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Final Report

Aging, antonyms and embodied cognition

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Project summary

The project had two goals. The primary goal was to investigate Chinese antonyms as a tool for studying age-related motivated cognition. The secondary goal was to examine interactions between self-representation and age-related changes via embodied cognition. The primary goal has been accomplished by two studies: (1) A cross-sectional study of affective evaluation of a list of antonyms by a sample of over 800 participants of all ages. (2) A scaling of a list of antonyms using the multidimensional item response theory to confirm the location shift due to age.

Vision scientists have used ambiguous pictures to study optical illusions in order to figure out how human perception works. Cognitive psychologists, on the other hand, frame equivalent gains and losses to study decision making and choice behaviors. This project identified Chinese antonyms as a novel class of neutral stimuli that could be sensitive to developmental changes during a life span. The goal was to show that these antonyms could be employed as suitable diagnostic items for aging research.

Research in cognition and emotion has found preferential processing of
positive relative to negative stimuli between younger and older adults. The theory of socioemotional selectivity, which posits that limits to life expectancies shift people’s motivation toward regulating emotional goals, is currently the dominant theory to explain this age-related positive effect. In this project, we surveyed affective responses toward a collection of Chinese antonyms from people in different ages and found that perceived valences of words indeed shifted toward positive assessment with age. Using the multidimensional item response theory, we were also able to quantify the age differences with regard a list of antonyms. Details of these results are reported in the Appendix.

Future directions. Embodied cognition research has shown that evaluative approach and avoidance movements could be made to depend on the relation to the abstract self-representation rather than the relation to physical self. Even though embodiment underlies social and emotional information processing, few, if any, studies have examined the interaction between aging and embodiment. This project has made some progress toward investigating the experimental settings that combine evaluation of antonyms with various modes of self-representation. One of the key problems which needs to be resolved is how to manipulate the directions and magnitudes of embodied cognition. Individuals also vary in their ability to relate with abstract icons on screen that are supposedly representations of themselves. In other words, there are serious measurement issues in how to construct a scale for the approach-avoidance movements so that comparisons across individuals and between groups are possible.

The project outcomes of the project, so far, are one published conference proceeding, one invited talk, two manuscripts for submission to the journal Behavior Research Methods, and three conference presentations (two have been given, one to occur this November).
Publications, invited talks, and conference presentations


Appendix - Manuscripts to be submitted for publication
A cross-sectional study of Age Differences in the affective evaluation of Chinese antonyms

Abstract

Unlike IQ test norms, most affective norms currently used are not age-adjusted. However, age-related positivity effect found in many life-span studies suggests that younger and older adults may react differently to identical affective stimuli. In this study, we examined the age differences in affective evaluations of Chinese antonyms. Specifically, we focused on whether or not affective stimuli need to be adjusted by age. Results showed that younger and older adults clearly differed in their affective evaluations of Chinese antonyms. They implied that the age should be included in the development of affective norm and stimulus words need to be indexed by age. The main contribution of this study lies in demonstrating the age-related effect in a cross-sectional study of affective evaluation of words. This finding pointed out a weakness in the affective norms currently in use and argued for the development of age-adjusted affective norms.

Introduction

The past decade has witnessed significant advances in research on emotion. A wide range of methodologies, procedures, and tasks, such as implicit memory task, free recall task and recognition task, was used to study emotion. Meanwhile, various types of stimuli have been used in exploring emotional processes, including pictures of facial expressions, static pictures of emotional scenes, video clips, imagery inductions, nonlinguistic verbalizations, environmental sounds, prosody, and spoken and written words.

More specifically, in recent years, an increasing number of studies have used words as stimuli for studying emotional processing. Among those research, valence, arousal level, concreteness and familiarity were four dimensions often mentioned. From the psycholinguistic point of view, each word carries different objective semantic features (e.g. frequency, number of letters, and orthographic neighbors) and subjective semantic features (e.g. valence, arousal level, concreteness, familiarity, word association, and imageability). Unsurprisingly, each one of these factors can influence the processing of word in emotion-related tasks. For instance, Altarriba and Bauer (2004) found that emotional words activate different levels of concreteness and imageability—emotional words are more imaginable but less concrete than abstract words and emotional words are less imaginable and less concrete than the concrete words. Besides, many empirical experiments also showed positive and negative words cost lower reaction times and earn higher accuracy than neutral words (Ali & Cimino, 1997; Borod, Andelman, Obler, Tweedy, & Welkowitz, 1992; Eviatar & Zaidel, 1991; Graves, Landis, & Goodglass, 1980; Inaba, Nomura, & Ohira, 2005; Kuchinke et al., 2005). In Lee & Lee (2006), they found out that negative words had a higher level of concreteness rating than the positive and neutral words. The positive words were rated to be more familiar than the other two categories. In addition, emotional affect has
been conceptualized along two dimensions: valence, which describes the extent of pleasure or sadness, and arousal, which describes the extent of calmness or excitation (Russell, 1980; Lang and others, 1993; Kensinger, 2004). The newly proposed U-shaped model (Winston and others 2003, 2005; Cunningham and others 2004) postulates the relation between the two dimensions is a U-shape curve. That is, both more negative and more positive word can increase our feeling of arousal; whereas, neutral valence words do not usually vary our level of arousal. The same result was also showed in a study in the chemosensory domain (Lewis et. al, 2006) and the report of Spanish adaptation of ANEW (Redondo, et.al, 2007). Taken together, these studies provided an important direction about the essentiality to control affective factors which could influence word perceptions and its relevant semantic features. It indicates that both objective and subjective features of words should be considered in the application of norms for emotion-related studies. To date, more and more studies consider various affective dimensions in the development of word norms for their own language, such as Affective Norms for English Words (ANEW; Bradley & Lang, 1999), Berlin Affective Word List (BAWL; Võ, et.al, 2006), and Spanish adaptation of ANEW (Redondo, et.al, 2007). In Taiwan, there was an affective norm for Chinese words in relation to different dimensions reported by Lee & Lee (in preparation).

However, those norms mentioned above were developed upon data collection from younger population and were not age representative. Research findings of the age-related positivity effect in many life-span studies suggest the significant differences to identical affective stimuli between older adults and younger adults. Many studies related to the interplay of aging and affective have documented significant age differences in reaction to affective materials. In recognition and recall tasks, older adults are more likely to ignore or forget negative information and also sometimes relatively more likely to attend to or remember positive information than younger adults are. For example, older adults responded faster to the happy faces than neutral faces, and they responded faster to the neutral faces than angry faces. Younger adults, however, were faster to detect discrepant faces when the facial expressions were angry than when they were sad or happy (Charles, Mather, & Carstensen, 2003). In a study of preferences and memory, older adults preferred and remembered the advertisement with emotional slogan better than the slogans about exploration and knowledge (Fung & Carstensen, 2003). In the presented study of affective evaluation of word, Liu and Sheu (2008) used 15 antonyms and 105 abstract words testing the age difference in neutral words. The result revealed that older adults performed a marked age-related positivity effect in a neutral stimuli only paradigm. Older adults rated Chinese abstract words more positively than younger adults. Even for the Chinese antonyms which are composed of two characters with opposite meaning, older adults also rated them more positively than younger adults did. The same findings were also reported by other researches: compared with younger adults, older people decreases in processing of negative information, but not from increases in processing of positive information. Wood and Kisley (2007) reported that responses to negative images declines linearly with age, but responses to positive images is surprisingly age invariant across most of the adult. Taken together, these studies suggest a constraint in current usage of the affective norms.

Other weakness in previous researches in studying emotion is that these studies all demonstrated the age effect by presenting explicit neutral, negative and positive
stimuli. However, the valences of these stimuli were defined by the experimenter and consequently the experiment somehow became a kind of categorization tasks with clear valence boundaries. Therefore, to avoid the experimenter effects has become an important issue. Duckworth et. al. (2002) have reported that even novel and nonrepresentational stimuli could elicit automatic evaluation and suggested that all experience is continually evaluated as either positive or negative without conscious thinking. From the point of view, we would predict that even neutral stimuli could also elicit affective response; meanwhile, based on the age differences found in the previous studies, we also expect that older adults may generate different responses toward neutral stimuli opposed to younger adults.

In this way, we reported a survey of affective responses toward Chinese antonyms by people of all ages for investigating the age differences in the affective evaluation. Chinese antonym, which is composed of two characters with opposite meanings in one dimension, is a very important semantic term in language. From the linguistic point of view, Chinese antonym is logistically supposed to be an objectively neutral target in valence dimension. However, the antonymy relation makes Chinese antonym ambiguous in meaning. The opposite meanings can give rise to multiple interpretations. It involves multiple perceptual representations of the unique word. Devoid of context, either meaning could claim dominance. That is, our percepts for the antonyms are unstable and alternate between the possible interpretations. What people recognize an antonym depends on their prior experience with this word. The top-down processes in mind decide the possible interpretation of an antonym. For example, if a person unconsciously pays more attention on 贫 (poor) when seeing 貧富 (poor-rich), he/she may rapidly associate negative feeling and then generates negative evaluation toward the word. In other words, attention bias could result in opposite response for an antonym. From findings related to age difference in responding to affective stimulus mentioned above, older adults had a tendency to neglect negative information. To date, researchers always focused on studying the semantic part of Chinese antonyms. However, seeing the opposite meaning of antonyms, it is worth using Chinese antonyms to investigate whether the subjective affective response toward objective neutral stimulus could vary with age changes or not.

In this study, we sampled participants across several different age groups to examine whether age could impact subject’s feeling toward objective neutral stimulus in emotional task and to determine whether affective word norms should be indexed by age. 100 Chinese antonyms were used as stimuli to collect the subjects’ perceived meanings of these antonyms in terms of valence, arousal level, concreteness and familiarity. Chinese antonyms are composed of two characters with opposite meaning (e.g., 上下, 正反). Logically, it can be thought as a kind of neutral word. Therefore, antonym could be a useful tool for investigating the subjective affective feeling.

Method

Participants

A sample of 851 subjects (417 females, 434 males) from Central and Southern
Taiwan ranging in age from 18 to 81 years old (Mean=42.16, Median=41, SD=19.32) was asked to rate 25 or 30 of these 100 Chinese antonyms on a 5-point rating scale. The degrees of educations were restricted to an elementary school level and above.

**Stimulus**

A list of 100 antonyms (see Appendix) was collected from a database maintained by the Ministry of Education of Taiwan (Ministry of Education of Taiwan, 2000). We selected middle or low frequency antonyms ranged from 1 to 28 times per million with number of the sum strokes of two characters ranged from 6 to 36.

**Procedure**

The survey was conducted in university and college campuses, municipal parks, office buildings, and coffee shops in Central and Southern Taiwan. Participants were asked to rated a sample of 30 antonyms out of a list of 100. Each subject received a questionnaire containing the words to be evaluated, and instruction sheet. Subjects were instructed to rate each word immediately when they saw it at the first moment in order to avoid any bias of their feeling. Additionally, a word was used as example to give the subject a basic reference. After reading the instructions and before evaluating the words, any doubts were solved before starting the assessment.

Subjects evaluated each antonym in a 5-points scale for four dimensions respectively (valence, arousal level, concreteness and familiarity). For valence, larger numbers indicate more positive valence and smaller numbers indicate more negative valence; point 3 indicates neutral. For arousal, larger numbers indicate high arousal and small numbers indicate low arousal and calm. For familiarity, larger numbers indicate more familiar and small numbers indicate less familiar. And for concreteness, larger numbers indicate more concrete and small numbers indicate more abstract. The presentation order of words and the order in which each dimension was evaluated were randomized.

**Data Analysis**

A mixed-effect cumulative logit-normal model was applied to account for the correlated data caused by repeated categorical responses. The overall age effect was examined, and gender and education level were considered as covariates. Mixed-effects cumulative logit-normal models are subject-specific model to fit the repeated nonnormal outcomes in a regression framework, and allow the thresholds to vary across subjects by adding a subject-specific random variable to the thresholds of each subject. In other words, we assumes that subjects are random sampled out of a certain population, and the scope of the inferences is about the overall characteristics of this population. Seeing that all subjects may not have the same discriminability for the antonym or that subjects use the same criteria for responding, the mixed-effects model is appropriate to account for the random subject effect. The model for our data can be expressed as:
\[ \eta_j = \beta_1 \times \alpha \varepsilon_a + \beta_2 \times \sigma \varepsilon \chi_a + \beta_3 \times \varepsilon \delta u_a + U_j \]

\[ P(Y_j = 1 | x) = \frac{1}{1 + \exp[-(c_1 + \eta_j)]} \]

\[ P(Y_j = k | x) = \frac{1}{1 + \exp[-(c_k + \eta_j)]} - \frac{1}{1 + \exp[-(c_{k-1} + \eta_j)]} \]

\( \varphi \text{ for } k = 2, 3, 4 \)

\[ P(Y_j = 5 | x) = 1 - \frac{1}{1 + \exp[-(c_4 + \eta_j)]} \]

Where \( j \) denotes subject id, \( \eta \) represents a continuous latent scale that determines each subject’s perception and \( \beta_1, \beta_2, \beta_3 \) are the regression coefficients. \( x \) stands for the three treatment factors, and the cutpoints. \( U \) variable denotes a subject-specific random variable to the thresholds of each subject. \( Y_i \) is the response for an item of a subject on a 5-point scale. The cumulative probability \( P(Y_i \leq k) \) is the probability that a response variable will be less than or equal to a particular value for \( k = 1, \ldots, 5 \). The probability of a particular ordered categorical response is defined through the cumulative probabilities — for example, \( P(Y_i = 4) = P(Y_i \leq 4) - P(Y_i \leq 3) \). Thus, the cumulative logit model for the ordered responses can be expressed by the foregoing representation.

To fit the mixed-effects cumulative logistic-normal model, the SAS NLMIXED procedure was used.

**Results**

Figure 1 showed the distributions of each age group (the first ranged from 18 to 29, the second, 30 to 59, and the third, 60 and above) in each dimension and figure 2 showed the mean ratings of sex and the three age groups for the four dimensions. As the two figures show, we may expect age differences in most of the four dimensions.
Table 1 shows the parameter estimates of the mixed-effects models. Significant age effects were found in all but the arousal dimensions. Furthermore, in valence, age was the only factor to determine subject’s rating of word ($t = -12.44, \ p < .0001$). In familiarity, excluding age, both gender and the level of education are significant. In concreteness, subject’s rating of word was judged both based on his/her age ($t = -5.30, \ p < .0001$) and education level ($t = -2.45, \ p = .0144$). Among the three dimensions with age effect, valence was most influenced by age. In arousal level, education level and gender elicited different level of rating toward the word, and males tended to rate higher score of arousal than females.

Figure 1  Distributions of responses by age and dimension
### Table 1  Parameter Estimates for the 4 dimensions

|             | Estimate | SE  | DF  | t-value | Pr > |t| |
|-------------|----------|-----|-----|---------|------|---|
| **Valence** |          |     |     |         |      |   |
| Age         | -0.0369  | 0.0030 | 848 | -12.44  | <.0001 |   |
| Sex (Male)  | -0.0039  | 0.1028 | 848 | -0.04   | 0.9695 |   |
| Education   | 0.0020   | 0.0636 | 848 | 0.03    | 0.9748 |   |
| **Arousal** |          |     |     |         |      |   |
| Age         | -0.0035  | 0.0030 | 850 | -1.17   | 0.2407 |   |
| Sex (Male)  | -0.2965  | 0.1042 | 850 | -2.85   | 0.0045 |   |
| Education   | -0.1364  | 0.0642 | 850 | -2.12   | 0.0339 |   |
| **Concreteness** |      |     |     |         |      |   |
| Age         | -0.0133  | 0.0025 | 849 | -5.30   | <.0001 |   |
| Sex (Male)  | 0.0846   | 0.0874 | 849 | 0.97    | 0.3334 |   |
| Education   | -0.1329  | 0.0542 | 849 | -2.45   | 0.0144 |   |
| **Familiarity** |      |     |     |         |      |   |
| Age         | -0.0280  | 0.0036 | 849 | -7.72   | <.0001 |   |
| Sex (Male)  | 0.4091   | 0.1260 | 849 | 3.25    | 0.0012 |   |
| Education   | -0.2816  | 0.0777 | 849 | -3.62   | 0.0003 |   |

### Discussion

The mixed-effects analysis showed that ratings varied with age for most of the words. The slopes were mostly positive. Even the objectively neutral targets appeared to elicit an age difference. Besides, not only the perceived valence of antonyms but also concreteness and familiarity shifted positively with age. It means that the subjective affective evaluation varies with age changes. When people are getting older, their affective responses are different from younger people. This result suggested an important direction that the age factor should be included into the affective norm and words should need to be indexed by age.

### Conclusion

In this study, a survey of affective responses toward antonyms by people of all ages was conducted. Four subjective affective evaluations were collected. The objective stimuli and the variety of subjects’ age provided a good frame in investigating the link between cognition and aging. By using the objective stimulus materials, we examined whether or not the subjective affective response is varied diversely based on subject’s age. The result revealed that the perceived meanings of these antonyms showed a tendency to shift toward positive side when subject is older.
It means that even the objectively neutral targets could also elicit the age difference in responding to stimulus in emotional task. It highlights an important direct that stimulus in affective-relevant study should be indexed by age. Naming, affective responses toward words should be age normed. That points out the limitation of those presented affective norms now in use. Seeing that norms for emotional words may be age-dependent, affective norms which are across age are more appropriate in investigating the interplay of aging and cognition and needed to be established.

In summary, the age effect found in this study revealed the importance of age factor in affective norm. It strongly suggested the need of including age factor into the norm. In this way, affective norms can be more appropriate used in investigating the influence of ageing in human cognition for future studies.

**Further research**

Nevertheless, it is noteworthy that the presented studies were cross-sectional designs. Even though the results in our studies showed strong evidences for the age effect in affective evaluation of antonym, the possibility of a cohort effect could not be eliminated. Therefore, it would be interesting to further explore the age effect in affective evaluations in longitudinal study. More important, it would also be interesting and worthy to extend the results of current research for developing an affective word norm across different age populations. The appropriate norm with different affective dimensions would be very useful to facilitate research of emotion and aging to either better control the variability of stimuli or systematically manipulate them according to their attributes.
References


Abstract

Most affective word norms use mean ratings to order items even though mean scores may not be appropriate summaries of discrete levels of responses. Most word norms control for item frequency, but few of them consider how item responses may be affected by population characteristics such as age or gender. Many life-span studies showed that younger and older adults evaluate positive and negative stimuli differently. The current study used Chinese antonyms as items to quantify this age shift in the affective evaluation of words. Each antonym in the sample was assessed in four different affective dimensions and a multidimensional item response theory (IRT) model was proposed to calibrate participants’ responses. Our results confirmed the aged-related positivity effect and argued for the development of age-adjusted affective norms.
Quantifying Age Differences in the Affective Evaluation of Chinese Antonyms

Introduction

The past decade has witnessed significant advances in research on emotion. A wide range of methodologies, procedures, and tasks, such as implicit memory task, free recall task and recognition task, was used to study emotion. Meanwhile, various types of stimuli have been used in exploring emotional processes, including pictures of facial expressions, static pictures of emotional scenes, video clips, imagery inductions, nonlinguistic verbalizations, environmental sounds, prosody, and spoken and written words. Therefore, standardized stimulus database is no doubt becoming a necessary and powerful tool which provides researchers a better control material in investigating affective-relevant processes. To date, an increasing number of affective norms for different types of stimulus materials have been created and widely used in various experiments, for instance, the International Affective Digitized Sounds (IADS; Bradley & Lang, 1999b) and the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 1999).

Specifically, more and more studies have used words as stimuli for studying emotional processing. Owing to the argue need, several affective word norms for different language including various affective dimensions have been development, such as Affective Norms for English Words (ANEW; Bradley & Lang, 1999), Berlin Affective Word List (BAWL; Võ, et.al, 2006), and Spanish adaptation of ANEW (Redondo, et.al, 2007). In Taiwan, there was an affective norm for Chinese words in relation to different dimensions reported by Lee & Lee (in preparation). Among those databases, valence, arousal level, concreteness and familiarity were four dimensions often mentioned. In Lee & Lee (2006), they found out that negative words had a higher level of concreteness rating than the positive and neutral words. The positive words were rated to be more familiar than the other two categories. In addition, emotional affect has been conceptualized along two dimensions:
valence, which describes the extent of pleasure or sadness, and arousal, which describes the extent of calmness or excitation (Russell, 1980; Lang and others, 1993; Kensinger, 2004).

The newly proposed U-shaped model (Winston and others 2003, 2005; Cunningham and others 2004) postulates the relation between the two dimensions is a U-shape curve. That is, both more negative and more positive word can increase our feeling of arousal, whereas neutral valence words do not usually vary our level of arousal. The same result was also showed in a study in the chemosensory domain (Lewis et. al, 2006) and the report of Spanish adaptation of ANEW (Redondo, et.al, 2007).

Unfortunately, those norms mentioned above were developed upon data collection from younger population and were not age representative. Research findings of the age-related positivity effect in many life-span studies suggest the significant differences to identical affective stimuli between older adults and younger adults. Many studies related to the interplay of aging and affective have documented significant age differences in reaction to affective materials. In recognition and recall tasks, older adults are more likely to ignore or forget negative information and also sometimes relatively more likely to attend to or remember positive information than younger adults are. For example, older adults responded faster to the happy faces than neutral faces, and they responded faster to the neutral faces than angry faces. Younger adults, however, were faster to detect discrepant faces when the facial expressions were angry than when they were sad or happy (Charles, Mather, & Carstensen, 2003). Likewise, in a study of preferences and memory, older adults preferred and remembered the advertisement with emotional slogan better than the slogans about exploration and knowledge (Fung & Carstensen, 2003). In the presented study of affective evaluation of word, Liu and Sheu (2008) used 15 antonyms and 105 abstract words testing the age difference in neutral words. The result revealed that older adults performed a marked age-related positivity effect in a neutral stimuli only paradigm. Older adults rated Chinese
abstract words more positively than younger adults. Even for the Chinese antonyms which are composed of two characters with opposite meaning, older adults also rated them more positively than younger adults did. The same findings were also reported by other researches: compared with younger adults, older people decreases in processing of negative information, but not from increases in processing of positive information. Wood and Kisley (2007) reported that responses to negative images declines linearly with age, but responses to positive images is surprisingly age invariant across most of the adult. Taken together, these studies suggest a constraint in current usage of the affective norms.

Taken together, these studies have demonstrated the age effect by presenting explicit neutral, negative and positive stimuli. However, the valences of these stimuli were defined by the experimenter and consequently the experiment somehow became a kind of categorization tasks with clear valence boundaries. Therefore, to avoid the experimenter effects has become an important issue. Duckworth et.al. (2002) have reported that even novel and nonrepresentational stimuli could elicit automatic evaluation and suggested that all experience is continually evaluated as either positive or negative without conscious thinking. From the point of view, we would predict that even ambiguous stimuli could also elicit affective response; meanwhile, based on the age differences found in the previous studies, we also anticipate that older adults may generate different responses toward identical stimuli opposed to younger adults.

In this way, we reported a survey of affective responses toward Chinese antonyms by young and old subjects for investigating the age differences in the affective evaluation.

**Chinese antonym**

Chinese antonym is composed of two characters with opposite meanings in one dimension. The antonymy relation makes Chinese antonym ambiguous in meaning, and therefore gives rise to multiple interpretations. Human perceptions for the antonyms are
unstable and alternate between the possible interpretations. What people recognize and respond to an antonym depends on their prior experience with this word. The top-down processes in mind decide the possible interpretation of an antonym. For example, if a person unconsciously pays more attention on 貧 (poor) when seeing 貧富 (poor-rich), he/she may rapidly associate negative feeling and then generates negative evaluation toward the word. In other words, attention bias could lead to opposite response for an antonym. Devoid of context, either meaning could claim dominance and gain more weight in how the word is interpreted. Seeing the opposite meaning of antonyms, it is worth using Chinese antonyms to investigate whether the subjective affective response toward ambiguous stimulus could vary diversely with age changes or not. The weights can be determined by a forced-choice paradigm.

**Item response theory**

Item response theory (IRT) has emerged as a popular approach for solving various measurement problems, and widely used in assessment and evaluation research. Traditional approaches to measurement scales (i.e., classical test theory) are based on the averages of items and have failed to consider subject’s ability on a particular item. In contrast to the CTT approach, IRT refers to a set of mathematical models that describe the relationship between items and respondents in probabilistic terms. That is, IRT is a transformation of the raw scores so that the items and the respondents are simultaneously located on the same scale. The idea behind IRT is that people respond to items on tests based on their ability and the difficulty of the item.

**A Multidimensional Approach for Polytomous Items**

Seeing that subjects evaluated antonyms in terms of four dimensions, an appropriate way to carry out the analysis is through a multidimensional approach. A Multidimensional
Item Response Model known as the Multidimensional Random Coefficient Multinomial Logit (MRCML) Model (Adams, Wilson & Wang, 1997) was fitted. Multidimensional item response model provides us a methodology for combining information from different dimensions according to how well the latent variables are correlated and provides the estimates of levels on the latent traits. In this study, we carried out a partial credit model (Masters, 1982) for multidimensional data with ordered response in which the response categories are scored so that the total score of a respondent represents a rating of the person’s location on a latent scale and the increment between two categories for items are allowed to be different. The probability formula for multidimensional partial credit model can be expressed as:

\[
P(0) = \frac{1}{\gamma} \\
P(1) = \frac{\exp(\theta_{j,d} - \delta_i - \tau_{i,d} - c_g)}{\gamma} \\
P(2) = \frac{\exp(2\theta_{j,d} - 2\delta_i - \tau_{i,d} - \tau_{i,2d} - c_g)}{\gamma} \\
P(3) = \frac{\exp(3\theta_{j,d} - 3\delta_i - \tau_{i,d} - \tau_{i,2d} - \tau_{i,3d} - c_g)}{\gamma} \\
P(4) = \frac{\exp(4\theta_{j,d} - 4\delta_i - c_g)}{\gamma}
\]

where \( \gamma = \sum_{m=0}^{4} \exp \left[ \sum_{i=0}^{m-1} (\theta_{j,d} - \delta_i - \tau_{i,d} - c_g) \right] \)

The symbol \( \gamma \) denotes the sum of the numerators of the five categories, and the symbol \( d \) corresponds to the number of dimensions. Hence, this approach estimates latent abilities across dimensions simultaneously. \( \theta_{j,d} \) represents the latent ability of subject \( j \) in the \( d \) dimension. Therefore, the person's abilities in each dimension can be represented by the ability vector \( \Theta = (\theta_1, \theta_2, \ldots, \theta_D) \). Item difficulty has been divided into two components—the average difficulty of the item \( \delta_i \), and the incremental (also called “step” parameter) \( \tau_{i,d} \). \( \tau_{i,ld} \) denotes the \( l^{th} \) cutpoint between categories for the \( i^{th} \) item in the \( d \) dimension. For an item with five categories, there are four cutpoints \( (\tau_1, \tau_2, \tau_3, \tau_4) \). The step parameters are allowed to vary across items; whereas, the sum of the step parameters of single item is equal to zero.
Then the probability of each category of response for an item depends on the difficulty of all
the thresholds for the item. $c_g$ denotes an average difficulty level for each group.

In IRT framework, one essential feature is that item properties are invariant across
different the samples of respondents. This means that the item parameters remain stable even
when the items are rated to different groups of people. Consequently, the benefit of IRT
model is the new and objective scale with equal interval which can help us to know that
which category an antonym is more likely to be endorsed by subjects.

The Presented Study

Currently the commonest way used in describing the relation between the materials
of the affective database is the mean scale method, which departs from the assumption of
Likert-type scale. With regard to this, an item-specific analysis by applying the
Multidimensional Item response theory (IRT) was used as an alternative for calibrating
evaluative responses toward words adjusted by age and affective dimension. Thus, it can help
us to know the quality of the antonym in the four affective assessments.

The second, this article used Chinese antonyms to investigate the impact of age in
subject’s feeling toward stimulus in emotional task. We sampled both young and old groups
as subjects, and used 25 Chinese antonyms as stimuli to collect the subjects’ perceived
meanings of these antonyms in terms of valence, arousal level, concreteness and familiarity. A
forced-choice paradigm via paper-and-pencil questionnaires was used to detect whether
younger and older adults respond differently to targets or not.

In this study, we used the ConQuest software (Wu, Adams, & Wilson, 1997) to
performance the multidimensional IRT model. Age was included as a factor in the model.

Method
Participants

A sample of 213 younger adults (89 females and 124 males, age ranged from 18 to 25) and 170 older adults (78 females and 92 males, age 60 years or above) from Central and Southern Taiwan were asked to rate the same 25 antonyms across dimensions on a 5-point rating scale. The degrees of educations were restricted to an elementary school level and above.

Materials

25 Chinese antonyms were randomly selected from the word list used in the study by Chu and Sheu (2009) according to the rank of valence score ranging from the twenty-fifth to the seventy-fifth. The used 25 Chinese antonyms and its adaptations of English are shown in appendix A.

Procedures

The survey was conducted in university and college campuses, municipal parks, office buildings, and coffee shops in Central and Southern Taiwan. Each subject received a questionnaire containing the 25 antonyms, and the instruction sheet. Subjects were instructed to rate each word immediately when they saw it at the first moment in order to avoid any bias of their feeling. A word was used as example to give the subject a basic reference. After reading the instructions and before evaluating the words, any doubts were solved before starting the assessment.

Each antonym was evaluated in a 5-points scale for four dimensions respectively (valence, arousal level, concreteness and familiarity). For valence, larger numbers indicate more positive valence and smaller numbers indicate more negative valence; point 3 indicates neutral. For arousal, larger numbers indicate high arousal and small numbers indicate low arousal and calm. For familiarity, larger numbers indicate more familiar and small numbers indicate less familiar. And for concreteness, larger numbers indicate more concrete and small
numbers indicate more abstract. The presentation order of words and the order in which each dimension was evaluated were randomized.

**Results**

We first introduced the meaning of the new scale briefly. For the polytomous item with five categories (1~5), when an item parameter, also called ‘item difficulty’, is smaller than zero, it means more subjects generate responses ‘4’ or ‘5’ toward this item. On the contrary, when an item parameter is larger than zero, it means more subjects generate responses ‘1’ or ‘2’ toward this item. In terms of the person’s ability, it is a oppose situation. When person’s ability is lower than zero, it means he/she has higher probability to generate more responses ‘1’ or ‘2’; whereas, when person’s ability is higher than zero, it means he/she has higher probability to generate more responses ‘4’ or ‘5’ for all items.

The average difference in performance between the two groups is statistically significant ($z = 0.229/0.005 = 45.8$) at the .05 level. Therefore, in sum, older adults tended to score higher toward the antonyms, whereas younger adults tended to score lower toward the antonyms. The same result can be seen in the following figure.

Additionally, as mentioned before, one of the beautiful features of IRT is that item and participant can be expressed and located in one logit scale. A straightforward plot named ‘Item-Person Map (IPM)’ provided by IRT is a visualized and meaningful tool showing the relationships between items, subjects and groups. All of them can be presented on the vertical line of the IPM, in which all types of information are evaluated simultaneously. The IPM illustrates the connection between group and item and participant locations, enabling a very rich repertoire of interpretations of the relative locations of respondents and items (see Wilson et al., 2006).

Figure 1 shows the IPM of the four dimensions. The four left panels display the
distribution of participants’ latent ability of the four dimensions and all the 25 antonyms are plotted in the four right panels according to their difficulties of dimensions. Moreover, the two groups are located in the middle panel based on the overall difficulty of each group. Therefore, they can be compared side by side. It is helpful to interpret the relationships between words and subjects, and the difference of groups.

Subjects who were likely to give high score to words are located toward the top of the distribution on the left panel. The IPM also showed clear evidence that younger and older adults responded differently toward the 25 antonyms. On average, older subjects had a tendency to rate the 25 antonyms across the four dimensions higher than younger adults did. Young people tended to generate high arousal, more concrete, more familiar and less positive responses toward antonyms in the four dimensions respectively.

Figure 1

From the perspective of items, items are plotted to indicate their difficulty level. Antonyms on the upper right hand side were more likely to receive low scores. Therefore, by looking at the location of the right hand side, we can tell which antonym is thought as, for example, more positive.

In arousal, subjects were more likely to feel “成敗 (successful-defeated)” as “high arousal”, whereas subjects were more likely to feel “橫豎 (horizontal-vertical)” as “low arousal”. Thus, on average, “成敗 (successful-defeated)” is the most high arousal word and “橫豎 (horizontal-vertical)” is the most calm word among the 25 antonyms.

In concreteness, subjects were more likely to feel “高低 (high-low)” as “most concrete”, whereas subjects were more likely to feel “虛實 (empty-full)” as “most abstract”.
Thus, on average, “高低 (high-low)” is the most concrete word and “虚實 (empty-full)” is the most abstract word among the 25 antonyms.

In familiarity, subjects were more likely to feel “高低 (high-low)” and “對錯 (right-wrong)” as “most familiar”, whereas subjects were more likely to feel “陰陽 (lunar-solar)” as “most unfamiliar”. Thus, on average, “高低 (high-low)” and “對錯 (right-wrong)” are the most familiar word and “陰陽 (lunar-solar)” is the most unfamiliar word among the 25 antonyms.

In valence, subjects were more likely to feel “往返 (go-return)” as “positive”, whereas subjects were more likely to feel “疏密 (sparse-dense)”、“虚實 (empty-full)” and “漲跌 (rise-fall)” as “negative”. Thus, on average, “往返 (go-return)” is the most positive word and “疏密 (sparse-dense)”、“虚實 (empty-full)” and “漲跌 (rise-fall)” are the most negative word among the 25 antonyms.

On the other hand, IRT provides a new scale ranking items with objectivity and equal interval. Table 1 lists the relatively item locations of each dimension both in multidimensional IRT and in the mean score method. As can be seen in table 1, there are considerable differences in the relatively locations of items conducted by the two methods.

Under the classical method, For valence, IRT method showed that “往返 (go-return)” was rated most positively, whereas, “正反 (observe-reverse)” got highest average score. For arousal, both IRT method and mean score method showed that “成敗 (successful-defeated)” was rated most arousal. For concreteness, both IRT method and mean score method showed that “高低 (high-low)” was rated most concrete. For familiarity, IRT method showed that “高低 (high-low)” was rated most familiar, whereas, “對錯 (right-wrong)” got highest average score. The differences are supposed from the different parameter estimated function of the two methods. Compared with the mean score method, IRT models are fitted on the
probability that a person will make a particular response according to their latent abilities.

In summary, the MIRT methods hold promise of more precisely estimating for the quality of antonyms.

Table 1

Conclusion

The presented study employed the multidimensional item response theory to figure out the attributes of the 25 antonyms in the four dimensions simultaneously. The multidimensional IRT models rescaled the 25 antonyms in a new scale which is objective and has equal interval, providing more precise information on the item level than the classical method and suggesting us a powerful tool to develop a short, reliable questionnaire by select stimulus material based on the new scale in the future.

Moreover, the age difference was also found in this study. IRT is appropriately applied to explain the quantitative difference between younger and older adults. The result showed that identical targets appeared to elicit an age difference, highlighting a considerable modification that the age factor should be included into the affective norm and words should need to be indexed by age. Naming, affective norms should be age adjusted. That points out the limitation of those presented affective norms now in use. Seeing that norms for emotional words may be age-dependent, affective norms which are across age are more appropriate in investigating the interplay of aging and cognition and needed to be established.

This paper has illustrated the use of item response theory to calibrate affective evaluation toward words. The implement of IRT model demonstrated an encouraging improvement in the measurement of stimuli, providing more precise estimates of the relationship both on item and respondent level and a more comprehensive understanding of
the true nature of the relationship when developing norms.
References


Appendix A. The 25 Chinese Antonyms and the Adaptations of English

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<td>公私</td>
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</tr>
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<td>3</td>
<td>凹凸</td>
<td>concave-convex</td>
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<td>正反</td>
<td>observe-reverse</td>
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<td>positive-negative</td>
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<td>many-few</td>
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<td>橫豎</td>
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<td>25</td>
<td>鬆緊</td>
<td>loose-tight</td>
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Table 1  Item Locations in Multidimensional IRT and Mean Score Method

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</table>

* presented by the index of item (see appendix A.)
**Figure 1** The multidimensional Item-Person Map. Items are shown by their index.
Always look on the bright side of life:
Aging and positivity effect

Ching-Fan Sheu

Institute of Education
National Cheng Kung University

30 June 2011
Outline

1. Introduction
2. The age-related positivity effect
3. The socio-emotional selectivity theory
4. A neutral stimuli only paradigm
5. Automatic evaluation of words
6. Age-related changes in ratings of Chinese antonyms
7. An industrial application
8. Conclusions
Collaborators & Former Students

Chi-Ying Liu, Hsin-Hua Chen & Mei-Chen Chu
Aging - Imagining it versus living it
The age-related positivity effect - memory

After making a choice, older adults tend to produce more choice-supportive memory (Mather & Johnson, 2000).

Option 1

**VOLVO**

<table>
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<tr>
<th>Advantage</th>
<th>Disadvantage</th>
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Option 2

**TOYOTA**

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<th>Advantage</th>
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<td>Hard to control</td>
</tr>
<tr>
<td>Lower price</td>
<td>Safety</td>
</tr>
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</table>
The age-related positivity effect - attention

- The dot-probe task (Mather & Carstensen, 2003). Compared with responses to neutral faces, older adults responded slower to the probe behind negative faces and faster to the probe behind positive faces. Younger adults showed the opposite.
The age-related positivity effect - preference

- Emotional advertisements work better with older adults (Fung & Carstensen, 2003).
The socioemotional selectivity theory

- People become motivated toward pursuing emotion-related goals as oppose to other goals as their expected time to live become shorter (Carstensen, et al., 1999).
Motivated cognition

Figure: Is the glass half full or half empty?
Some limitations of the standard approach

- The experimenter determines the stimulus valence.
- The participants may know that experimental tasks are emotion-related.
- Age effect is confounded with cohort effect.
Research questions

1. Could the age-related positivity effect be observed in a neutral stimuli only paradigm?
2. Could the age-related positivity effect be observed in an automatic evaluation paradigm?
3. Do ratings of words change across age?
4. Could the age-related positivity effect be found in ecologically valid stimuli?
Rating neutral words

- Participants were 63 older adults (mean age = 64; 32 females, 31 males) and 61 younger adults (mean age = 24; 33 females, 28 males).
- They rated 120 neutral words on a 5-point scale.
Results

Ratings of Words by Young and Old Adults

Mean Proportions of Categorical Responses

Negative Neutral Positive

●
●
●
●
●
●
●
●
●
●
●
●

Old
Young

Ratings of Words by Young and Old Adults

Positivity Effect
Analysis

A Model for Age Effect in Judging Neutral Words

Valence

Probability

Old Young

Positive

Negative

Sheu (NCKU)
A Model for Age Effect in Judging Neutral Words

Probability
Valence
Old Young
Positive Negative

Sheu (NCKU)
Positivity Effect
30 June 2011
Analysis and results

- A generalized mixed-effects model was used to account for the data.
- The estimated distance between the cut points used by older and younger adults to judge neutral versus positive was significantly different (1.863, SE = 0.074).
- The estimated shift in the antonyms condition for younger adults was also significant (-1.005, SE = 0.083).
Conclusions

- The positivity bias were found for both young and old participants.
- The positivity effect was stronger for older participants.
- Younger adults rated antonyms more negatively than older adults.
- The results supported the socio-emotional selectivity theory in a neutral stimuli only paradigm.
Automatic evaluation of Chinese antonyms

- To examine the age-related positivity effect in an automatic evaluation paradigm.

- “Evaluative responding can be immediate, unintentional, stimulus-based and linked directly to approach and avoidance motives.” (Duckworth, et al., 2002).

- Preferences need no inferences (Zajonc, 1980).

- Embodied cognition (Niedenthal, et al., 2005).
### Chinese antonyms

<table>
<thead>
<tr>
<th>Chinese</th>
<th>English</th>
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<tbody>
<tr>
<td>上下</td>
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<td>true-false</td>
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<td>high-low</td>
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</table>
Participants & procedures

- Participants were 48 older adults (60 years or above; mean age = 67; 23 males & 25 females) and 53 younger adults (18 to 30 years; mean age = 23; 22 males & 31 females).
- Sixty-eight neutral words and 68 Chinese antonyms were used.
- At each presentation of a word, the participant was asked to pull (or push) the lever toward (or away) from himself/herself.
- Data from participants who did not use affect-related criteria in determining their responses were removed.
Procedures - continued

Method

- Use joystick to control the direction of words (approach and avoidance).

Participants

- 20 younger adults (18 to 24 years old): 10 males and 10 females
- Some data were dropped from this study because they didn't make judgments by emotional valence (positive and negative).

Stimuli

- A sample of 68 abstract words and 68 antonymic words
Analysis and results

- For each individual, pull/push distances were transformed to signed ranks.
- Type III test of fixed effects

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</table>
Results - 95% CIs

Means of Signed Rank

Old.Abs    Old.Anto    Young.Abs    Young.Anto

Sheu (NCKU)
Conclusions

- On average, younger adults evaluated antonyms significantly more negatively than neutral words. No such difference was found for older adults.

- Regardless of word types, older adults made significantly more positive evaluations compared with younger adults.

- The results were consistent with those found in ratings of neutral words.

- The age-related positivity effect was found in the neutral stimuli only paradigm using two different response modes.
Rating of antonyms across age

Is there an age-related positivity shift in the perceived meanings of words?

- A list of 100 antonyms were chosen from a database maintained by the Ministry of Education of Taiwan.
- We selected middle or low frequency antonyms (1 to 28 per million) with number of strokes ranged from 6 to 36.
- Each word was assessed for familiarity, concreteness, arousal level and emotional valence using a 5-point scale (Lee & Lee, 2007).
Rating of antonyms across age - participants

A total of 793 persons participated in the study.

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</table>
Results - Biplot

Sheu (NCKU)

Positivity Effect

30 June 2011
### Results - Emotional valence by age

| Age (years) | 20 | 40 | 60 | 20 | 40 | 60 | 20 | 40 | 60 | 20 | 40 | 60 | 20 | 40 | 60 | 20 | 40 | 60 | 20 | 40 | 60 |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Positivity Effect | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) | ![Graph](image.png) |
Results - 10 most positive antonyms by age

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Valence Rating of top 10 Words

Positivity Effect

Sheu (NCKU)
### Results - 10 least positive antonyms by age

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#### Positivity Effect

Sheu (NCKU)
Level of emotional arousal by age

| Age (years) | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 320 | 340 | 360 | 380 | 400 |
|-------------|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Positivity Effect |

Sheu (NCKU)
Conclusions

- The perceived valences of antonyms seemed to shift toward positivity across age.
- Ratings for the level of arousal did not show similar shift toward positivity.
- Affective words might need to be age normed.
An industrial application
Participants & procedures

- Participants were 54 older females (50 to 65 years) and 51 younger females (30 to 45 years).
- Sixteen negative statements and 19 positive statements were used.
- The participants endorsed the valence of each statement on a seven-point scale (-3 to 3).
- The participants also filled out a questionnaire on aging anxiety.
Results

Mean Ratings by Both

Order
Mean rating
33
5 13 4
30
2
17
29 21 27 11 28
3 31 7 14 18 24 35 1 19 25 26 32 12 20
34 22 9
6 16 8 15 23
10

Mean Ratings by Both

Sheu (NCKU)
Results - continued

Mean Ratings by Old

Mean Ratings by Young

Sheu (NCKU)
Results - continued
Results - continued

Sheu (NCKU)

Positivity Effect

30 June 2011 39 / 43
## Type III Test of Fixed Effects

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Conclusions

- Older and younger adults did not differ in their mean ratings for positive statements.
- Older adults gave higher average ratings for negative statements than did younger adults.
- The average ratings of negative statements were not different from those of positive statements.
- Judging negative stimuli as positive may be a more effective strategy for successful aging than pursuing positive stimuli.
Psychological immune system - Looking at life through rose-tinted glasses
Thank you!

- Comments?
- csheu@mail.ncku.edu.tw
<table>
<thead>
<tr>
<th>國科會補助計畫</th>
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<td>學門領域: 實驗及認知心理學</td>
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無研發成果推廣資料
### 98年度專題研究計畫研究成果彙整表

**計畫主持人：許清芳**  **計畫編號：98-2410-H-006-021-**

**計畫名稱：老化，反義字，及體現認知量化**

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<th>本計畫實際貢獻百分比</th>
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其他成果
(無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)

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請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   ■達成目標
   □未達成目標（請說明，以 100 字為限）
     □實驗失敗
     □因故實驗中斷
     □其他原因
   說明：

2. 研究成果在學術期刊發表或申請專利等情形：
   論文：□已發表 □未發表之文稿 ■撰寫中 □無
   專利：□已獲得 □申請中 ■無
   技轉：□已技轉 □洽談中 ■無
   其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

   Future directions. Embodied cognition research has shown that evaluative approach and avoidance movements could be made to depend on the relation to the abstract self-representation rather than the relation to physical self. Even though embodiment underlies social and emotional information processing, few, if any, studies have examined the interaction between aging and embodiment. This project has made some progress toward investigating the experimental settings that combine evaluation of antonyms with various modes of self-representation. One of the key problems which needs to be resolved is how to manipulate the directions and magnitudes of embodied cognition. Individuals also vary in their ability to relate with abstract icons on screen that are supposedly representations of themselves. In other words, there are serious measurement issues in how to construct a scale for the approach-avoidance movements so that comparisons across individuals and between groups are possible.