Assessing the existence of a semantic space to express action tendencies

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ABSTRACT

There is an abundance of literature showing that action tendencies measure can help in improving prediction of people final behaviour in different fields. Applying action tendencies in combination with differential semantics could be useful in understanding the relationship between product design and people final decision making. In this regard, a questionnaire including a reduced set of action tendencies would be desirable. The present research applies differential semantics to assess the existence of a semantic space of action tendencies people use to express their intention to react. One hundred volunteers reported to which extent 19 images prompted them to react in 37 different ways. They also selected the emotion and meaning they most associated to each image. Results show that there exists a semantic space with 11 axis people use to express their intention to react. The semantic space is little sensitive to the sample of people in the experiment. The observed relationship of semantic axes with emotions and meanings, and the comparison of the resulted axis with previous literature, evidence that they correspond to action tendencies.

1. Introduction

The popularization of design approaches such as Kansei Engineering (Nagamachi, 1995), emotional design (Norman, 1990) or product semantics (Krippendorff, 2005) has led to an increased interest in the study and assessment of people's perception of objects and how this relates to their reactions.

Taking this into consideration, the traditional approach to product and service design consists of using different methods for gathering people's perceptions, and then applying statistical techniques to relate them to people's final responses, which usually refers to people's decision-making processes regarding product purchase, recommendation, risk assumption, and innovation adoption, among other things (Alcántara et al., 2013; Yuen et al., 2021).

However, while the literature shows good results for establishing the relationship between perception and design elements (in Kansei for example, Nagamachi, 1995), results, at least in the authors' experience, are not as effective in models attempting to estimate people's behaviour from their perception.

Research into emotions and behaviour has made it clear that from stimulus to reaction, emotional labelling and the associated experience mediates a complex process, with interactions between several external and internal factors that need to be taken into account—including, among others, perception, feelings, moods, emotions and context (see De Bossuyt, 2012; and Lowe and Ziemke, 2011, for good reviews).

Some published works show that knowledge and methods from this field of research may be hugely beneficial in better understanding the relationship between the design of products and services and customer behaviour. Huang et al. (2012), for example, proposed a basic emotion-based semantic differential (SD) method that improves the conventional SD method by considering the relationships between Kansei tags and the basic emotions. Also, Desmet et al. (2019) introduced a user design-centred approach taking into account the influence that mood has on thought/action tendencies to improve scenarios and personas ® techniques.

There is an abundance of literature showing that consideration of action tendencies can help in improving the prediction of final behaviour, as in the case of job satisfaction (Chhokar J, 1989; Hartman et al.,
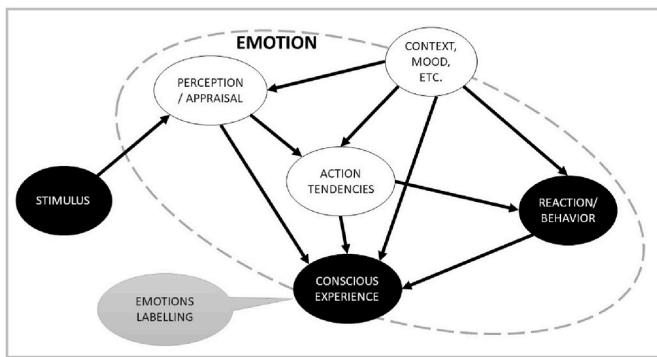
Fig. 1. The process of emotion according to appraisal theories (adapted from Bossuyt et al., 2012).

1986), for example, or in a variety of outcomes related to psychopathology and psychological well-being (Mu and Berenbaum, 2019). In the same way, it could be applied to gaining a better understanding of the relationship between people's perceptions of products and services and their responses. Thus, this paper focuses on the possibility of introducing the assessment of action tendencies into the study of people's perception of products and services.

Action tendencies are defined as the readiness to act (De Bossuyt, 2012; Frijda, 1986, 2010; Lowe and Ziemke, 2011) and to think (Fredrickson, 1998) in certain ways in response to specific emotions.

Action tendencies are a central element in appraisal theories of emotions, in which cognitive evaluation in terms of the significance for well-being (appraisal) of a stimulus is a relevant component of emotion, activating and coordinating action tendencies which result in physiological and emotional reactions influencing overt behaviour (De Bossuyt, 2012; Frijda, 1986, 1993, 2010; Frijda et al., 1989; Lazarus, 1991; Lowe and Ziemke, 2011; Roseman and Smith, 2001; Sander and Scherer, 2009; Scherer, 2009; Scherer and Fontaine, 2019). This is a complex process (Fig. 1), depending heavily on the sociocultural context (Frijda, 1986) and occurring before the process of labeling the emotions (OToole & Mikkelsen, 2021; Scherer and Fontaine, 2019; Scherer and Moors, 2019).

There is a vast array of literature on the topic of action tendencies. Many of these published works are aimed at establishing the relationship between emotional feelings, appraisal, and action tendencies—as well as the relationship of these aspects with behaviour (see De Bossuyt, 2012; and Lowe and Ziemke, 2011; for complete reviews, Scherer and Fontaine, 2019; Scherer and Moors, 2019). There is much interest in action tendencies among various fields of psychology (with such applications as, for example, treatment of food disorders (Ferentzi et al., 2018), addictions and phobias (Mu and Berenbaum, 2019), and measurement of job satisfaction (Chhokar J, 1989; Hartman et al., 1986)) as well as in computer sciences for developing different models; such as those aimed at increasing the credibility of the reactions of virtual agents in order to replicate natural conversations (Yacoubi and Sabouret, 2018).

To this end, there is a variety of methods and experimental setups for action tendency measurement. De Bossuyt (2012) presents in her thesis a complete review on the measurement of action tendencies. According to her, action tendencies are mental constructs that cannot be observed directly, and experimental protocols have to be carefully designed, taking into account the way that appraisals and subsequent emotional feelings are provoked in people, and how action tendencies are measured.

For the former, most of the experiments found in the literature attempt to provoke emotions either by asking participants to recall situations or by provoking situations (gaming, rewarding, scenarios, role playing, imagery tasks based on situational experiences (Boiger et al., 2018)). There are two main categories of methods used to measure action tendencies: self-report methods and inference from observed behaviour (movement, facial expressions, voice, etc.).

In spite of some drawbacks, the self-report method is unparalleled in its simplicity and has the possibility of being applied in a variety of different contexts and experimental settings.

Taking this into account, many published works on people's perception of products and services have applied the semantic differential method (Alcántara et al., 2005; Chiu and Lin, 2018; Huang et al., 2012; Khalaj and Pedgley, 2014). According to Huang et al. (2012), this is due to the following: 1) experiments are relatively easy and inexpensive to conduct; 2) the method demonstrates a high degree of reliability and validity; and 3) it provides a unified platform for quantifying subjective assessments such as emotions.

Thus, the best option for measuring action tendencies in the study of people's perception of products seems to be the self-report method in combination with differential semantics (also a self-report method). Examples such as the questionnaires applied by Hartman for measuring job satisfaction (1986), the association test used by Ferentzi et al. (2018) for analyzing food disorders, or the visual self-report assessment tool developed by OToole & Mikkelsen (2021) show the suitability of applying action tendency self-reporting to the domains of design, marketing, hospitality management and others.

Published research focuses either on a number of action tendencies related to a reduced number of emotions and/or appraisals (or the set defined by Frijda (1986), and further elaborated in the GRID and the CoreGrid instruments (Scherer et al., 2013)), or exhaustive listings from previously conducted interviews, with those considered most relevant for participants for the specific emotion being subsequently selected (Desmet et al., 2019). Boiger et al. (2018), for example, studied anger and shame experiences, asking participants to rate combinations of 15 situations and approximately 15 appraisals/action tendencies and to indicate for each appraisal/action tendency how strongly they thought it was associated either with anger or with shame. Desmet et al. (2019) examined the relationships between 20 moods and 68 distinct tendencies.

In this context, the semantic differential method (Osgood et al., 1957) considers that there is an underlying mental structure of perception defined by a set of independent concepts, called semantic axes, which define a multidimensional semantic space people use to express their perception of things. In this way, all expressions and adjectives people use to verbalize their perceptions can ultimately be reduced to a limited set of concepts.

Is there a similar structure for expressing reactions? If so, a limited set of action tendencies could be used. To the authors' knowledge, this has not been previously published.

This paper investigates the existence of a semantic space people use to express their intention to react. Differential semantics is used to assess to which extent a set of images elicits a series of reactions in people. The research also assesses the relationship of the resulting semantic space with emotions and meanings as reported by people in the same experiment.

Thus, the research hypotheses are as follows:

H1. There is a limited set of concepts people use to express their intention to react in a given manner in front of stimulus: The Action Tendencies Semantic Space (ATSS).

H2. The ATSS has a relationship with emotions and symbolic meanings.

2. Material and methods

To test the research hypotheses, 100 volunteers reported to which extent a set of images caused them to react in different ways. They also reported the emotion and meaning they most associated with each image.

Firstly, in a pilot study, 10 people assessed 25 different images in terms of their reactions to them, choosing for each image one of a set of

Table 1
Reactions, emotions and meanings included in the questionnaire.

Reactions		Emotions		Meanings	
Spanish	English	Spanish	English	Spanish	English
abrazar	hug	Aburrimiento	Boredom	Atrayente	attractive
acariciar	cares	Agobio	Burden	Belleza	beauty
ahorrar	save	Alegría	Joy	Colorido	colorful
besar	kiss	Ansiedad	Anxiety	Comodidad	comfort
bostezar	yawn	Asco	Disgust	Competitividad	competitivity
cerrar los ojos	close eyes	Asombro	Astonishment	Atrevimiento	daring
chupar	lick	Confianza	Confidence	Muerte	dead
comer	eat	Curiosidad	Curiosity	Asquerosidad	disgusting
comprar	buy	Decepción	Disappointment	Autoridad	dominance
contemplar	gaze at	Envidia	Envy	Señorío	dominion
correr	run	Excitación	Excitement	Naturalida	ease
dormir	sleep	Felicidad	Happiness	Dinamismo	energy
esconderme	hide	Indiferencia	Indifference	Exclusividad	exclusivity
estudiar	study	Indignación	Indignation	Cordialidad	friendliness
explorar	explore	Inseguridad	Insecurity	Diversión	fun
gritar	cry/shout	intriga	Intrigue	Injusticia	injustice
insultar	insult	Ira	Anger	Vida	life
ir	go	Lujuria	Lust	Lujuria	lust
llorar	cry	Melancolía	Melancholia	Lujo	luxury
lucir	show off	Miedo	Fear	Obscenidad	obscenity
meditar	meditate	Nostalgia	Nostalgia	Organización	order
pegar	hit	Optimismo	Optimism	Prepotencia	prepotency
pensar	think	Rechazo	Rejection	Espectáculo	show
proteger	protect	Relax	Relax	Triunfo	success
protestar	protest			Apetitoso	tasty
quedarme quieto	stand still			Ternura	tenderness
regalar	give			Ordinariez	vulgarity
reír	laugh				
resoplar	snort				
robar	steal				
sonreír	smile				
soñar	dream				
suspirar	yearn				
tirar a la basura	throw away				
tocar	touch				
usar	use				
vomitar	vomit				

50 different reactions (verbs) obtained from published works on products perception and on action tendencies. It turned out that this questionnaire took too long to complete, and people objected to the extent that some of them refused to finish.

After analysis of the variability in responses from the pilot (for both images and verbs), it was determined that a shorter questionnaire could be designed which avoided biases occurring due to people's tiredness. Images considered similar to others (similar scores in many verbs), and verbs that either generated confusion (variability >50%) or did not stimulate people (variability <10%), were dropped from the questionnaire. Even so, the resulting questionnaire was still long, and people were allowed more than one session to complete it.

One hundred volunteers took part in the final experiment. They reported their perceptions of 19 different images in a questionnaire which included 37 different verbs (Table 1).

They were instructed to look at the image for 5 s and then report to what extent it incited them to do each action according to a 5-point, Likert-type scale: -2 (totally disagree), −1 (disagree), 0 (neither disagree nor agree), 1 (agree), and 2 (totally agree).

Table 1 displays the reactions in the questionnaire.

Volunteers completed the questionnaire either on a computer screen or in a paper color copy. Finally, they selected from a list the emotion and meaning they most associated with each image. The list included 24 emotions and 27 meanings obtained from literature on product semantics, emotions and appraisal (Table 1).

To randomize the experiment, there were 10 different questionnaires. Each of them firstly included the questionnaire on action tendencies, with images presented in a random order and the list of verbs also randomly presented for each image. Next, images were presented
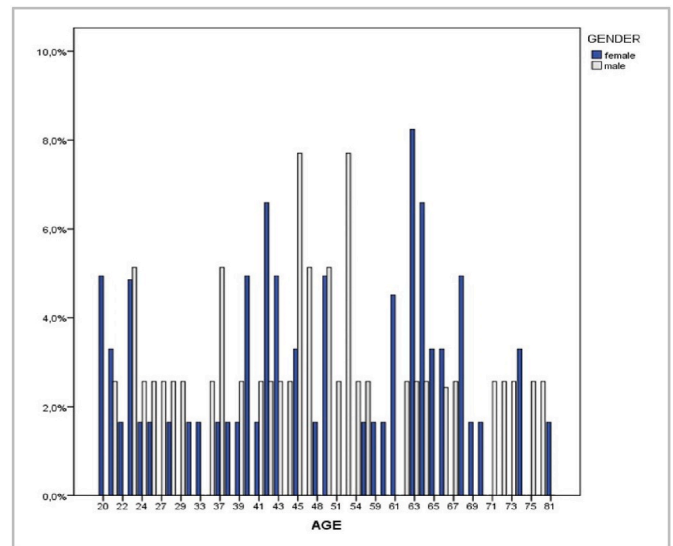

Fig. 2. Age distribution of participants.

again at random, with the lists of emotions and meanings also randomized. Volunteers evaluated each image in a questionnaire assigned at random.

Fig. 2 shows the age distribution of participants. Ages ranged between 20 and 81 years old (mean = 48.03 years, sd = 16.63 years).
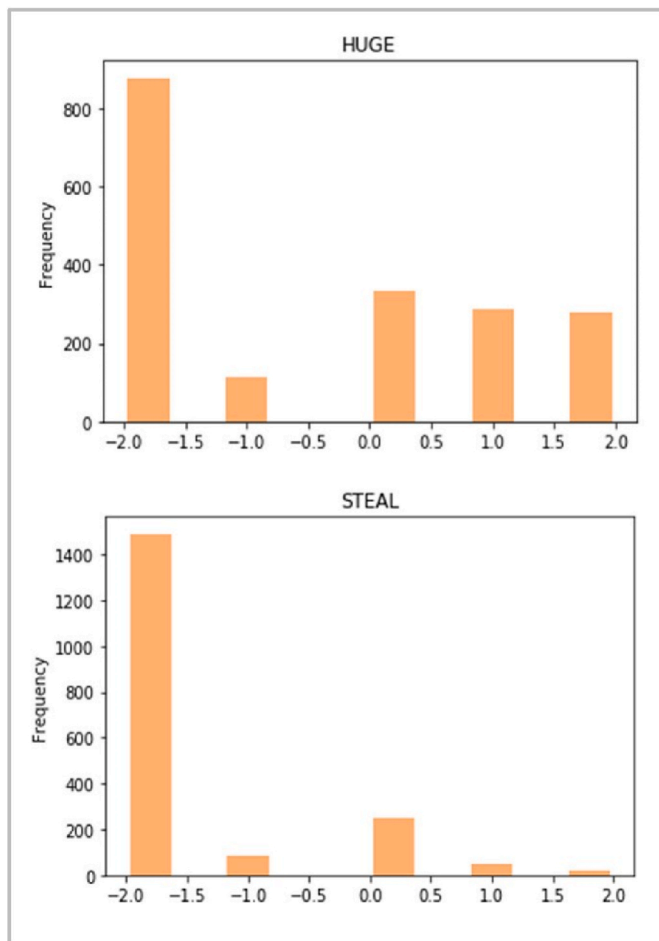
Fig. 3. Frequency distribution for huge (top) and steal (bottom).

2.1. Data analysis

Data analysis consisted firstly of a descriptive statistical analysis of reactions, emotions and meanings in order to detect and process outliers, and secondly, verification of the extent to which the images stimulated a variety of responses.

Descriptive statistics included frequency distribution plots for all reactions, emotions and meanings. Also, the median scores for all reactions are represented for a selection of images.

2.1.1. Assessment of the existence of an Action Tendency Semantic Space (ATSS)

This data analysis is aimed at testing H1. There is a limited set of action plans people use to express their tendency to react in a given manner in response to stimuli: the Action Tendency Semantic Space (ATSS).

The ATSS results from a Principal Components Analysis (PCA) with a varimax rotation. Being an exploratory analysis, as extraction criteria, each resulting principal component had to explain more than 1% of variance after rotation. Bartlett's sphericity test and the KMO test were conducted to test the adequacy of data for PCA.

In order to assess the influence of the sample of participants in the ATSS, PCA was done for a progressively higher number of participants, from 40 up to 100. The number of people increased by 10 for each step. For each step, 10 different PCAS were done selecting 10 random samples of people from the total participants.

The analysis variables obtained from each PCA were the number of principal components (PC) (*factors*), total variance explained (*variance*), and reactions showing higher correlation with them (*names of the axes*).

Afterwards, the final ATSS results were obtained from a PCA of all data gathered (n = 100). Under assessment were communalities, weight of variables in principal components, and total variance explained.

Cronbach's alpha was used to test internal consistency of the resulting principal components. To this end, an SPSS reliability test was used to compute Cronbach's alpha for all verbs with a correlation higher than 0.3 with each axis. The effect on the consistency of the axis of leaving out each verb was also measured. Values between 0.6 and 0.95 are considered to show a good internal consistency.

2.1.2. Relationship of ATSS with emotions and meanings

The goal of this analysis is to test H2. The Action Tendency Semantic Space has a relationship with emotions and meanings.

Cross-tabulation analysis of the relationship between emotions and meanings, as well as of their relationships with principal components in the ATSS, allowed statistically significant associations between them to be identified. Chi-square and normalized and corrected residuals were used to identify statistically significant associations between the different levels of variables. Residuals over 1.96 are significant for $p < 0.05$. The sign indicates the direction of the association, while the size of the residual indicates the intensity of the association (Agresti, 2002).

For this analysis, principal components, which are continuous variables, were categorized as follows: Values $< -0.75 = -1$, -0.75 to $0.75 = 0$, and $>0.75 = 1$.

Data analysis was done using SPSS 18 for Windows.

3. Results

The frequency distributions (Figure A1) show that for most reactions, there was a wide distribution of people's answers. There is a high percentage of answers for totally disagree (-2), meaning that for these images, people were not prompted to react in the specified way. However, in general, there are enough answers in the rest of the categories to warrant further analysis. This is the case, for example, of huge (Fig. 3, top). There are some reactions, such as hit or steal (Fig. 3, bottom), for which most answers are totally disagree.

Fig. 4 show the median of responses for all reactions to a selection of images (a tropical beach, Fig. 4, top and a dish of lentils, Fig. 4, bottom)). The results show the differences among images and that there are a variety of reactions for each of them. The results obtained stand to reason. For example, the image of a tropical beach (Fig. 4, top) prompts people to gaze, explore, go, meditate and dream, but not to insult, cry, hit, protest, steal, throw away, or throw up.

The frequency distribution of emotions (Fig. 5, top) shows that relaxation is the most frequently occurring, followed by indifference and curiosity. The frequency distribution of meanings (Fig. 5, bottom) shows that beauty occurs most frequently, followed by luxury and disgusting.

There are some images, such as the image of a dirty kitchen (Fig. 6), for which there is a broad consensus in terms of emotions and meanings, whereas others, such as the picture of a sunrise (Fig. 7), provoke a greater variety of answers.

3.1. Assessment of the existence of an action tendency semantic space (ATSS)

The total variance explained by the axes in a PCA valid solution, and its variability, decrease slightly with the number of people in the sample. Though differences are not statistically significant, the total variance explained falls from 69% to 67%, with a final solution explaining 70%. Variability resulting from the 10 random samples also decreases, but this was expected, since the degrees of freedom diminish as the number of people in a random sample approaches the total number of participants (n = 100).

Taking this into account, the number of resulting axes alternates between 9 and 13 depending on the people in the sample and its size. The valid solution for 100% of participants has 11 axes. Fig. 8
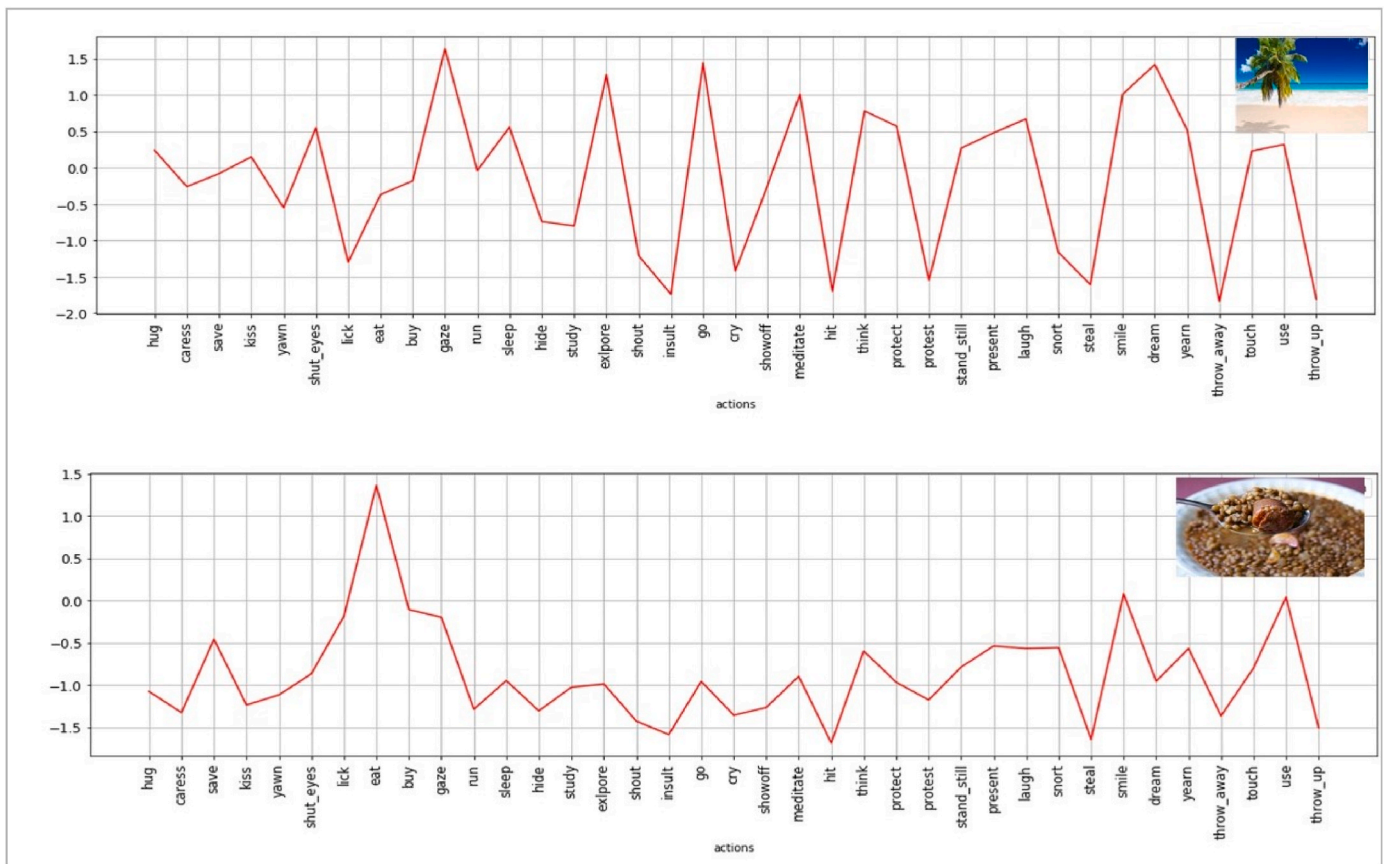
Fig. 4. Median reactions for the images of a tropical beach (top) and of a dish of lentils (bottom).

summarizes the results of all the PCAs conducted for each sample of participants from 40 to 100.

Results show that though the number of axes and the meaning of some of them change, it is for a small part of the total variance. There is a basic structure formed by 8 components (PC1 to PC8) which explains more than 50% of the total variance and appears in all analyses from 50 volunteers upwards.

The analysis of the different PCAs for each number of participants shows—according to the Bartlett sphericity test and the KMO test—that the data is suitable for this type of analysis. The first result was always statistically significant ($p < 0.05$) and the values for the second were always >0.8.

For the PCA of the sample with 100 volunteers, communalities were all greater than 0.6, except for "*save*" (0.57). The 11 factors in the final valid solution are in Table 2 (the weight table is in Table B1). The table shows the results for Cronbach's alpha, including those cases where leaving one variable out of the scale improved internal consistency.

The first PC includes terms showing a reaction of approach, feeling physically attracted, whereas the second (PC2) refers to a cognitive reaction related to utility/value (buy, use, etc.). In the same utilitarian sense, eat appears as an independent component (PC7).

The third component (PC3) includes reactions reflecting an attitude of enjoying passive contemplation. In the line of passive reactions, there is also a relax reaction (PC8) and an independent one, including signs of boredom, such as yawn and sleep (PC11).

There is a component of reflection (PC4), as well as two components showing a negative reaction—repulse (PC5) and avoid (PC6)—and one for snort and protest (PC10). Finally, steal and hit (PC9) point towards a more aggressive reaction along the lines of the fight tendency.

3.2. Relationship of ATSS with emotions and meanings

Cross-tabulation results show statistically significant ($p < 0.05$) associations (residual >1.96) between different meanings and emotions. Especially high are:

- Emotion of relax with meaning of comfort (residual = 11).
- Emotion of happiness with meaning of tenderness (r = 10.1).
- Indifference with meaning of luxury (r = 12.6).
- Disgust and repulsion with meaning of disgusting (r = 26 and r = 9.3 respectively).
- Fear with meaning of dead (r = 19.3).
- Anger and indignation with meaning of injustice (r = 9.8 and r = 25.1 respectively).

Table 3 summarizes the results of cross-tabulation analysis between principal components (categorical) and emotions and meanings. In it, residuals equal or greater than 3.8 are shown (2 times the threshold of 1.9, indicating that the association is $p < 0.05$ statistically significant).

For example, an attraction (PC1) over the mean (>0.75) relates to trust, happiness and joy, whereas values under the mean (<- 0.75) are associated with burden, boredom and negatives such as repulsion and disgust. Regarding meanings, values over the mean correspond with tenderness (related to happiness), beauty and injustice, whereas negative values refer to disgusting (related to disgust) and tasty.

Similarly, a repulsion (PC5) over the mean relates to repulsion and disgust, whereas values under the mean are close to fear and insecurity. Regarding meanings, values over the mean correspond with vulgarity and disgusting, whereas negative values refer to dead (related to fear) and dominion.
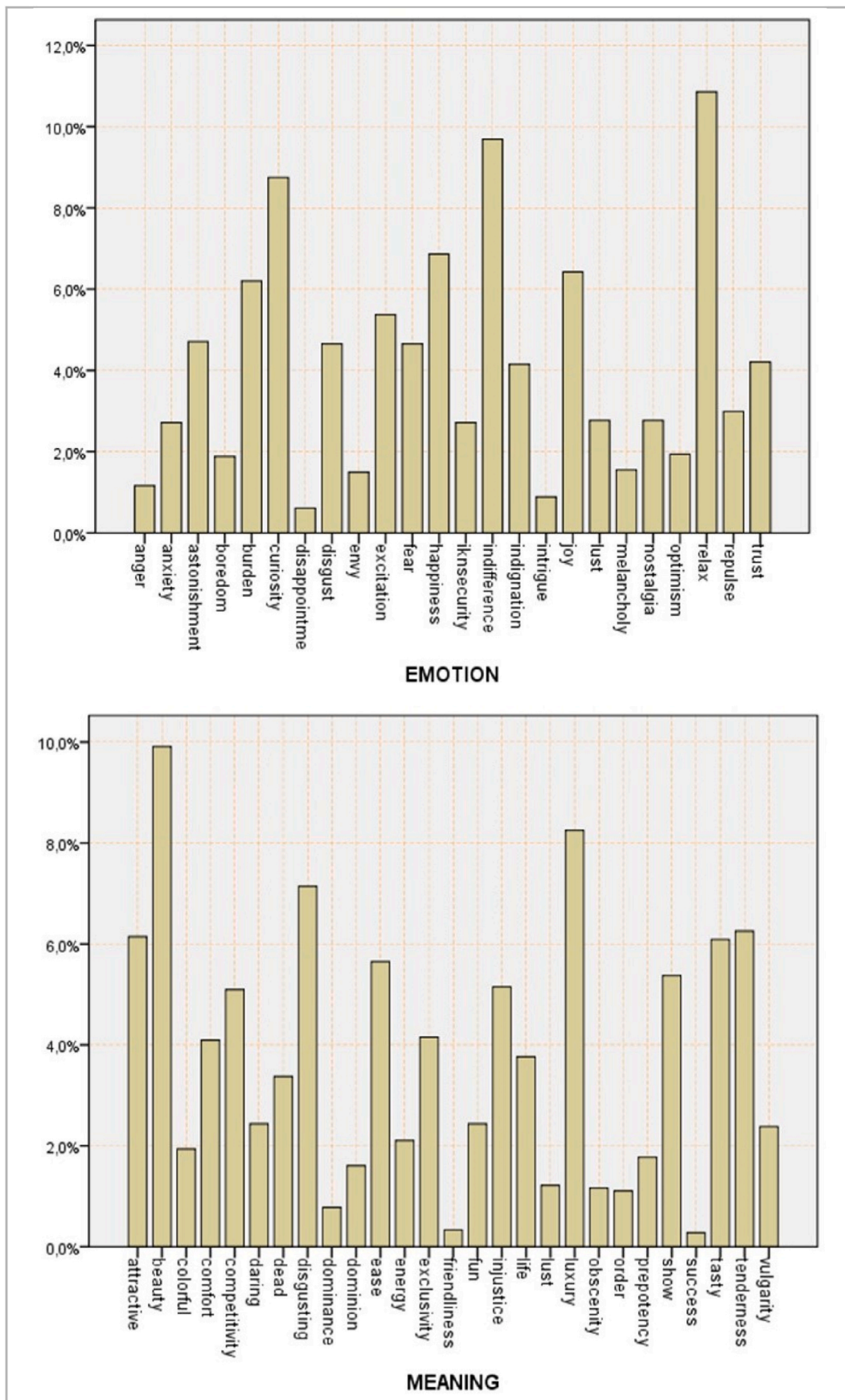
Fig. 5. Frequency distribution of emotions (top) and meanings (bottom) (% of cases).
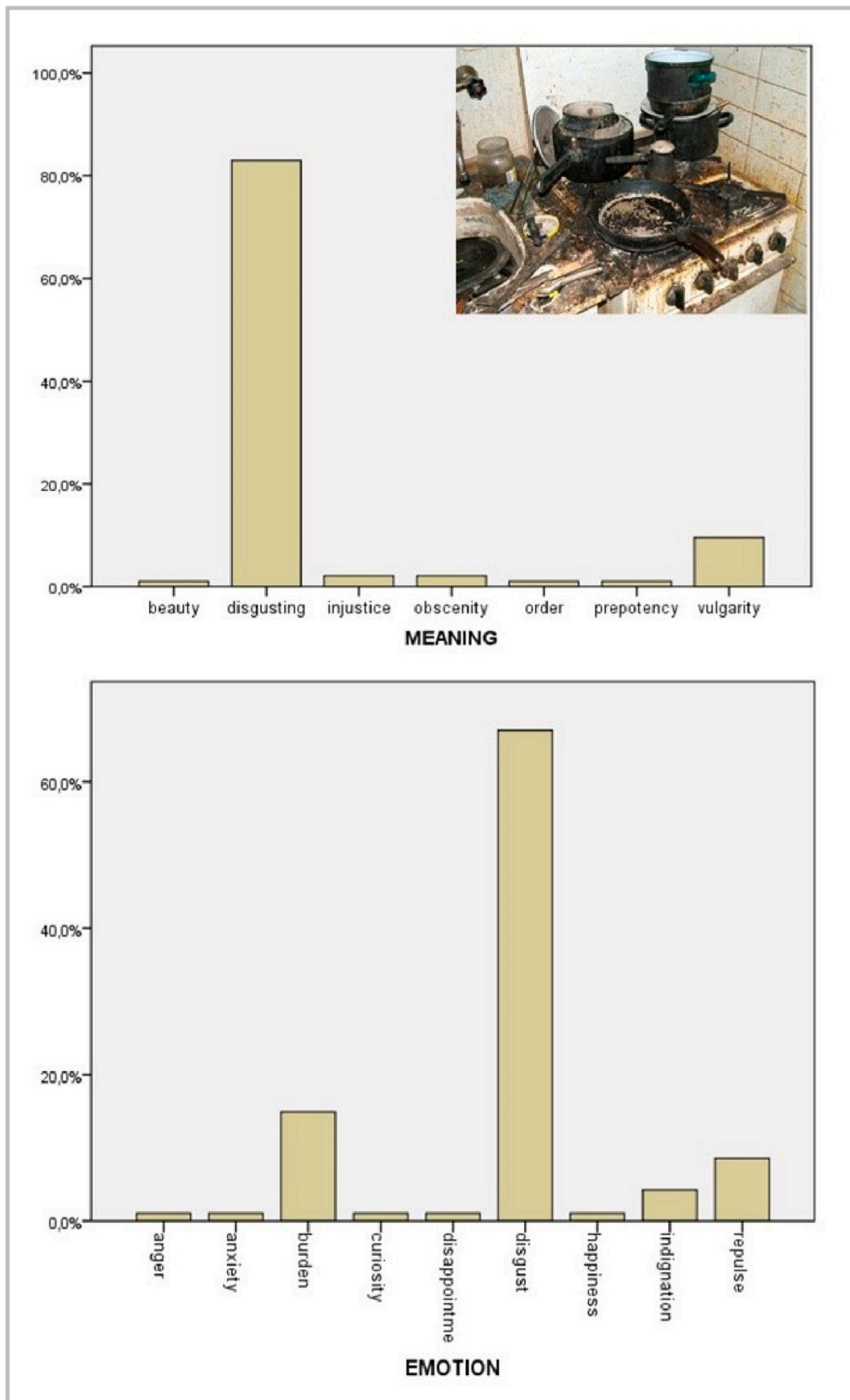
Fig. 6. Frequency distribution of meanings (top) and emotions (bottom) for the picture of a dirty kitchen.
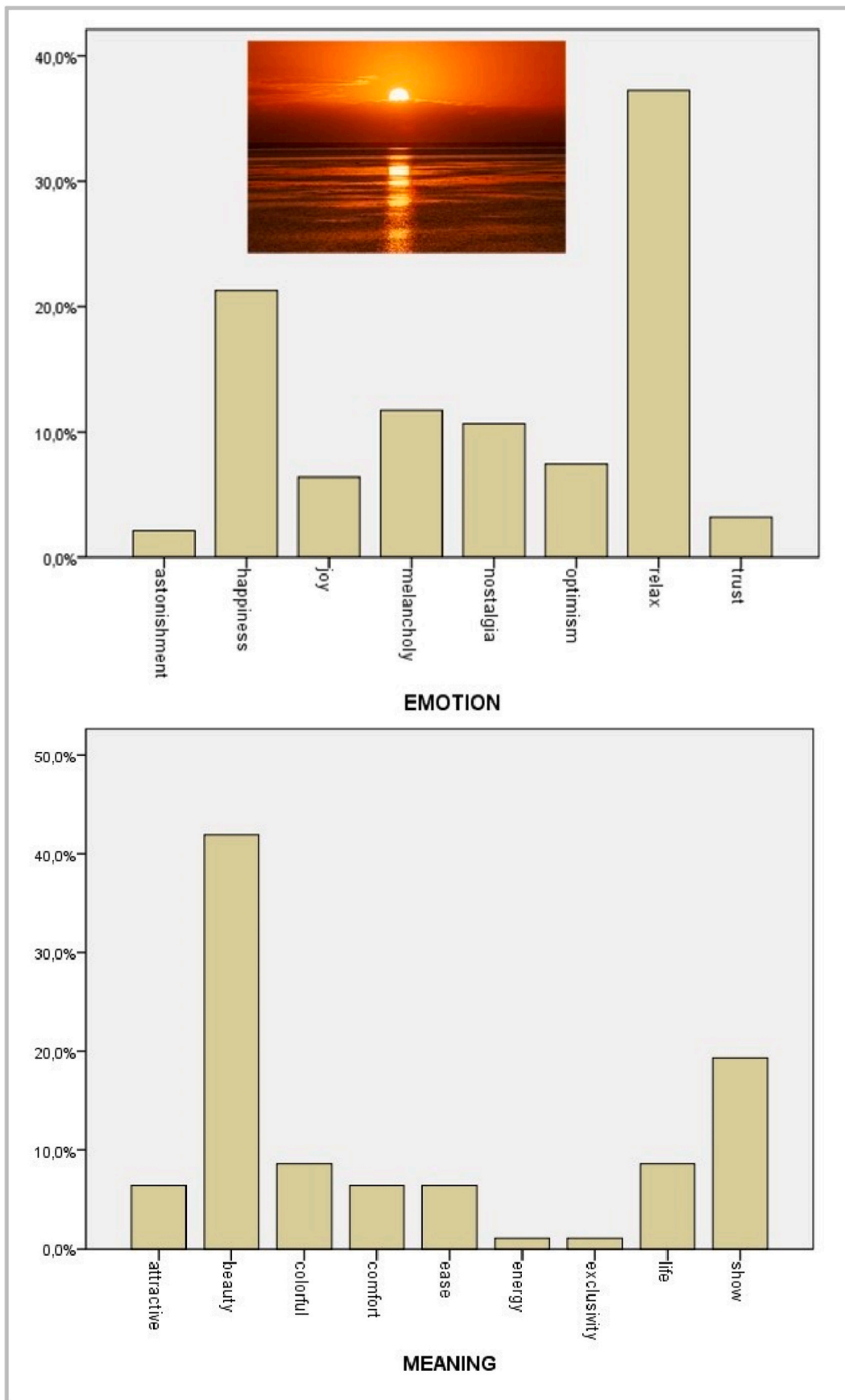
Fig. 7. Frequency distribution of emotions (top) and meanings (bottom) for the picture of a sunrise.
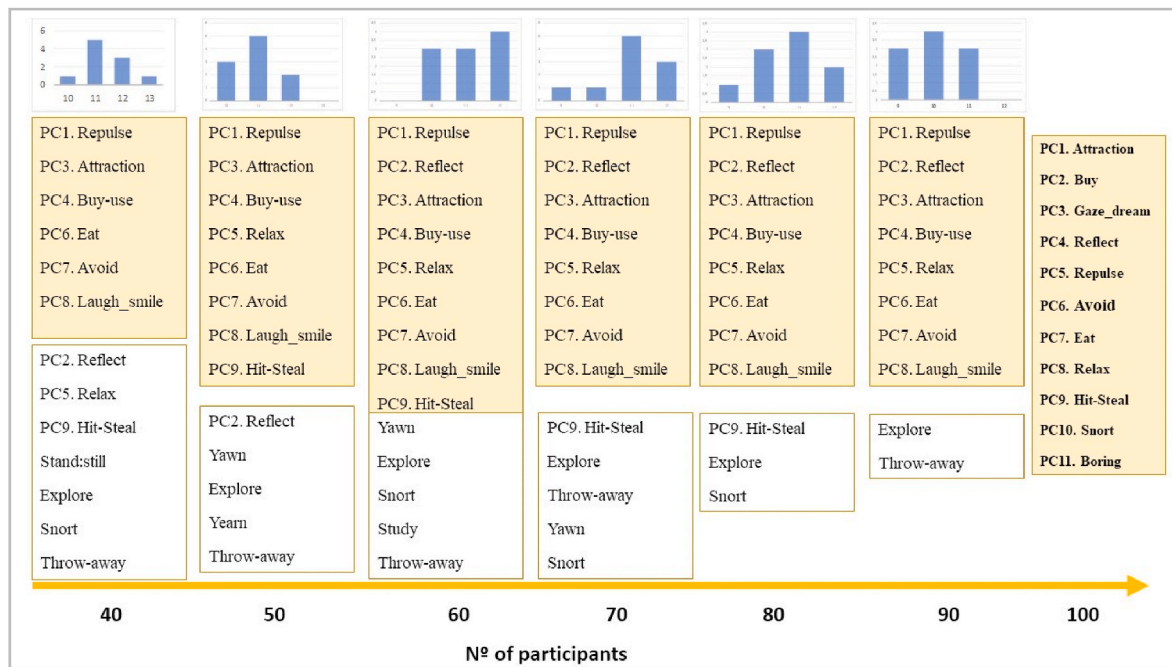
Fig. 8. Summary of the results of all the Principal Component Analyses. Shadowed boxes include axes appearing in all the random trials for a given size of the sample. Frequency distribution plots of number of axes are included at the top. Numbering of axes in the final solution is kept in all PCAs for better comparison.

Table 2
Principal Component Analysis results for 100% of participants. PC: Principal component.

PC	% variance	Reactions with correlation		Name	Cronbach's Alfa
		>0.6	>0.35		
PC1	10.81	Caress, hug, kiss, touch, protect	Smile, laugh	Attraction	0.84
PC2	9.35	Buy, use, make a present, show-off	save, touch	Buy	0.8
PC3	8.3	Gaze, smile	Dream, laugh, explore, yearn	Contemplate	0.71
PC4	7.71	Think, meditate, study	Explore, go, cry, yearn	Reflect	0.55 (0.6 without cry)
PC5	6.93	Vomit, throw away	Insult, cry, hit, protest	Repulse	0.78 (1 without protest)
PC6	6.33	Run, hide, shout		Avoid	0.53
PC7	4.82	Eat, lick		Eat	0.61
PC8	4.74	Shut eyes, stand still	Sleep	Relax	0.67
PC9	4.34	Steal, hit	Insult	Steal-hit (Fight)	0.74
PC10	3.8	Snort	Protest, shout	Snort	0.59 (0.69 without snort)
PC11	3.0	Yawn	Sleep	Boredom	0.66
TOTAL	**70.13**				

4. Discussion

The results of the present research show that there is a limited set of independent concepts people use to express their intention to react in a given manner in front of images.

Though the number and meaning of components resulting from the PCAs varies with the sample size and the individuals within it, there is a stable structure of 8 components appearing in all PCAs from 50 people upwards. They explain around 60% of the variance. Finally, the analysis for 100 people adds 3 more components explaining an extra 11.04% of the variance.

Cronbach's alpha generally resulted in a value greater than 0.6, and results from the KMO and Bartlett's tests supported the goodness of the data for the PCA. Regarding Cronbach's alpha, though values under 0.7 are usually considered as poor, an internal consistency value of 0.6 may be accepted for scales with less than 10 items, as suggested by Loewenthal (1996), and as is the case in the present research.

In agreement with differential semantics, and according to the first hypothesis of the present research, these concepts would represent a semantic space of action tendencies (ATSS) reflecting an underlying mental structure people use to express their intention to react. All 37 reactions considered in this study are different manners to express 11 independent concepts referring to intentions to react.

The existence of such an underlying mental structure may be substantiated by the published research showing a relationship between emotions, feelings and action tendencies, and patterns of neural firing and brain neurophysiology (Lowe and Ziemke, 2011; Mauss and Robinson, 2009). This a prominent field of research with no conclusive results as yet, but there is evidence of a relationship of emotions, feelings, appraisal and action tendencies with measurements of brain activity. Its relationship with ATSS is an interesting topic that warrants further research.

It is not easy finding support in the literature for the existence of the ATSS. Most of the literature on action tendencies focuses on specific emotions and uses a set of action tendencies considered to be related to certain emotions, as in the case of anger with the fight-or-flight response (De Bossuyt, 2012).

Desmet et al. (2019) studied the relationship between mood and action tendencies, with the goal of including people's moods in user-centred design techniques such as scenarios. In their research, participants rated the likelihood that a particular tendency would occur when they were in a particular mood. They performed a factor analysis of 68 thought/action tendencies associated with mood states obtained from different sources. Thus, they used action tendencies in their

Table 3

Results of the correspondence analysis of principal components with emotions and meanings (normalized corrected residuals >3.8). PC: Principal component.

PC	Name	Values	Emotions	Meanings
PC1	Attraction	> mean	Joy, Happiness, indignation, trust	Tenderness, injustice, beauty
		< mean	Boredom, burden, disgust	Disgusting, tasty
PC2	Buy_Use	> mean	Envy, lust, excitation	Exclusivity, luxury
		< mean	Fear, indignation	Tenderness, dead, dominion
PC3	Contemplate	> mean	Astonishment, relax, excitation	Beauty, fun, attractive
		< mean	Indignation, repulse,	Injustice, disgusting
PC4	Reflect	> mean	Indignation, nostalgia, relax	Injustice
		< mean	Fear, indifference	Dead, tenderness, lust
PC5	Repulse	> mean	Disgust, repulse	Vulgarity, Disgusting
		< mean	Fear, insecurity	Dead, dominion
PC6	Avoid	> mean	Fear, insecurity	Dead, dominion
		< mean	Happiness and relax	Comfort and tenderness
PC7	Eat	> mean	Trust, joy, happiness	Tasty
		< mean	Lust curiosity	Exclusivity, luxury
PC8	Relax	> mean	Relax	Beauty, comfort
		< mean	Joy, curiosity	Energy, dominion
PC9	Steal-hit	> mean	Anger	Dead, injustice
		< mean	Disgust	Disgusting, tasty
PC10	Snort	> mean	Indignation, burden, excitation	Injustice, obscenity
		< mean	Fear, relax	Dead, tenderness
PC11	Boredom	> mean	Boredom, relax	Comfort, friendliness
		< mean	Anger, indignation	Injustice

experiment and not reactions. They reported nine factors which could be interpreted as mood-stimulated tendencies (such as, for example, tendency to be critical, tendency to be impulsive or tendency to be easy-going).

To the authors' knowledge, there are currently no published works addressing the existence of such a semantic space. The action tendency component of the GRID instrument (Fontaine and Scherer, 2013) includes 36 items representing 16 action tendencies: approach, avoidance, being-with, attending, rejection, indifference, antagonism, interruption, dominance, submission, apathy, excitement, exuberance, passivity, inhibition and helplessness, which agree quite well with the results presented here (attraction, buy-use, contemplate, reflect, repulse, avoid, eat, relax, steal-hit, snort and boredom). However, a structural analysis of them (Fontaine and Scherer, 2013) revealed a three-factor-only structure: defensive vs appetitive, disengagement vs intervention and submit vs attack action tendencies, further represented by 14 items only in the CoreGrid instrument. Latter, Scherer and Fontaine (2019) performed a PCA on action tendencies but also included in the analysis both bodily reaction and facial/vocal expression GRID items.

Nevertheless, a comparison with published research shows that the semantic axes (principal components) in the ATSS correspond with the action tendencies. Also, the observed relationship between the semantic axes in the ATSS and emotions and meanings supports the hypothesis that they are action tendencies.

From a conceptual standpoint, Frijda (1986) defines an action tendency as a state of readiness to perform one or more actions which is aimed at establishing, modifying or maintaining a particular relationship between the appraising person and the stimulus. Thus, each action tendency can result in different behaviours. When the context in which the reaction/decision is framed is made specific, an action tendency will manifest in the form of different actions in the same manner that a principal component in the ATSS correlates with different verbs depending on the image. For example, a tendency to hurt someone can result in hitting or insulting or another action (De Bossuyt, 2012; Fontaine and Scherer, 2013; Roseman, 2011; Yacoubi and Sabouret, 2018). Interestingly, the results of the present research show that when the buy-use action tendency is activated (associated with excitement and with the perception of exclusivity and luxury), people can then make action plans regarding purchasing, recommending, making a present, using, etc., depending on the context. In principle however, a stimulus that doesn't achieve a positive activation in this mode will have lower probability of provoking a reaction of buying, using, giving, etc.

In the literature review in Table 1 on page 4 of the doctoral thesis by Evelien De Bossuyt (2012), it is possible to identify a complete list of

Table 4

Comparison of action tendencies in the ATSS with literature (from De Bossuyt, 2012) and GRID. PC: Principal component, AT. Action tendency.

| PC	Reactions with higher correlation	Name	AT in De Bossuyt et al. (2012)	AT in GRID	Emotions	Emotios in De Bossuyt et al. (2012)
PC1	Caress, hug, kiss …	Attraction	Approach/increase contact,	Approach	Joy, Happiness, indignation, trust	Joy
PC2	Buy, use, make a present	Buy			Envy, lust, excitation	
PC3	Gaze, smile, dream	Contemplate	Reorient, understand, do nothing	Helplessness	Astonishment, relax, excitation	Surprise, Sadness
PC4	Think, meditate, study	Reflect	reorient, understand		Indignation, nostalgia, relax	Sadness
PC5	Vomit, throw away …	Repulse	Avoid/reject, repulse/remove, vomit, remove/move away from oneself	Rejection	Disgust, repulse	Disgust
PC6	Run, hide	Avoid	Avoid, escape, get to safety, hide self	Avoidance, indifference	Fear, insecurity	Fear, Anger
PC7	Eat, lick	Eat			Trust, joy, happiness	
PC8	Shut eyes, stand still	Relax	Become inactive/withdraw, do nothing/ search new plan	Passivity	Relax	Sadness
PC9	Steal, hit	Steal-hit	Attack/fight, destroy, aggress, hurt.	Antagonism	Anger	Anger
PC10	Snort, protest	Snort	Do nothing, reject		Indignation, burden, excitation	Sadness
PC11	Yawn, sleep	Boredom	Do nothing	Apathy	Boredom, relax	Sadness
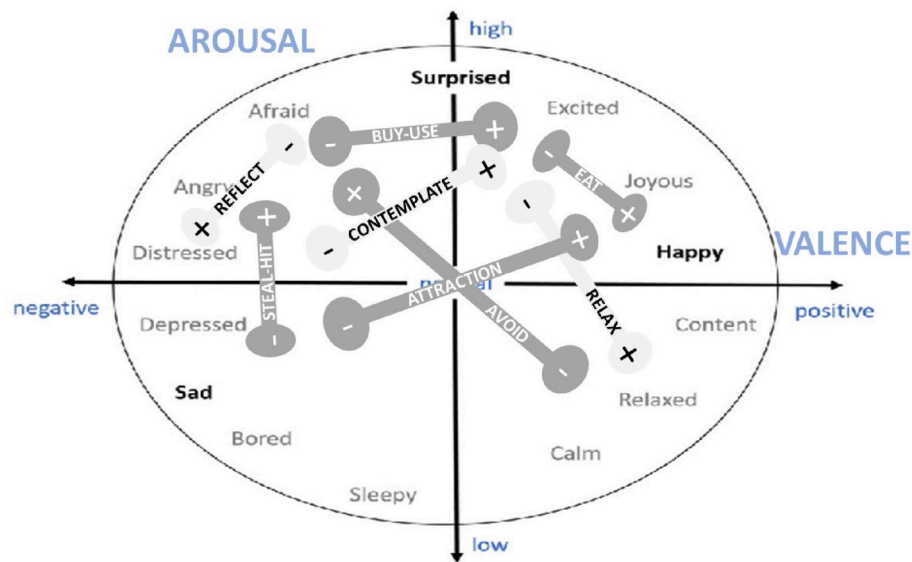
Fig. 9. Representation of action tendency connecting emotions related to positive and negative activation. Dark: active; Light: passive.

action tendencies used in published studies. There are published results matching most of the principal components resulting from the present research (Table 4).

The discrepancies between the results of the present research and those found in the literature are two-fold:

(1) There are action tendencies that appear in the ATSS which are not found in the literature. They refer to utilitarian and more cognitive behaviours, such as buy-use and eat, as well as to more passive (both positive and negative) reactions, such as contemplate or protest. In the case of the latter, it could be argued that in general, the literature focuses on studying intense reactions rather than moderate- or low-activation emotions such as these. For utilitarian action tendencies, there is an abundance of literature regarding the use of action tendencies in treating food disorders and addictions (Ferentzi et al., 2018).

(2) There are some action tendencies in the literature, such as expiate or punish oneself, that were not included in the study for several reasons: firstly, it was considered very difficult to stimulate them using general images (without personal and situational references), and secondly, the number of reactions in the questionnaire had to be reduced in order to make the experiment shorter. Furthermore, reactions related to these are not likely to be of interest in the realm of product and service design.

In any case, differences between the present research and the literature listed by De Bossuyt (2012), in terms of the experimental protocols (as discussed below) regarding the stimulation and measurement of action tendency, could account for occurrences of discrepancies.

With respect to the relationship of semantic axes in the ATSS with emotions (emotion labels) and meanings, the comparison in Table 4 shows a good agreement between results from the present research and results from the literature, supporting the notion that principal components in ATSS are action tendencies.

Additionally, appraisal theories propose that the process of stimulus evaluation or appraisal activates and coordinates action tendencies (De Bossuyt, 2012; Frijda, 1993; Frijda et al., 1989; Frijda and Zeelenberg, 2001; Roseman, 2011; Sander and Scherer, 2009; Scherer, 2009). Our research has demonstrated that action tendencies are related to meanings and emotions, which are also related to each other, thus establishing a complex relationship between all three elements of emotions as described in the literature (De Bossuyt, 2012; Lowe and Ziemke, 2011). There is a need for further research to be conducted into the mediating

effects of emotions and meanings on action tendencies, in order to ascertain the role of meanings as triggers of action tendencies.

Nonetheless, the prevalent definition of action tendency encompasses its role as a mechanism for shifting emotional states (Frijda, 1986). Within this context, mapping of the relationship of action tendencies in the ATSS with emotions in the core affect model of Russell (Fig. 9) (Russell, 2003) shows them to be mechanisms for shifting emotional states.

As shown in Fig. 9, fear, for example, would connect with relax via the action tendency of avoiding. In other words, the action tendency of avoiding the stimulus would shift from fear to relax. Meanings of dead and dominion could act as triggers, being blockers comfort and tenderness. Similarly, reflect would change from fear to distress. In that case, triggers could be dead, lust and tenderness, whereas injustice would block the change. Also, positive activation of the buy-use action tendency connects fear with excitation. Exclusivity and luxury act as triggers, whereas tenderness, dead and dominion act as blockers. Therefore, in an emotional state of fear, a perception of dead and dominion would activate avoid or reflect and block buy-use.

This result also supports that action tendencies in the ATSS adjust to the concept of action tendencies as considered in the literature. They are meaningful and go in the direction of their role in the stimulus-behaviour process.

Taking all of this into consideration, it is possible to say that the results support the research hypotheses:

H1. There is a limited set of concepts people use to express their intention to react in a given manner in front of stimulus: The Semantic Space of Action Tendencies.

H2. The action tendencies in the ATSS have a relationship with emotions and symbolic meanings.

These results open up the possibility of applying the study of action tendencies to better understanding the process of mediating between product and service design and people's decision-making, especially by adopting the experimental procedure used in the present research in conjunction with differential semantics.

From a methodological point of view, it is tempting to say that the procedure followed in this experiment could represent a suitable and cost-effective way of assessing action tendencies.

Different authors have cited interference in the process and the personal and subjective nature of people's thought processes as being the main drawbacks of self-reports (De Bossuyt, 2012; OToole &

Mikkelsen, 2021; Rosenberg and Ekman, 2005; Scherer, 2004). However, as previously stated, self-report methods have the dual advantages of simplicity and cost effectiveness.

OToole & Mikkelsen (2021) question whether action tendencies are well captured by verbal categorization, and they propose a visual self-report assessment method based on drawings of people engaged in actions representing 8 action tendencies, comprising combinations of approach, avoid, reward and threat; this is the Depicted Action Tendencies (DAT) instrument. They have validated the method against the CoreGrid instrument, applying the self-report method and showing the action tendencies to have a significant relationship with emotional labelling. This work opens up an interesting line of research into the development of alternative methods for conducting questionnaires. It could be especially useful for individuals with difficulties in verbalizing sensations and feelings. On the contrary, other authors support the idea that people can verbally label emotional feelings and express their intention to act (Mu and Berenbaum, 2019).

Regarding the experimental protocol and its limitations, the procedure used is robust, and Cronbach's alpha results in adequate values. The ATSS shows a basic structure which, above 50 people, shows little sensitivity to the characteristics and the number of people taking part in the experiment. It remains stable independently of the size of the sample (greater than 50 people) and of the people in it (10 random trials). It must be mentioned that, though random composition was not controlled, participants in the sample covered a wide range of ages, both male and female. The size of the sample did not allow investigation of the sensitivity of the ATSS to gender and age. This should motivate further research into the existence of specific ATSSs for age and gender as well as the existence of differences in action tendency due to age and gender.

In terms of using images as stimuli, the published research is generally aimed at provoking emotions in people to measure action tendencies. It is usually focused on one or a few emotions and deploys fairly complex situational experimental setups, using gaming, role-playing or situational scenarios, for example (De Bossuyt, 2012). Simpler protocols include associating emotions with certain words (Ferentzi et al., 2018) or film clips (Christie and Friedman, 2004) asking participants to recall situations which they associate with the given emotions, and then reporting the related action tendencies (Frijda et al., 1989; Mu and Berenbaum, 2019). Using images may be criticised for having a low potential for activating emotions and action tendencies. However, descriptive statistics in the present research show a variety of answers for all reactions being neutral (0 in the Likert scale) for around 25% of answers only.

Component PC11—labelled as boredom—could reflect a general bias in the experiment given that the questionnaire was quite long, but represented only a small percentage of total variance. However, only 9.2% of answers selected indifference as an emotion. They were for 9 out of 19 images, most of these images being of products and some scenes. Actually, it represented up to 55% of answers for the image of the jewel of a TOUS bear. This poses the need for further research specifically focused on the assessment of action tendencies for different products and services.

On the contrary, the fight action tendency appears expressed as steal and hit, which was quite unexpected regarding the images. Actually, it was not one of the 8 basic action tendencies and represented only 4.34% of variance. It appeared nonetheless.

A final acknowledgement should be given to the influence of language and culture on results. The study was done in Spain and in Spanish. Some authors report relevant cultural differences in action

tendencies associated with different emotions, such as anger (Redford, 1999) or anger and shame (Boiger et al., 2018). Thus, extrapolating the results of the study to other languages and cultures should be done with a measure of caution.

Therefore, future research will focus on the validation of an action tendency-measuring instrument (built with a reduced set of reactions from the ATSS) and the subsequent assessment of whether it improves the results of predictive models of people's decision-making from their perceptions of products and services.

5. Conclusions

This paper gives evidence of the existence of an Action Tendency Semantic Space (ATSS) formed by eleven action tendencies. The basic space formed by 8 action tendencies shows low sensitivity to the sample of participants in the experiment. According to the definition of action tendencies, the axes in the ATSS relate to emotion labels and meanings. Also, they connect emotional states as defined in the literature.

The ATSS is formed by:

(1) Attraction. Tendency to increase physical contact or approach.
(2) Buy-Use. Referring to utilitarian cognitive judgement in terms of value.
(3) Contemplate. Tendency to passively enjoy.
(4) Reflect. Referring to actions for better understanding and comprehension.
(5) Repulse. Active reaction in response to a negative appraisal of the stimulus and related to negative feelings.
(6) Avoid. Active reaction in response to a negative appraisal of the stimulus and related to negative feelings
(7) Eat. Referring also to utilitarian cognitive judgement in terms of eating.
(8) Relax.
(9) Aggress (fight). Active reaction in response to a negative appraisal of the stimulus and related to negative feelings.
(10) Snort-protest. Passive reaction in response to a negative appraisal of the stimulus and related to negative feelings
(11) Boredom/indifference.

Author contributions

Enrique Alcantara: Conceptualization, methodology, validation, formal analysis, data curation, writing-original draft, supervision; **Maria-Arantzazu Ruescas-Nicolau**: Investigation, resources, writing - review & editing; **Miguel A. Artacho-Ramírez**: Methodology, formal analysis, data curation, writing-original draft; **M Luz Sánchez-Sánchez**: Investigation, resources, writing - review & editing; **Lirios Dueñas**: Conceptualization, validation, investigation, resources, writing-original draft, project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Fig. A.1. Frequency plots for all reactions.

Appendix B

Table B.1
Principal Component Analysis rotated weight matrix.

	Component										
	1	2	3	4	5	6	7	8	9	10	11
Cares	.825										
Hug	.801										
Kiss	.733										
Touch	.697	.359									
Protect	.643			.372							
Buy		.821									
Use		.761									
Present		.760									
Show off		.698									
Save		.581		.375							
Gaze			.712								
Smile	.409		.656								
Dream	.347		.595	.324							
Laugh	.370		.589								
Explore			.566	.488							
Go			.505	.432							
Yearn	.338		.370	.350				.333			
Think				.721							
Meditate				.680							
Study				.613							
Throw away					.845						
Vomite					.778						
Insult					.534				.473		
Cry				.356	.372	.343					
Run						.834					
Hide						.740					.313
Shout						.627				.355	
Eat							.846				
Lick							.687				
Shut eyes								.715			
Stand still								.680			
Steal									.680		
Hit					.394				.653		
Snort										.739	
Protest					.400					.529	
Yawn											.671
Sleep				.323				.388			.437

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