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Article

The Associations between Imageability of Positive and Negative Valence Words and Fear Reactivity

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Abstract: This study investigated the associations of imageability with fear reactivity. Imageability ratings of four word classes: positive and negative (i) emotional and (ii) propriosensitive, neutral and negative (iii) theoretical and (iv) neutral concrete filler, and fear reactivity scores – degree of fearfulness towards different situations (TF score) and total number of extreme fears and phobias (EF score), were obtained from 171 participants. Correlations between imageability, TF and EF scores were tested to analyze how word categories and their valence were associated with fear reactivity. Imageability ratings were submitted to recursive partitioning. Participants with high TF and EF scores had higher imageability for negative emotional and negative theoretical words. The correlations between imageability of negative emotional words and negative theoretical words for EF score were significant. Males showed stronger correlations for imageability of negative emotional words for EF and TF scores. High imageability for positive emotional words was associated with lower fear reactivity in females. These findings were discussed with regard to negative attentional bias theory of anxiety, influence on emotional systems, and gender-specific coping styles. This study provides insight into cognitive functions involved in mental imagery, semantic competence for mental imagery in relation to fear reactivity, and a potential psycholinguistic instrument assessing fear reactivity.

Keywords: mental imagery, fear reactivity, emotion recognition, emotion regulation, propriosensitive

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1. Introduction

The imageability scale is a classical psycholinguistic measure for assessing the degree to which words evoke mental images [1,2]. Mental images are perceptual representations that codify past sensory experience. Mental imagery allows for conscious recall of past experiences and reenacts them as visual scenes, sounds, smells, as well as sensations of any kind in the absence of the stimuli [3]. As Paivio stated, "imagery can and does occur as an associative reaction to words, and [...] it plays a part in our memory for (and comprehension of) language" [4].

Different words can have stronger or weaker links to sensory experience, and thus differ in imageability ratings on a seven-point Likert scale. Words that rely heavily on external sensory information (i.e. concrete words) and internal sensory information (i.e., words describing proprioceptive, interoceptive and emotional states) have high imageability as they are more directly connected to sensory and perceptual experience (external or internal) [5]. These words arouse mental images easily relative to words that rely more heavily on linguistic information, such as, abstract or theoretical words that have low imageability due to difficulty in picturing the words [6–13]. High-imageability words are processed and understood more easily than low-imageability items [1,4,14,15].

In this study, we assessed how individuals' fear reactivity is associated with imageability. Fear is a response to stimuli that are perceived as threat. It may manifest as overt behavioral responses, physiological, and cognitive responses [16,17]. Overt behavioral responses of fear include actions employed to avoid or reduce contact with feared object. Physiologically, fear reactions include heart palpitations and sweating. Finally, examples of cognitive fear responses constitute feelings of distress or anxiety of feared objects [17]. In the present study, the Fear Survey Schedule – II (FSS; [18]) was used to measure fearfulness and number of extreme fears in individuals. FSS-II was developed to measure phobic behavior or extreme fear, and generalized anxiety in experimental studies [18].

Specifically, we investigated whether imageability ratings of different word categories were associated with an individual's fearfulness towards different situations and their total number of extreme fears, phobias. Individuals' scores for these two constructs fall on a continuum. A correlation between fearfulness and imageability will provide support for a new psycholinguistic instrument assessing fear reactivity as well as important cues regarding cognitive mechanisms and semantic competence of persons with more or less marked fear reactivity. Specifically, this study might allow us to understand how varying degrees of fear reactivity tend to associate with different categories of words with perceptual representations.

There is scarce literature on imageability and fear reactivity or anxiety. Ferguson *et al.* [19]Ferguson, Moghaddam, Bibby (2007) showed individuals with high scores on health anxiety on Whitely Index - a questionnaire designed to assess hypochondriasis - reported higher imageability and higher negative emotional valence for health-related words [19].

Individual differences in imageability exist such that different people exhibit more or less ease or difficulty in recalling sensory experience (for a review of some classical studies on this topic see e.g. [3,20,21]). This variance may be due to their specific cognitive style determined by, or at least correlated with factors related to personality (see [22,23]). Sensory processing sensitivity is such a personality trait that involves being more or less responsive, reactive or receptive to some environmental stimuli (for a review see e.g. [24,25]): people with high sensory processing sensitivity process some (pieces of) information more strongly and deeply, and perceptively retain this information more easily than others. Thus, they have a higher imagery capacity for a particular item compared to people with low sensory processing sensitivity.

In particular, anxiety is positively correlated to high sensory processing sensitivity (see e.g. [25–30] Ahadi Basharpoor, 2010; Aron Aron 1997; Hofman et al., 2007; Grimen Diseth, 2016; Liss et al., 2005; Liss et al., 2008), which may explain Ferguson et al's (2007) finding that people with high health anxiety had higher imageability scores specifically for health related words [19]. Thus, it is possible that the imageability scale might serve as an index for measuring anxiety levels, of interest especially, fear tendency.

Since people with high anxiety have high sensory processing sensitivity, we expect that people with high fear reactivity scores will have higher imageability ratings on all word classes denoting emotions, sensations or even situations and conditions characterized by a negative hedonic tone (i.e. that feels unpleasant to whom experiences them). This correlation is expected to be the strongest in negative emotional words. To test this hypothesis, four word classes were used, as adapted from Esposito et al., (2016) [31]: two classes represent internal states, i.e., specifically (i) emotional states and (ii)'propriosensitive' ; (iii) the third class consists of theoretical words and (iv) the last class consists of concrete filler words; this last group was matched for frequency and letter length with other words to serve as fillers. (i) 'Emotional words' is constituted of words that denote emotional states including primary and secondary emotions as well as moods. (ii) 'Propriosensitive' words

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describe internal sensations of proprioceptive and interoceptive kind, i.e. related to body positions and muscle tension (e.g. 'spasm', 'convulsion' or 'relaxation', 'balance') and to the viscera, internal organs, temperature, pain, vasomotor activity, etc. (e.g. 'cold', 'pain', 'pale', 'nausea'). (iii) 'Theoretical words' in this study were identified to indicate a particular sub-class of abstract words. Typically, words are qualified as abstract when their meaning is not determined on the basis of sensory information but is fixed definitionally by inferential relationships with other words. However, abstract words are not a homogeneous class. A number of them include emotional information (see e.g. [32]). To avoid this bias, we built a class of 'theoretical words' which only include words that rely substantially on linguistic information, i.e. on definitions. This is composed by technical terms driven by various scientific disciplines (e.g. 'function', 'fallacy', method', etc., see [5]). (iv) The fourth class comprised of concrete fillers. These are concrete words that rely on external sensory information, such as, 'armchair', 'car', 'dictionary', etc. We then tested for correlation between the imageability ratings of the four words classes with degree of participants' fearfulness towards different situations (Total Fear score or TF score) and total number of extreme fears or phobias (Extreme Fear score or EF score), used here as a measure of fear reactivity.

2. Material and Methods

2.1. Words

One hundred and eighty Italian words were selected as experimental stimuli. These words belonged to one of the three categories: emotional words (N = 60), propriosensitive words (N = 60), and theoretical words (N = 60). Each word category consisted of negative, positive, or neutral valence words. In addition, 180 words were selected as concrete fillers. Experimental words and concrete fillers were balanced based on written frequency (67.2 vs. 67.3, respectively; $t < |1|$) and letter length (8.5 vs. 8.5; $t < |1|$) of words. (i) Emotional words consisted of both transient emotions and moods. The list was composed based on examples from previous studies using emotional words. We included only emotional words that are considered to be stable across different cultures [33–40]. As for moods, the list was composed based on the cases discussed in [11,36,41]. Examples of words included 'anguish', 'amazement', 'joy', 'happiness', 'sadness', 'unhappiness', 'disappointment', 'love', 'fear', 'anger', 'depression', 'boredom', 'distress', 'indolence', 'relief'. (ii) Words denoting propriosensitive states were selected based on the words used in studies by [42] and [43–45]. Some examples are 'agitation', 'balance', 'blush', 'cramp', 'spasm', 'pain', 'hunger', 'cold', 'fullness', 'fever', 'malaise', 'relaxation', 'wheeze'. (iii) The list of theoretical words was not derived from previous databases of abstract words. This is because many words that are considered abstract may be linked to internal – emotional or propriosensitive – sensory information (e.g. 'friendship', 'love', 'freedom', or 'wellness' etc.; on this see also [12,13]). Therefore, the class of theoretical words was selected with the focus on obtaining a set of terms which rely mainly on verbal definitions like 'axiom', 'fallacy', hypothesis', 'fraud', 'democracy', 'definition', 'exception', 'unanimity' 'protocol', etc. (iv) The concrete fillers (matched for length and frequency with the other three groups) were composed uniquely of concrete words, i.e. words which strongly rely on external sensory information. Words such as 'table', 'fennel', 'candle', 'juice', 'cork', 'pillow', 'melon', 'book', 'stem glass', and 'airplane' were included in this class (see [31]).

For (i) and (ii), positive and negative words were distinguished based on their valence. Emotional words such as 'apathy', 'remorse', 'anxiety', 'anguish', 'stress' etc. and propriosensitive words such as 'spasm', 'convulsion', 'pale', 'burn', 'unease', 'nausea' etc., were considered negative as they have a negative hedonic tone. They were contrasted to emotional words such as 'happiness', 'satisfaction', 'thrill', 'pleasure', 'relief', etc. and to propriosensitive words such as 'relaxation', 'balance', 'sit', 'excitement', 'sleep', 'jump', etc., which have a positive valence. (iii) As for theoretical words, most of them have a neutral valence (e.g. 'hypothesis', 'property', 'parallelism', 'chronology', 'idiom' etc.) since they denote something that does not affect us in any way. However, some refer to

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situations or conditions that are problematic or give rise to negative consequences or feelings (e.g. 'abstruse', 'fallacy', 'incongruence', 'fraud', 'contamination' etc.). On this basis, theoretical words were divided into neutral and negative words based on valence. The list consisted of words such as 'hypothesis', 'property', 'parallelism', 'chronology', 'idiom', etc. These words do not have a specific affect. Negative theoretical words refer to situations or conditions that are problematic or give rise to negative consequences or feelings (e.g. 'abstruse', 'fallacy', 'incongruence', 'fraud', 'contamination' etc.). (iv) Concrete fillers were not distinguished as positive and negative, but were considered as a uniformly neutral class. Two research assistants judged the valence of the words independently and their agreement was calculated using Cohen Kappa (>.98). As standard procedure in the field, valence scores of these words were also checked with the scores from [46] Warriner et al.'s (2013) database. Positive emotional words (mean valence = 7.15, SD = .584) had significantly higher valence than negative emotional words (mean valence = 3.03, SD = .703); t(50, 2-tailed) = 21.87, $p < 0.01$. Positive propriosensitive words (mean valence = 6.13, SD = 1.45) had significantly higher valence than negative propriosensitive words (mean valence = 3.80, SD = 1.26); t(54, 2-tailed) = 6.30, $p < 0.00$. Negative theoretical words (mean valence = 3.47, SD = 0.80) had a significantly lower valence than neutral theoretical words (mean valence = 5.32, SD = 0.71); t(46, 2-tailed) = -7.56, $p < 0.00$. Valence of all negative words (mean valence = 3.44, SD = 1.10) was significantly lower than all positive words (mean valence = 6.64, SD = 1.21). Positive and negative words were significantly different from neutral words (mean valence = 5.73, SD = 0.92). There was no significant difference in arousal for positive (mean arousal = 5.04, SD = 1.37) from negative emotional (mean arousal = 4.99, SD = 1.16) words, for positive (mean arousal = 4.08, SD = 1.23) and negative propriosensitive (mean arousal = 4.63, SD = 0.68) words, and for neutral (mean arousal = 4.07, SD = 0.66) and negative theoretical (mean arousal = 4.67, SD = 1.16) words; $p < 0.01$. Arousal scores for neutral words (mean arousal = 3.91, SD = 0.81) were significantly different from arousal scores for positive (mean arousal = 4.56, SD = 1.38) and negative words (mean arousal = 4.78, SD = 0.98); $p < 0.01$. For analysis purposes, all negative words and all positive words were combined from all words categories as well. Neutral theoretical words were included in all positive words as they were significantly more positive (mean valence = 5.32, SD = 0.71) than negative words (mean valence = 3.44, SD = 1.05); t(114, 2-tailed) = -9.72, $p < 0.01$.)

2.2. *Questionnaire*

2.2.1. Fear Survey Schedule - Revised (FFS-R). Cognitive Behaviour Assessment (CBA) Schedule 7

Participants were administered the full 58-item FSS-R [18] from the Cognitive Behaviour Assessment Battery – Schedule 7 [47]. Answering each question on the survey was mandatory, so there were no missing data for any participants who completed it. FSS-R results were scored according to Sanavio et al. 1997's scoring manual for CBA Schedules [48]. The two main scores of interest are TF and EF scores. The TF scores represent individual's tendency to react with fear to different situations. The EF score indicates the exact number of situations that induce a fear or phobic response (total number of situations for which an individual lies in the far high end of the fear Likert scale).

2.2.2. Procedure

The survey was created and run between July 2014 and November 2014 using Google Forms Online Surveys. Participants were asked to complete the FSS-R section of the CBA questionnaire and to rate the imageability of a set of 360 words. Imageability was rated for each word on a 7-point Likert scale (1 being low and 7 being high imageability). Instructions to participants were in Italian, a translation of Paivio et al.'s (1968) original instructions [49]: "Nouns differ in their capacity to arouse mental images of things or events. Some words arouse a sensory experience, such as a mental picture or sound, very quickly and easily, whereas others may do so only with difficulty (i.e., after a long delay) or not at all. The purpose of this experiment is to rate a list of words as to the ease or difficulty

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with which they arouse mental images. Any word which, in your estimation, arouses a mental image (i.e., a mental picture, or sound, or other sensory experience) very quickly and easily should be given a high imagery rating: any word that arouses a mental image with difficulty or not at all should be given a low imagery rating. Think of the words 'apple' or 'fact'. Apple would probably arouse an image relatively easily and would be rated as high imagery; fact would probably do so with difficulty and would be rated as low imagery." (see [49], p. 4; for an analysis of these instructions and how people might plausibly interpret them to assign ratings, see [50].

The experiment consisted of two parts. In the first part, participants were asked to complete the CBA questionnaire and ratings of a random selection of 180 words; in the second part, they were asked to rate the remaining 180 words. Only data from participants (95% of the total sample) who completed the questionnaire and ratings of both word blocks were used for the analyses.

3. Results

3.1. Preliminary Analysis

The data were explored and analysed using R-project (ver. 3.1.1). Prior to data analysis, univariate and multivariate distributions of TF, EF, and imageability judgment scores were examined for normalcy, homogeneity of variance, outliers, and influential cases [51]. All these variables, except EF scores, were normally distributed. EF scores were distributed as a non-continuous variable and showed a significantly skewed distribution ($p < 0.01$). This variable did not satisfy the normalcy assumptions and was therefore treated as an ordinal (rather than interval) variable. The distance of each case to the centre was evaluated to screen for multidimensional outliers [51]. TF scores and EF scores were, as expected, positively correlated to each other, $r = .69$, $p < .001$, sharing however, only 47.3% of their common variance. No significant differences emerged between female and male participants for the imageability scores (F range = .16 - 1.6; ns). There was also no significant gender difference for TF (male M = 67.1; SD = 30.8; female M = 68.7; SD = 27.0; $F(1,169) = .13$; $p > .05$) and EF scores (male M = 3.67; SD = 4.71; female M = 4.29; SD = 4.59; $F(1,169) = .75$; $p > .05$).

3.2. Correlational Analysis

For the whole group, there was a significant positive correlation of TF score and imageability ratings of negative emotional words ($r = .18$, $p = 0.02$, df = 170), and negative theoretical words ($r = .18$, $p = 0.02$, df = 170). Only males (not females) showed a significant positive correlation of TF scores with imageability ratings of negative emotional words ($r = .27$, $p = 0.02$, df = 170). For EF scores of the whole group, there was a significant positive correlation with imageability of negative emotional words (Kendal's Tau = .14, $p = 0.01$). There was also a significant positive correlation of EF score and imageability of negative words from all experimental word clusters combined (emotional, propriosensitive, theoretical; Kendal's Tau = 0.11, $p = 0.03$), and for negative theoretical words (Kendal's Tau = .13, $p = 0.02$). Only males (but not females) showed a significant positive correlation of EF scores with imageability of negative emotional words (Kendal's Tau = .24, $p < 0.01$). There was a significant positive correlation of EF scores of males with negative words from all experimental word clusters (Kendal's Tau = .20, $p = 0.02$), positive theoretical words (Kendal's Tau = .20, $p = 0.02$), and negative theoretical words (Kendal's Tau = .21, $p = 0.02$). Figure 1 shows the linear correlations of TF scores (Fig. 1A) and EF scores (Fig. 1B) with imageability ratings for word clusters that were significant in either male or female participants.

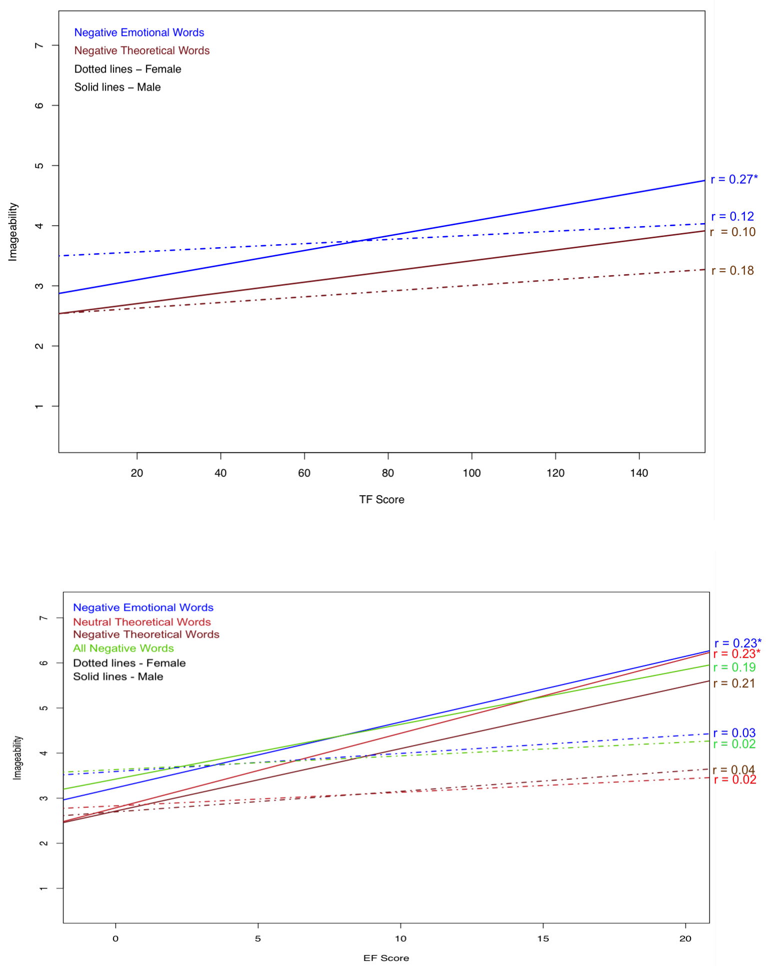

Figure 1. Only significant linear correlations (either in male of female) of TF (A) and EF (B) scores with mean imageability of words clusters. In Fig 1A TF scores were significantly related to imageability of negative theoretical words for the whole group (r= .18, p = 0.02). This significance was not gender specific.

3.3. Tree-base Model Analysis

3.3.1. Category-Words Level

Figure 2 shows the optimal tree that describes how imageability ratings of the word categories predict the TF subscale (Fig. 2A) and EF subscale (Fig. 2B) of CBA scores for males and females. For TF scores, the imageability of negative emotional words was the best measure that statistically differentiated the distribution for males. Specifically, males with higher TF scores (M=77.4) gave higher imageability ratings for negative emotional words (> 3.67) than those with lower TF scores (M=56.9). For females, the imageability of negative words best stratified the TF score distribution. At the next level, the imageability ratings for positive and negative emotional words further differentiated the distribution. A high score on negative emotional words (> 4.70) was predictive of higher TF score for females with high imageability of negative words (> 2.96). Simultaneously females with high imageability scores for positive emotional words ($\geq$ 3.68) showed lower TF scores. For EF scores, imageability of all negative words combined from all experimental word clusters (emotional, propriosensitive, and theoretical) was the best measure that statistically differentiated the distribution for males and females. For males with low imageability on all negative words (<4.78), imageability ratings on negative propriosensitive words further affected the stratification of the population such that

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higher imageability predicted lower ES scores. For females, imageability ratings on all positive words, neutral theoretical words, and negative emotional words further stratified TF scores hierarchically. Of interest, lowest ES scores in females were predicted hierarchically by low imageability of all negative words (< 4.78) and high imageability of all positive words ($\geq$ 4.48).

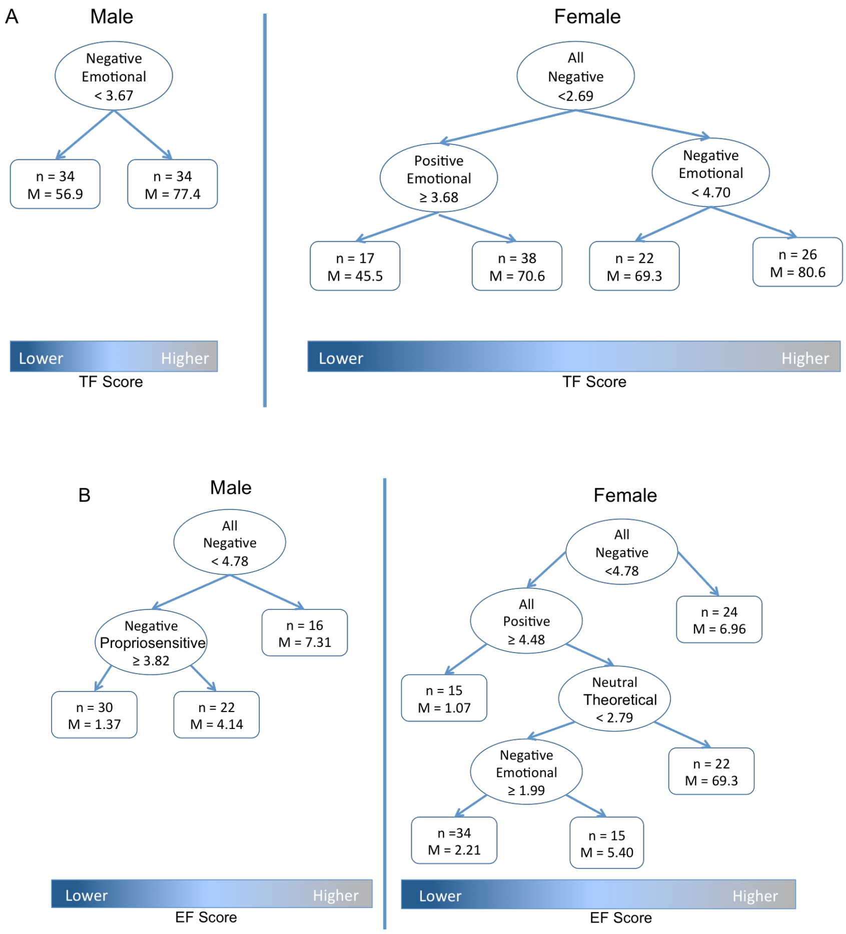

Figure 2. The optimal tree that describes how imageability ratings of word categories predict the TF (A) and EF (B) scores for males and females.

3.3.2. Single-Word Level

Figure 3 shows the optimal tree that describes how imageability ratings at the single word level (all 360 words were considered independently) predict the TF (Fig. 3A) and EF (Fig. 3B) subscales of the CBA for males and females. For male TF scores, the imageability of word 'anxiety' was the best measure that statistically differentiated the distribution. 'Anxiety' belongs to the negative emotional word category. Those with lower imageability score for anxiety, imageability score of the word 'puzzle', a neutral theoretical word, further stratified the TF scores in males. High imageability for 'puzzle' ($\geq$ 5.50) predicted low TF scores. For females, a positive theoretical word 'convocation' best stratified the TF scores. High imageability for the word 'convocation' (>2.50) predicted higher TF scores and was further stratified by the imageability of the propriosensitive word 'salivation'. For EF scores, imageability ratings of the word 'frustration' (negative emotional word) for males and the word 'contamination' (negative theoretical word) for females were the best measures that statistically differentiated the distribution. Males and females with higher EF scores gave higher imageability ratings to the word 'frustration' (>4.5) and 'contamination' (>6.5) respectively. Ratings on 'traffic' ($\geq$4.5), and 'pinch' ($\geq$5.5) further stratified the distribution hierarchically for males, while for females,

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the distribution was further stratified hierarchically with the words 'orientate' (≥1.5) and 'trailer' (<6.5), followed by 'joy' (≥4.6) and 'definition' (<3.5) horizontally.

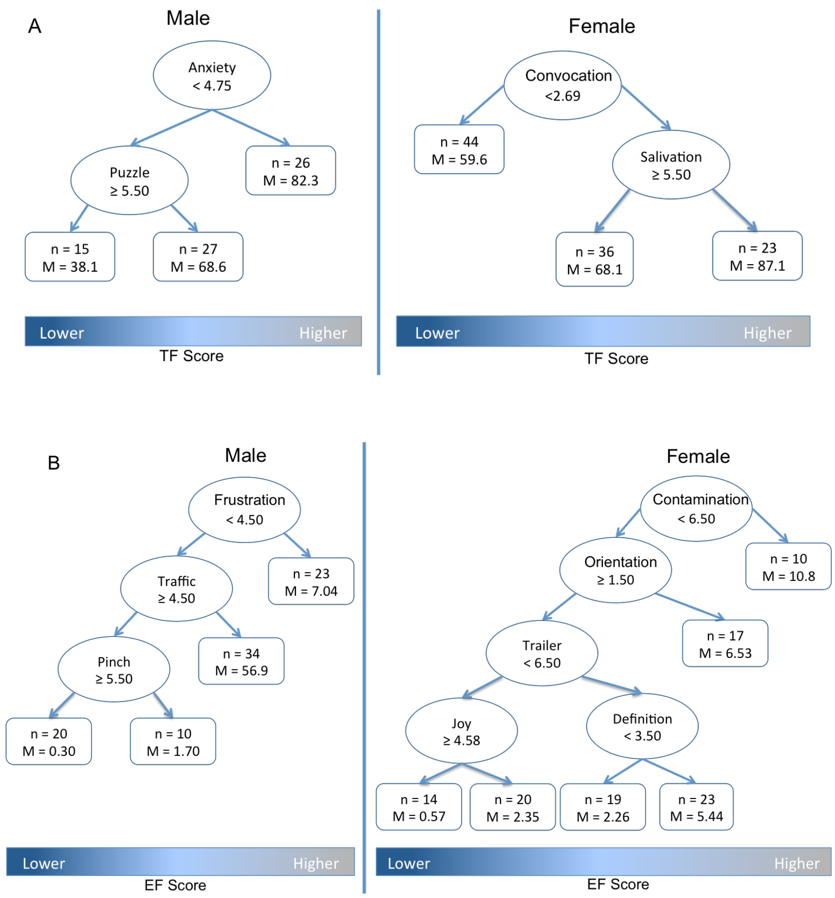

Figure 3. The optimal tree that describes how imageability ratings of single words predict the TF (A) and EF (B) scores for males and females.

4. Discussion

This study addressed how fear reactivity modulates semantic competence with specific word classes and their valence. This would contribute to understanding how fear reactivity would influence the association of words with mental images, i.e. with reevoked perceptual representations of past sensory experience. Imageability ratings of different word classes with negative and either positive or neutral valence (emotional, propriosensitive, theoretical words) were correlated with TF and EF scores, i.e., individual's tendency to react with fear and the number of situations that induce extreme fear or phobic response, respectively. This allows for the analysis of the manner in which imageability of different word categories is associated with fear reactivity. Thus, the study provides insights into underlying cognitive functions involved with mental imagery and representations, and semantic competence for mental imagery of people with high or low fear reactivity. This otherwise would have been difficult to conceptualize owing to the subjective and private nature of this phenomenon.

As expected, participants with greater fear reactivity and higher number of extreme fear inducing situations (higher TF and EF scores respectively) had higher imageability for emotional words with negative valence. In comparing males and females, this correlation was clearly evident in men, compared to women where the correlation was reaching near significance. This was similar for negative theoretical words. Additionally, EF scores were also positively correlated with imageability of all negative words.

The tree based models portray a clearer picture of the relation between imageability and fear reactivity. Specifically, for TF scores (Fig. 3A), as expected, high imageability of negative emotional words and high imageability of all words with negative valence irrelevant of the word categories were predictive of higher fear reactivity in males and females respectively. For females with high imageability of all negative words, having high imageability for negative emotional words further aggravated their fear reactivity.

These results are consistent with the negative attentional bias theory of anxiety (for review see [52]). Literature has shown that anxious individuals selectively attend to the threat-related information in the environment [52–55]. Thus, participants with high fear reactivity may have enhanced mental imagery for negative words. Additionally, increased imageability for emotional words with negative valence corroborates the notion that mental imagery has a powerful impact on emotion in at least three ways: a direct influence on emotional systems in the brain that are responsive to sensory signals; overlap between processes involved in mental imagery and perception which can lead to responding "as if" to real emotion-arousing events; and the capacity of images to make contact with memories for emotional episodes in the past [56–58].

Moreover, for females, but not males, results showed that having high imageability for positive emotional words was associated with a lower fear reactivity. This finding provides insight into potential coping strategies for anxious and fearful females. Our findings suggest that having high imageability for positive emotional words acts as a protective factor against high fear reactivity. In fact, several studies have demonstrated that women tend to use emotional-focused coping styles that are aimed at changing their emotional responses to a situation, as opposed to men who use more problem-focused or instrumental methods of handling anxious or stressful situations [59–61]. Hence, this could be a reason for why we do not observe such a pattern in our male sample. Being able to reevoked perceptual representations of positive emotional words with better ease may induce the same effects as emotional-focused coping.

Although the rest of the tree-based models are not so straight forward in interpreting the stratification, the first level of stratification for the rest of the tree-models are in accordance with the

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literature mentioned so far. For EF scores, as expected and discussed, high imageability of negative words irrelevant of word categories predicted higher number of extreme fear-inducing situations. For single-word tree models, based on the first level of stratification, high imageability of words that predicted higher fear reactivity and higher number of extreme fear inducing situations are constituents of negative emotional and negative theoretical words, respectively for males and females. Further testing to obtain in-depth information, for example, having ratings to understand degree of valence of positivity and negativity of words instead of using predefined ratings, as well as arousal ratings, would help better understand this stratification.

Another limitation, also a plausible reason as to why the stratifications of some tree models are not clear-cut to interpret, is that in our analysis, we did not consider fear reactivity scores for different categories of fears; animal, social and interpersonal, health, noises, etc. Future studies could look to assess fear reactivity scores of such subcategories and its correlation to imageability, to obtain clear stratification and hence predictions.

Nevertheless, this study stands to be relevant from a clinical perspective since the imageability ratings of word classes denoting emotional, propriosensitive and theoretical words can be associated with an individual's level of fear reactivity. Considering people with fear reactivity fall on a spectrum, there are no specific markers that can easily predict where on the spectrum a person falls. Our study shows that a simple task such as rating mental imagery may be useful for performing a stratification of the population. Lastly, this study provides an insight onto the possibility of controlling or enhancing relevant mental imagery, especially of that pertaining to emotional and theoretical word formation based on valence, maybe efficient in reducing fearfulness or general anxiety.

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Abbreviations

The following abbreviations are used in this manuscript:

TF	degree of fearfulness towards different situations
EF	Total number of extreme fears and phobias
FSS-II	Fear Survey Schedule
CBA	Cognitive Behavioural Assessment

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