**	–.07	.92**
Emotionality		.10*	.53**	.13**
Motor activity			.13**	–.36**
Memorability				.07

Note: *$p < .05$. **$p < .01$.

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vividness ($r_s = -.36$, $p < .01$), suggesting that the actions that imply a greater amount of motor activity (e.g., "to build a partition") tend to be less familiar or frequent and give rise to a less vivid mental image than those actions that imply less motor activity (e.g., "to sleep in a bed"), at least for a university student population. It must be kept in mind that a number of actions included in our stimuli set are bizarre or extremely unlikely. For example, the sentence "to hug a cactus" would imply a substantial amount of motor activity, but it is obviously very unfamiliar.

Another high correlation was observed between emotionality and memorability ($r_s = .53$, $p < .01$). In this study, emotionality reflects the intensity of the emotion elicited by an action, and not the kind of emotion concerned. Therefore, this correlation suggests that those actions that elicit more intense emotions are perceived as easier to remember over time than less emotional actions. This is consistent with a study by Kousta, Vinson, and Vigliocco (2009), which showed that emotionally significant verbal stimuli have a processing advantage over neutral words, and with several studies that have demonstrated a memory enhancement for both positive and negative emotional stimuli (for a review, see Hamann, 2001).

The intercorrelations observed in the present study were similar to those reported by Molander and Arar (1998), with the exception that these authors found a significant correlation between familiarity and emotionality ($r = -.28$, $p < .01$) when that correlation was not significant in our study ($r_s = -.001$, $p = .99$). However, it should be taken into account that discrepant results can be found among other studies when the correlation between familiarity and emotionality (or arousal) of words is examined, as positive correlations (Campos, Marcos, & González, 2002; Campos, Pérez-Fabello, & González, 2001), negative correlations (Paivio, 1968), and correlations close to zero (Rubin, 1980; Stadthagen-González, Imbault, Pérez Sánchez, & Brysbaert, 2017; Warriner, Kuperman, & Brysbaert, 2013) have been reported. Thus, further research is needed to clarify the relationship between these two variables.

It could be added that memorability correlated highly with familiarity ($r = -.66$, $p < .01$) and motor activity ($r = .52$, $p < .01$) in Molander and Arar's (1998) study, but those correlations were lower, although in the same direction, in the present study (see Table 4). These differences might come from the fact that we added 97

Table 5. *Intercorrelations (Spearman) among dimensions for the 439 items shared with Molander and Arar (1998)*

	Emotionality	Motor activity	Memorability	Vividness
Familiarity	–.04	–.37**	–.05	.92**
Emotionality		.19**	.46**	.09
Motor activity			.15**	–.32**
Memorability				.10*

Note: *$p < .05$. **$p < .01$.

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new sentences to the stimuli set used by Molander and Arar (1998). However, as shown in Table 5, the intercorrelations among the five dimensions are roughly the same when the new sentences are taken out. Thus, the discrepancies between the correlations reported by Molander and Arar (1998) and ours could be attributed to difficulties in rating the memorability dimension, as explained above, or to cultural and/or linguistic differences affecting the ratings of some of the sentences in one or more dimensions.

CONCLUSION

The present study provides familiarity, emotionality, motor activity, memorability, and vividness of visual imagery ratings in a set of 536 action sentences in Spanish, which constitutes, to date, the only normative study available for action-related sentences in Spanish including those dimensions. Analyses revealed a strong resemblance to the results obtained by Molander and Arar (1998) for the shared sentences, and good reliability and validity scores, except for the memorability dimension, whose moderate indexes may be attributed to inherent difficulties in the rating task compared to rating the other dimensions. The availability of the present norms is expected to allow researchers and experts interested in both theoretical and applied purposes to design studies that rely on the use of well-controlled materials in Spanish-speaking samples of participants. Of importance as well, the widely used corpus of materials provided by Molander and Arar (1998) is supplemented here by the inclusion of 97 new sentences describing actions usually performed using different body postures and face or hand movements, which may be useful for designing specific experiments aimed at studying how cognition is shaped by our body and its sensorimotor interactions with the world.

We consider that these norms constitute useful material for further studying influences of action and action processing on cognition, and especially for the study of memory for action events and enactment effects in memory. In this regard, there are promising areas of development focusing on issues such as the modulation of enactment effects by motor expertise (Peng, Li, & Zhu, 2018) and the role of enactment on the creation of false memories (Lindner, Schain, & Echterhoff, 2016) or memory for actions across the life span (Badinlou, Kormi-Nouri, Nasab, & Knopf, 2017; Silva, Pinho, Souchay, & Moulin, 2015).

Moreover, the present norms could have potential implications in the context of applied cognition initiatives, such as the development of reading comprehension programs (Glenberg, 2011; Glenberg et al., 2004, 2011; Kaschak et al., 2017; Walker, Wong, Fialko, Restrepo, & Glenberg, 2017), the acquisition of a second language (Macedonia & Mueller, 2016; Toumpaniari, Loyens, Mavilidi, & Paas, 2015), the attenuation of cognitive decline in older people (Banducci et al., 2017), and the diagnosis and rehabilitation of patients with motor-related neuropsychological conditions (Cotelli, Manenti, Brambilla, & Borroni, 2017; Herrera et al., 2012).

Finally, these norms will not only allow more researchers to work on issues of interest with Spanish-speaking samples of participants but also be useful to conduct new cross-linguistic research, as similar norms are already available in Swedish (Molander & Arar, 1998), German (Molander et al., 1999), Croatian (Arar & Molander, 1996), and Portuguese (Freitas & Albuquerque, 2007), and the field is ready for advancement taking into account potential modulation of action-related processes by aspects of language or cultural specificity. As an example, the familiarity of actions has proven to be different in German and Chinese groups of participants (Umla-Runge, Zimmer, Fu, & Wang, 2012). In addition, recent research has begun to more generally demonstrate the importance and usefulness of adopting a cross-linguistic perspective in linguistic, neuroscience, and cognitive research (e.g., Katsos et al., 2016; Łuniewska et al., 2016; Perry et al., 2015; Rueckl et al., 2015), as it allows the establishment of comparisons of similarity and disparity between languages. The availability of a wide corpus of ratings for verbal stimuli in different languages may be a particularly valuable resource to this end.

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NOTES

1. Subsequently, a revised version of the Vividness of Visual Imagery Questionnaire (VVIQ-2) was released (Marks, 1995; see also McKelvie, 1995).
2. This study was conducted with a sample of participants from Spain, and the sentences were translated into the variant of Spanish spoken in this country. We acknowledge potential limitations in the possibility to extrapolate our materials and results to other variants of Spanish, such as those spoken in Latin America, because of the existing differences in vocabulary and idiomatic expressions.
3. Due to the random selection of the stimuli presented to each participant, the completion of the total number of ratings for each of the sentences occurred at a different rate. As a result, those participants who took part in the final phase of the study rated a lower number of items (15.8% of the participants rated less than 200 sentences).
4. When reported, mean differences effect sizes were calculated with the Cohen *d* function of the effsize R package (Torchiano, 2017).

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/S0142716418000693

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