Design and development of an empirical smiley-based affective instrument

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Abstract. Smileys (also known as Emoticons or Emoji) are regularly used to convey emotion within internet communications, especially in text-centric media such as email and instant messaging. Herein we describe an approach to utilise these well known affect emblems to create an interactive affect indicator. The indicator displays a set of nine smileys and users are asked to select the smiley that most closely reflects their current emotional state. In order to validate the design, a small survey was conducted. Responses were analysed and the indicator updated to reflect the results. A larger survey was then performed. An initial analysis of this online survey was conducted to try and understand the emotional content embedded within users' understanding of the smileys they use. Nearly 1000 responses to the survey were collected. This report focuses on general results and then briefly examines if there are any differences based on gender, both at a quite coarse scale.

Keywords: empirical model; affective indicator; web services; affect; smileys; emoticons; emoji.

1. Introduction

Emotions play an important role in learning, exerting effects on information processing and performance [1, 2]. The Smiley Based Affect Indicator (SBAI) was developed [3] in order to create a tool that allowed learners to express their emotional states while using an online experiential training simulation [4, 5]. Uniquely, the underlying model that is used to report affective states is derived from a large online survey. It is a RESTful web service [6] that can relatively easily be integrated with or called from any internet-connected system. It was initially created to fulfil two goals:

1. To allow affect to be indicated without the need to explain a lot of theory behind the instrument. That is, it is designed as a way of conveying affect through a readily understood method widely used throughout computer-literate society
2. To allow affect indicators to be recorded by a system that could be technically separate from a system without either appearing separate or being challenging to incorporate

These goals are linked to an overarching aim to allow continuous monitoring of learners' affect while interacting with a learning technology. The gathered affect

reports may be fed back to the learning system for adaptation and personalization purposes. In addition, the affect reports inform evaluation of the learning technology by analyzing learners' reactions and activities during the learning episode

The work described herein reports the initial validation of this instrument and then goes on to outline changes made as a result of that work. It then covers the subsequent survey to collect empirical data in order to derive the underlying model. Finally, it reports on some findings from the initial model derivation.

1.1 Theory

The technical development and theoretical underpinnings of the SBAI are described elsewhere [2]. Briefly, in 1980, Russell formalised the theory that healthy humans do not suddenly experience emotional states but are in flux, moving through different emotions and different magnitudes of emotions [7]. He created the circumplex – a set of fundamental emotions arranged in a circular order. He concluded that human emotions move along the circumference of his circumplex – so that, for example, a human experiencing pleasure would never immediately experience depression, but would (no matter how fleetingly) also experience contentment and sleepiness (taking the shorter path). He then simplified the circumplex to consist of two dimensions: the valence of the affect (i.e., variation along a positive-negative or pleasure-displeasure dimension), and the intensity or arousal level of the affect (i.e., low vs. high intensity or activation).

Reductive facial expressions are a well established way to elicit self reporting, especially from young children [8]. For example, the FACES pain scale [9] uses a set of 7 pictures. Patients (typically 4-8 years old) are asked to point to the picture that represents the kind of pain they are feeling, starting with no pain on the extreme left, to the most pain ever on the extreme right.

Figure 1. The FACES pain scale: Reprinted from [9], with permission from Elsevier Science;

The idea behind the SBAI is similar, to use a reductive representation to prompt the user for a self-report. Bartneck [10], for example, has shown that human beings tend to find the emotional expression from a simple caricature such as smiley more distinct and easily recognizable, in comparison to a real human face. Product design also uses pictorial scales, such as the PrEmo system by Desmet *et al* [e.g. 11].

There are currently two other emoticon-based affective indicators. One, which is embedded within Crystal Island [12] is a vertical list of seven emoticons with single word sense labels is presented to the learner at 9 minute intervals. However, this instrument is tightly integrated into the larger learning system and it's triggering is not

within the control of the instructional designer. The second is the Mirror project[1] MoodMap widget (also described in [3]). This prompts separately for Valence and Activity values using two series of icons. It requires a more nuanced approach to affect self-awareness and reporting, with some explanation and training required to explain what is sought for each icon set.

Affective agents attempt to leverage on the inverse of this, providing affect cues to the learner, for example, Okonowo's emotional pedagogical agent called "Smiley" [13] that adapts his expression in accordance to user behaviour or the embodied agent with MAUI [14]. A good overview of the field of embodied affective agents can be found in Beale's overview [15].

1.2 Understanding Emoticons

Emoticons have been in use on the internet for over 30 years, with the first recorded usage of them within an email recorded in 1982 (James.Morris at CMU-10A. "Notes – Communications Breakthrough" [16]). They are primarily used to add emotional notation to textual communication [17]. As computer-based text has become richer, emoticons have evolved from simple combinations of punctuation symbols to pictorial representations, often referred to as Emoji. These Emoji first emerged in Instant Messaging clients (such as MSN Messenger) but have become widely adopted, with many services now providing a wide range of Emoji libraries of varying styles to choose from (*cf.* Adium emoticon sets[2]).

2. Methods

Two surveys were conducted, a first, closed survey to provide a pilot validation of the SBAI, and then a subsequent, open survey to collect data with which to build a model of affect values embodied by the SBAI.

2.1 Survey Design

Both surveys were deployed on LimeSurvey [18]. Each survey consisted of three parts:

1. An introduction, instructions and demographic information collection
2. A page presenting a smiley, then two nine point Likert scales to record valence (-1 through 0 to +1 for positive or negative embodiment) and activity (0 to 1 for strength of affect signal). A text box to have a single word that the respondent felt best described the smiley followed this. This was repeated nine times, one for each smiley used in the SBAI.
3. A conclusion page, with free text area for comments

[1] http://www.mirror-project.eu/

[2] http://www.adiumxtras.com/index.php?a=search&cat_id=2

The smileys were arranged in an order the authors perceived as most negative to most positive. This is the same arrangement (reading left to right and top to bottom) as on the default SBAI grid, as shown in Figure 2 (other arrangements are available from the web service).

Whilst this constructive ordering of the smileys in the survey may provide some first order skewing of the results, it was felt that was an appropriate sacrifice to make rather than have a random sequence of presentation, as, at the time of the survey design, it was not possible to anticipate the number of those taking the survey. If the sample size had been a small number, it was felt that the ordering effect would be a major confounder in any analysis.

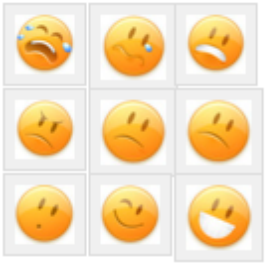


Figure 2 The pilot rendering of the Smiley Based Affect Indicator – a 3x3 grid ordered from most negative (top left) to most positive (bottom right). Note this is the original version (*cf.* **Figure 4**)

2.2 Validation Cohort

The validation cohort was recruited by an email to the researcher's colleagues and a single tweet, both containing a link to the survey. 22 replies were received in 10 days. Survey results were analysed using MS Excel 2011 on a Macintosh. 3 responses were excluded from the analysis, as they were incomplete. Of the 19 responses analysed, 5 were from females, 14 from males. Ages ranged from 22 to 48 with the average being 33.8 (SD 7.5). All had experience of further education.

2.3 Model Cohort

The model cohort was recruited by email (including one sent to every member of Trinity College, Dublin) and several tweets, both methods containing a short outline of the goals of the survey and then a link to the survey itself. The link was via a URL shortening service (http://bitly.com) that provided some analytics for the responses, in addition to that provided by the survey itself.

996 complete replies were received in 2 months. The cohort was composed of 285 women, 700 men and 11 respondents preferred not to say. Reported ages ranged from 15 to 103, with an average of 26.7 (SD 10.4). Analytics point to a large number of

responses to have been made in answer to the mailing to Trinity College; so cultural referents are skewed as a result. For example, nearly 70% of respondents give their country of birth as Ireland, and over 90% give Ireland as their country of current residence.

3. Results (Validation)

3.1 Valence vs Arousal

The average and standard deviation for each of the nine smileys were calculated. A graph of the Smileys plotting Valence vs Arousal is show in Figure 3 below:

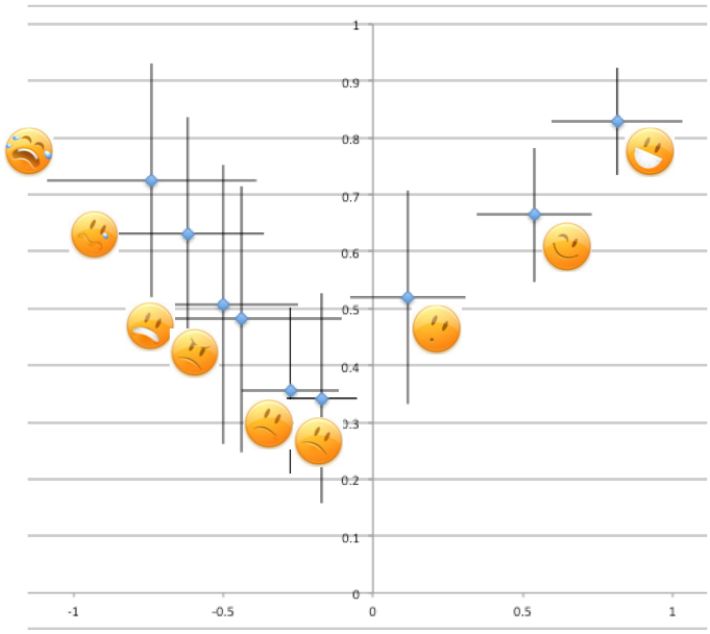


Figure 3. Smileys plotted on Valence vs Arousal with standard deviations displayed.

3.2 Smiley Sense Words

A table of each of the unique words entered for each smiley is shown below in **Table 1** (that is, redundancy only has been removed). It was soon discovered that the instruction to use a single word had not been obeyed in all cases – these compound sense phrases were recorded anyway. Sense stem words, produced by reducing the previous list to the base-level emotive word (for example, sadness, sorrow, tears, misery are all stemmed to "sad") are displayed in **Table 2**.

Table 1. Unique sense word / phrases from the validation survey per smiley.

Smiley	Unique sense words / phrases
1	*deep sadness, crying, sorrow, tears, sadness, hopelessness, Distraught, Upset, Happy but worked hard, wah, tantrum, sad, Despair, misery, desperation, distraught*
2	*undecided, sad, thrill, sorrow, unhappiness, Upset, a bit sad, sob, tearing up, hurt, ridiculus, sniff, sadness*
3	*disappointed, accident, embarrassment, angry, sadness, Anxious, stressed, grimace, worry, tense, Awkward, riduculus, afraid, disgusted, annoyed*
4	*unhappy, annoyed, anger, angry - upset, Angry, more angry, frown*
5	*wondering, unimpressed, query, depressed, disappointed, disappointment, Unhappy, being quiet, dismay, concerned, uncertain, perturbed, Bemused, perplexed, indifferent, sad, disappointed, down*
6	*neutral, unhappy, query, sad, disappointed, sadness, slightly not good, dismay, uncertain, perturbed, Peeved, Indifferent*
7	*Interested, surprise, jolt, surprised, amazement, concern*
8	*encouragement, smug, agreement, funny, happy, complicity, Understanding, joking, "OK, sounds good", wink, cheeky, clever, conviviality*
9	*very happy, beaming, happiness, happy, jubilant, cheery, smile, Delighted, agreement, laugh, excited*

Table 2. Stemmed sense words from the validation survey per smiley.

Smiley	Stemmed Unique sense words / phrases
1	*sadness, upset, anger, despair, exhausted*[3]
2	*undecided, sad, thrill, upset, hurt, ridiculous*
3	*disappointed, accident, embarrassment, angry, sad, anxious, worry, awkward, ridiculous, afraid, disgusted, annoyed*
4	*unhappy, annoyed, anger, confused*
5	*wondering, unimpressed, query, disappointed, unhappy, being quiet, dismay, concerned, indifferent, sad*
6	*neutral, unhappy, query, sad, disappointed, slightly not good, dismay, uncertain, perturbed, peeved, indifferent*
7	*interested, surprised, amazement, concern*
8	*encouragement, smug, agreement, funny, happy, complicity, understanding, joking, "OK, sounds good", wink, cheeky, clever, coniviality*

[3] Stemmed from “happy but worked hard”

4. Discussion of Validation

The value of the word reports shows up when comparing smiley pairs 3 & 4 with 5 & 6. Although these two pairs show marked overlap in averages (especially when standard deviation is taken into account), there is a marked difference in the word senses attached to 3 & 4. However, there is little difference in the word senses attached to 5 & 6, stressing the similarity of the images, as perceived by the validation cohort.

In order to represent the utility to which the SBAI is put, the emoticons were deliberately displayed consistently in a certain order for the survey. Perhaps if the smileys had been presented in a random order to each participant, there may have been different sense words or valence/arousal values entered. However, that independent appreciation of the emoticons would not reflect the purpose of the instrument, and may, itself, lead to confounding factors if the random order particularly skewed to one presentation order in a small validation sample.

Due to the similarity in both Valence/Arousal values and word reports, Smiley 6 was replaced with a more neutral image, as shown in Figure 4. This updated version of SBAI was used for the survey aiming at building a model of affect values (cf. section 5 below).

Figure 4. Smiley 6 was replaced with a more neutral emoticon**.**

5. Results (Model)

5.1 Valence vs Arousal

The average and standard deviation for each of the nine smileys were calculated. A graph of the Smileys plotting Valence vs Arousal is show in Figure 5.

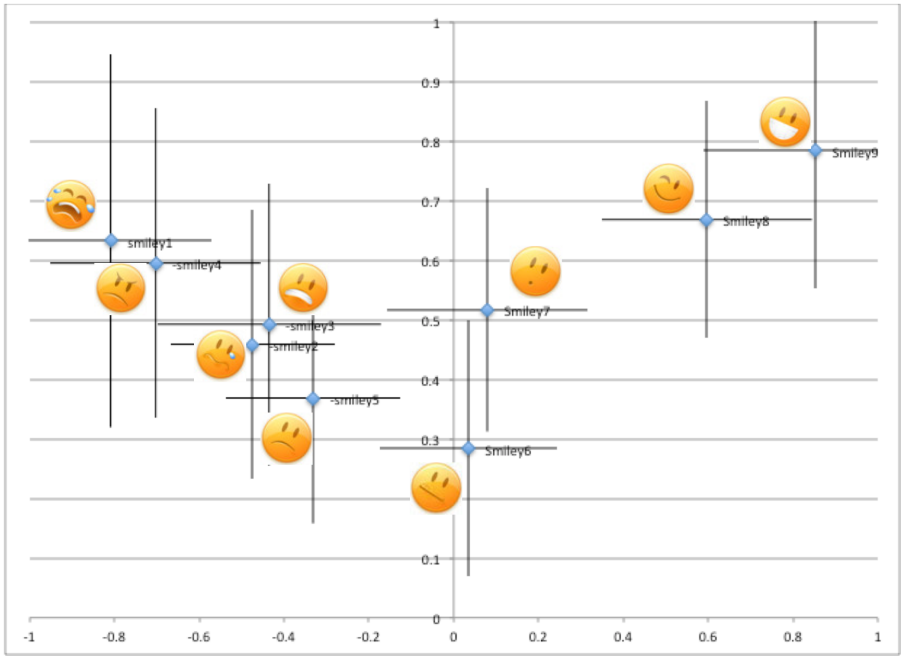
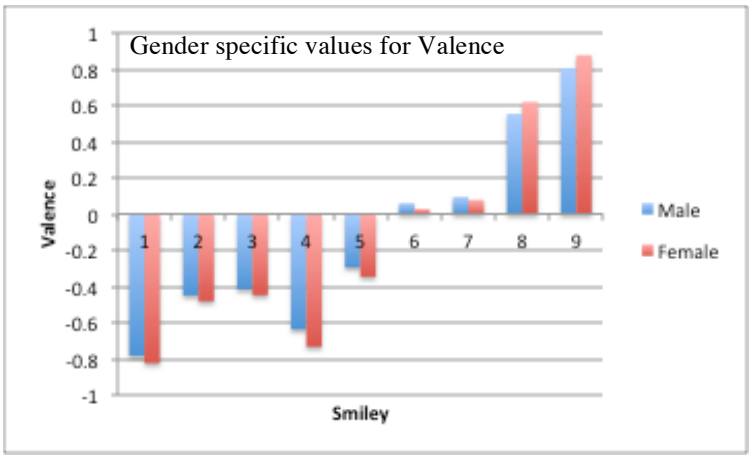


Figure 5 Plot of average valence against activity for the 9 smileys – bars are standard deviation.

The results were then categorized by gender and averages again calculated. Graphs for valence and activity are displayed in below:

a)



b)

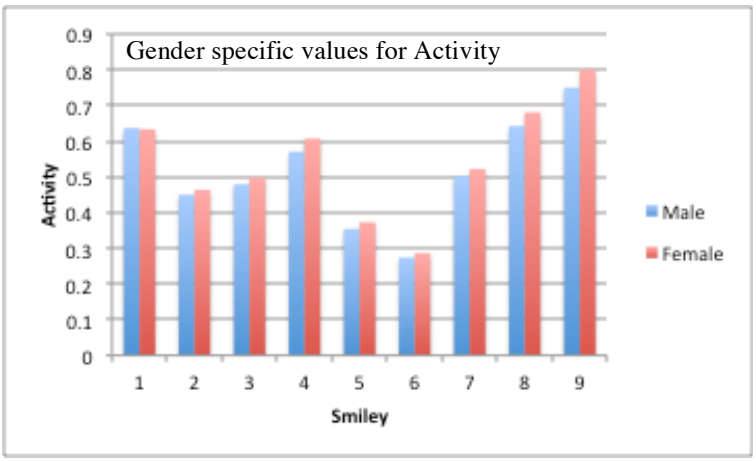


Figure 6 Plot of average valence (a) and activity (b) for the 9 smileys – by gender.

Again, respondents were asked to enter one word that they felt best expressed what the smiley was trying to represent. A first interesting result is that many felt that this was not a simple task, and indeed, some comments specifically addressed this issue, either to note that the task was difficult, or that they had ignored the instruction in order to better express themselves. For each smiley the number of unique words or phrases entered was analyzed.

Along with the top occurring word, and these can be seen in **Table 3** below:

Table 3. Number Of Unique Sense Words/Phrases and top occurring one for each smiley

Smiley	*Number of Unique Sense Word/phrases*	*Top Occurring Sense Word*
1	*210*	*Anguish*
2	*204*	*Sadness*
3	*258*	*Anxious*
4	*128*	*Anger*
5	*241*	*Unsure*
6	*309*	*Boredom*
7	*178*	*Surprise*
8	*271*	*Happy*
9	*170*	*Ecstatic*

6. Discussion of Model Results

An initial analysis of the survey responses showed that there were real differences in perception of the underlying embodiment for each of the smileys, such that they could usefully be used as a self-reporting affect instrument with confidence.

There were a variety of sense words associated with each smiley, but the variance in the number of unique words indicates that some are more singular in what they embody than others. Conspicuously, smiley 4 ( ) seemed almost universally understood as 'Anger'.

There has been much discussion about the 'basic' emotions – for example, Ekman created a list of 15, based on examinations of their cross-cultural physical embodiment [19]. It is notable that all of his list occur somewhere in the reported sense words attached to the emoticons.

Whilst the emoticons selected represent a good range of emotions, there is currently no referent for a high valence, but low activity affective state, or their inverse (i.e. extremes of valence with low activity). Of course, this is to be expected, as a highly emotionally aroused state would generally be strongly correlated to a strong affective response (valence). However, it is important to note this when the instrument is being utilized.

As a first step to a deeper examination of the data, a further analysis was performed to examine the values assigned based on gender. There were no significant differences between genders in expectations for the representation for smileys, but empirically males seem to assign slightly lower values for both valence and activity than females.

7. Conclusions and Future Work

The SBAI is a novel, RESTful web service to provide model-based affect reporting. Uniquely, that model is currently based on a survey of nearly 1000 respondents, allowing for a degree of adaptation of the base responses, depending on the profile of the user. This allows for a powerful link to be made between technologies using the SBAI and the underlying model, driving affect reporting that reflects core characteristics of the personalization. With more data collected, the number of characteristics to which the model can respond increases.

A deeper analysis of the data to investigate culture and co-factors is ongoing, however, more data will need to be collected in order to create a more heterogeneous cohort.

Several times, context was mentioned as a contributing factor to how the respondent might understand the underlying meaning of a smiley. A new experimental design in order to investigate this aspect is currently being developed.

Recently, the SBAI was deployed as part of a large cohort study on providing Affective Metacognitive Scaffolding using the ETU RolePlay Simulator – its embedding can be seen in Figure 7:

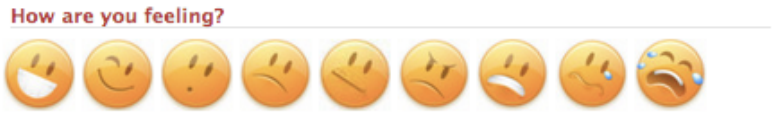


Figure 7 SBAI inserted into ETU RolePlay Simulator

It is expected that the deployment of the SBAI will allow for the development of affect-related aspects of personalized services, for example, allowing those authoring TEL material to create material that reflects the mood of the learner, perhaps delivering additional encouraging motivation and engagement during periods of negative valence and increasing the prevalence of material that generates a positive response. Monitoring affect may also provide information on the quality and tone of the materials within personalised services, allowing the curation of a corpus to ensure that material that reports negative affect states has corresponding supportive material.

Requests for access to the anonymized data for analysis or to base affect signal instruments on should be made to the corresponding author. You can take the survey yourself at: http://bit.ly/smILEY.

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