Emotion Twenty Questions: Toward a Crowd-Sourced Theory of Emotions

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Abstract. This paper introduces a method for developing a socially-constructed theory of emotions that aims to reflect the aggregated judgments of ordinary people about emotion terms. *Emotion Twenty Questions* (EMO20Q) is a dialog-based game that is similar to the familiar Twenty Questions game except that the object of guessing is the name for an emotion, rather than an arbitrary object. The game is implemented as a dyadic computer chat application using the Extensible Messaging and Presence Protocol (XMPP). We describe the idea of a theory that is socially-constructed by design, or *crowd-sourced*, as opposed to the *de facto* social construction of theories by the scientific community. This paper argues that such a subtle change in paradigm is useful when studying natural usage of emotion words, which can mean different things to different people but still contain a shared, socially-defined meaning that can be arrived at through conversational dialogs. The game of EMO20Q provides a framework for demonstrating this shared meaning and, moreover, provides a standardized way for collecting the judgments of ordinary people. The paper offers preliminary results of EMO20Q pilot experiments, showing that such a game is feasible and that it generates a range of questions that can be used to describe emotions.

1 Introduction

> There are some enterprises in which a careful disorderliness is the true method.
> –H. Melville, *Moby Dick*

Science often begins with a good question. One may wonder whether the question a scientist asks is fundamentally different than the question of a non-scientist, or whether they are fundamentally the same. It is usual, in the field of affective computing, for scientists to treat people as experimental subjects when studying

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emotions. This paper takes a contrary view, where people who would formerly be considered as experimental subjects now function more like theory-generating scientists and the scientists play more of an editorial role. This change of roles is not as substantial as it sounds, but mainly serves to give a new perspective to the study of emotions. This view, we argue, is useful for studying the non-scientific meaning of emotion words as they are used in social contexts. We do not argue against having a controlled, scientific vocabulary for studying emotions, but rather that the study of natural emotions warrants closer attention to how everyday people understand and describe emotions with natural language. This type of study falls under the umbrella terms of *commonsense knowledge* or *folk ontology* [1,2].

One function of natural language is to reference objects, whether real or virtual, using patterns of sound or writing. This system of reference provided by natural language is mainly *socially-constructed* (as opposed to innate), in that the names of things are established by the conventions of shared tradition and consensus of a community of speakers, e.g., speakers of a given language or workers in a specific profession. In some such communities, such as a scientific field, the process of socially constructing a terminology is deliberate, systematic, and precise; in other communities it is not. For example, the world-wide community of English speakers has no editorial board or royal academy to arbitrate the correct usage of words. Though it may seem serendipitous that such a loosely regulated system can function as well as it does, it is in fact due to this loose organization that natural language achieves it's flexibility and scalability. On the other hand, general natural language lacks the precision and conciseness that is necessary for specific purposes, such as scientific discussion.

The linguistic division of labor between everyday language and technical jargon is all very fine and well when the technical terminology is disjoint from common language, but it can become problematic when there is considerable overlap. The field of affective computing is one such example: the scientific terms for emotions overlap with common linguistic usage. Since one of the aims of affective computing is to process natural language, it is necessary to be mindful of the difference between the scientific and common definition of emotional terms. Much of the previous work in affective computing has focused on the scientific definition of emotional terms. Needless to say, these scientific definitions must have a high degree of similarity with the common definitions for them to be meaningful, but the scientific definitions are necessarily limited and may not correspond to everyday usage. This distinction can be seen as a prescriptive versus descriptive focus. However, currently there is a movement towards studying more naturalistic and non-prototypical emotion expression [3,4], which may benefit from a corresponding movement towards using the more natural, socially-defined terminological basis that we aim to discover in the research described by this paper.

To move from the scientific theory of emotions to a theory that explicitly accounts for subjectivity and social construction, we made use of *crowd-sourcing* [5] and *games with a purpose* [6]. Crowd-sourcing aims to gather the collective knowledge of a group and is closely tied to the emergent properties of online social communities and web intelligence [7]. Games with a purpose are a particular way of crowd-sourcing. In our case, we devised a game that we call *Emotion Twenty Questions* (EMO20Q). This game is similar to the ordinary Twenty Questions game except that it is limited to guessing about emotion words. Furthermore, it is implemented as an online chat application using the Extensible Messaging and Presence Protocol (XMPP) so that the games can be recorded and studied. As the introductory quote alludes, we carefully allow open-ended user response within the limited context of the EMO20Q game and the text chat modality.

2 EMO20Q

2.1 Rules

In the game of Emotion Twenty Questions (EMO20Q) there are two players who interact using natural language. In this paper, we consider the case when both players are humans. A game consists of a series of *matches*; in each match one of the players assumes the role of *answerer* and the other, the role of *questioner*. At the beginning of the match, the answerer picks an emotion word, unbeknownst to the questioner, which we call the *emotion in question*. The emotion in question need not be the emotion of answerer's current state and, importantly, the answerer is not forced to choose from a prescribed list of emotions. Once the answerer has picked an emotion, the questioner has twenty *turns* to guess the emotion in question, where a turn is a question posed by the questioner in natural language followed by an answer by the answerer. If the identity of the emotion in question is guessed in twenty or fewer turns, the questioner wins. On the other hand, if the emotion is still unknown to the questioner after twenty turns, then the answerer wins.

Although questioning and answering are the two basic plays of EMO20Q, there are other types of game actions that would best described as dialog acts. For example, a player may ask about rules, give directions, give hints, make clarifications, give-up/resign, or engage in small-talk. Also, as in other games, one player may cheer or jeer the other player to express sportsmanship or competitiveness. At the end of a match there is usually a recapitulation of especially salient turns and at that time the questioner may debate the answers given or whether the emotion in question is actually an emotion. This end-game behavior can be useful for determining fringe cases of words that may or may not be actual emotions and can identify erroneous answers.

There were some rules that were proposed in hindsight after our first pilot tournament. One particular rule is that synonyms should be counted as a correct, game-ending guess if the answerer cannot come up with a distinguishing characteristic (e.g., "brave" and "courageous", and "awe" and "amazement"). As these additional rules may improve the gameplay, the EMO20Q rules committee is considering them for future seasons.

2.2 Motivation

The game of EMO20Q serves to address several issues that arise when considering theories of emotion. First, this theory seeks to understand emotional behavior from the level of the individual player/subject. In Sect. 3 we formulate a general theory of emotions as an aggregation of the personal theories of each player. The questioner in EMO20Q can be seen as testing a hypothesis given his or her personal theory, and the person-independent theory can be seen as the union of the theories of the individual person-specific theories, with contradictions thrown out.

Another motivation of the EMO20Q game is that it allows for spontaneous natural language behavior while constraining the language to the targeted domain we wish to study. Much past work [8,9,10,11,12,13] has focused on eliciting responses from subjects who are presented with words as stimuli. However, the stimuli are predetermined and the responses are constrained, often as a Likert scale or prescribed set of emotion categories. In EMO20Q, potentially any word can be picked as an emotion word and any question can be asked of it; it is only limited by the game's rules and the subjects' good-faith judgment. Thus, in contrast with purely elicited experiments, EMO20Q can be presumed to have higher experimental validity and less experimental bias. The player/subjects of EMO20Q are less constrained by the elicitation methodology and we can assume that their honesty and cooperation is comparable to elicitation experiments, or improved due to the supervision of the other player and their shared communicative goals. There is the possibility of experimental effects due to interactions between players. Thus we can assume to have less experimental effects than in experiments with guided/elicited responses due to the bias from using a fixed set of stimuli and responses.

One drawback of this approach is that it will hard to quantify reliability in the unconstrained interactions of EMO20Q. Reliability can be measured in the amount of agreement between subjects, but this can be difficult because we do not force subjects to pick any particular words, so the words that are in common between users are determined by chance and hence sparse. Because of this, an alternative way to measure reliability could be done in offline question-answering of specific question-emotion pairs, which could be repeated across subjects.

The experimental methodology of EMO20Q has other advantages. Receiving stimulus and giving response using the same modality, natural language, has the potential to be more sensitive than Likert scales or restricting user input to fixed choices. This is because we can assume that natural language has the capabilities of expressing most, if not all, of the *communicable* distinctions between emotions. Even in cases where one is literally "at a loss for words", there are descriptions, like the quoted phrase, that people use to approximate such an emotion. One exception where the natural language modality could be less sensitive is in the case of less fluent subject/players, such as children and non-native speakers. In this case, we can imagine subjects who have conceptual distinctions in their theories of emotions that they are not able to verbally express without the aid of elicitation. The utility of the natural language modality can be seen in the productive, social aspects, and ubiquity of language, as well as the relation to engineering solutions, such as natural language processing.

3 Constructing a Theory from EMO20Q

How does one analyze data from EMO20Q? We use the data collected from the game to construct a theory. Our method uses a stripped-down definition of the term *theory* from mathematical logic which states that a theory Γ is simply a set of sentences in some language $\mathcal{L}$ that is true of a model M [14]. In the case of EMO20Q, Γ is the set of questions that were answered with "yes" and negations of the questions that were answered with "no" for a given emotion, $\mathcal{L}$ is the language of propositional logic, and M is a mental model of emotions, which we assume is only accessible through observation of communicative behavior. In this view, each question in EMO20Q can be represented as a proposition $p \in P$ that can be judged true or false of a given emotion $\varepsilon \in E$ by player $i \in I$ according to that player's mental model, $M_{\varepsilon,i}$. Assuming now that player i is the answerer who has just been asked question p, we can say that $\models_{M_{\varepsilon,i}} p$ if the player answers "yes" or $\models_{M_{\varepsilon,i}} \neg p$ if the player answers "no". The previous notation is read "$p/\neg p$ is satisfied by $M_{\varepsilon,i}$", or equivalently "$M_{\varepsilon,i}$ is a model of $p/\neg p$".

A theory for a specific emotion ε and a specific player i, denoted $\Gamma_{\varepsilon,i}$, is constructed as a Boolean vector of length $|P|$, where $|P|$ is the total number of questions. For every question p_n asked of player i, the n-th position of the vector $\Gamma_{\varepsilon,i}$ will be *true* or 1 if the player has answered yes to p_n when the emotion in question was ε. In this case we can say that p_n is a *theorem* of $\Gamma_{\varepsilon,i}$. Similarly, *false* or 0 is assigned to element n of $\Gamma_{\varepsilon,i}$ if p_n received no as an answer while being questioned while ε was the emotion in question. In this case, $\neg p_n$ is a theorem of Γ. If a contradiction is reached, i.e., if both p_n and $\neg p_n$ are members of the set $\Gamma_{\varepsilon,i}$, then both are removed. In practice, this has not happened and we assume that it will not because a player is consistent with him or herself in normal situations, so such a contradiction would be a warning flag that a player may not be playing consistently.

One can proceed in a similar manner for a person-independent theory Γ_ε of a particular emotion ε. In this case, the proposition p_n associated with a particular question is added to Γ_ε if any player has answered yes to p_n when questioned about emotion ε, and conversely for $\neg p_n$ when any player has answered no. In the case of a person-independent theory, in general one can expect some contradictions and these would signify when there is disagreement about whether such a proposition is true or false of that particular emotion. In this case, as before for the person-specific case, both propositions should be removed from the theory to prevent contradictions.

If a theory for a specific emotion can be seen as a long list of propositions that are true of it, the theory of a set of emotions can be seen as an matrix Γ indexed by the emotions in one dimension and the questions in the other dimension. If the theory Γ contains emotions ε_m for $1 \leq m \leq |E|$ and propositions p_n for $1 \leq n \leq |P|$, then Γ will be an $|E| \times |P|$ matrix. Ordinarily, Boolean algebra would dictate that this matrix would consist of ones and zeros. Such a representation has been explored under the aegis of *formal concept analysis* [15]. However, we need the matrix to be sparse to represent the fact that not all of the combinations of questions and emotions have been encountered and that there may be some contradiction among subjects. To this end, we propose that the matrix be a $(1, 0, -1)$-matrix, or a *signed matrix/graph* [16], where 1 indicates that the proposition of column-m is true for the emotion of row-n, -1 indicates that it is false, and 0 indicates that it has not been seen or that a contradiction has been encountered.

4 Results

In preliminary experiments, we collected a total of 26 matches from 12 players. Since each match has two players, this averaged about 4 matches per player. The number of matches played by a player ranged from 2 to 12. The mean and median number of questions was 12.04 and 15.5, respectively, when failures to correctly guess the emotion were averaged in as 20 questions.

In the data, a total of 23 unique emotions were chosen, i.e., only three emotions were observed more than once, and these involved related word forms (e.g., "confused" and "confusion"; "frustrated" and "frustration"). The emotions that were played are: *admire*, *adore*$^+$, *anger*, *awe*$^+$, *boredom*, *bravery**, *calm*, *confidence**, *confusion*$^+$, *contempt*, *disgust*, *enthusiasm*$^+$, *frustration*, *gratefulness*, *jealousy*, *love*, *proud*, *relief*, *serenity*, *shame*, *silly*, *surprised*, and *thankful*. The starred emotion words were disputed by players after the games and those marked by a plus were emotions that were not successfully guessed. In addition, there were 66 additional emotion words that were referred to in questions that attempt to identify the emotion in question.

There was a total of 313 questions-asking events that received unambiguous yes/no answers. After normalizing the questions for punctuation and case, there was a total of 297 unique questions types with 13 questions types (29 tokens) seen more than once and no questions were seen more than 3 times. Since the surface forms of the questions vary widely and because at the current stage we have not developed natural language processing techniques to extract the underlying semantics of the questions, we used manual preprocessing to standardize the questions to a logical form that is invariant to wording. This logical form converted the surface forms to a pseudo-code language with a controlled vocabulary by converting the emotion names to nouns if possible, standardizing attributes of emotions and the relations of emotions to situations and events. Examples of the standardized questions are shown in Tab. 1. After the standardization, there were a total of 222 question types. We also manually mapped the surface form of the answers to yes/no/other answers. In the future, we will explore how to automate these steps and represent fuzzyiness in the answers that are not clearly "yes" or "no".

After the manual normalization we found that there were 37 questions types that had been asked at least twice, eight questions types that were asked three

Table 1. Examples of question standardization

Standardized Question	Examples
cause(emptySet,e)	*can you feel the emotion without any external events that cause it?*
	is it an emotion that just pops up spontaneously (vs being triggered by something)?
cause(otherPerson,e)	*is it caused by the person that it's directed at?*
	Do you need someone to pull this emotion out of you or evoke it? if so, who is it?
e.valence==negative	*is it considered a negative thing to feel?*
	2) so is it a negative emotion?
situation(e,birthday)	*would you feel this if it was your birthday?*
	is it a socially acceptable emotion, say, at a birthday party?
e==frustration	*oh, is it frustrated?*
	frustration?

times, four that were asked at least four times (a total of 90 question tokens were repeated at least twice). Examining the normalized questions revealed interesting patterns of question reuse through the social interactions of the players, though more longitudinal data will be needed to rigorously characterize these interactions. Approximately half of the questions were emotion identity questions.

To get a better idea of the relative frequencies of general types of questions, we devised a way of classifying the questions using the following categories: *identity questions* (guessing an emotion), *attribute questions* (asking about dimensional attribute like valence or activation), *similarity/subsethood questions* (asking if the emotion in question is similar to or a type of another emotion), *situational questions* (questions that ask about specific situations associated with the emotion in question), *behavior questions* (questions that are asked about the behavior associated with the emotion in question), *causal questions* (questions about the cause, effect, or dependency of the emotion in question), *social questions* (questions asking about other parties involved in the emotion–this overlaps somewhat with causal questions and situational questions), *miscellaneous questions* (questions that defied classification or had categories with too few examples). Some examples of these categories are given in Tab. 2.

Table 2. Examples of question categories

Question Categories	Examples
identity (42%)	*is it angry?*
	guilt?
attribute (13%)	*is it something one feels for long periods of time?*
	is it a strong emotion?
similarity/ subsethood (10%)	*is the emotion a type of or related to content or zen contentment (is that a word?_)*
	so it's similar to excited?
situational (14%)	*is the emotion more likely to occur when you are tired?*
	would i feel this if my dog died?
behavior (3%)	*you can express it in an obvious way by sighing?*
	do adults usually try to discourage children from feeling this?
causal (7%)	*yes. mynext question is can it harm anyone besides the feeler?*
	I think I know, but I'll ask one more question...does it ever cause children to wake up and cry?
social (8%)	*are you less likely to experience the emotion when around good firiends?*
	13)would you feel that towards someone who is superior to you?
miscelaneous (3%)	*i dont' know if this is a valid question, but does it start with the letter D?*
	or an aspirational emotion?
	does the word function or can be conjugated as anything eles? i.e. can it be a verb too?

5 Discussion

One of the claims we made in Sect. 2.2 was that the methodology of EMO20Q allowed for less experimental effects than other types of elicitation. Another benefit is that one class of experimental effect is easily measurable: influence of one subject's guessing strategies on another subject can be quantified in terms of question reuse. In fact, examining the question reuse revealed interesting patterns that in a different context could be studied in its own right as a social phenomenon over time, as opposed to being considered an extraneous effect, though more longitudinal data will be needed to rigorously characterize these interactions.

There were some experimental effects with hinting behavior. In after-action reviews with the players, there was anecdotal evidence of retribution type experimental effects, where one player who gives only yes/no answers without any hints will be given less hints when it is their turn to be questioner. Furthermore, there is also mercy type experimental effects, whereby more hints are given by the answerer as the questioner approaches the 20 question limit. Since our main focus was the yes/no questions we did not attempt to quantify the hinting behavior as this did not effect the collection of yes/no question/answers for emotion words.

By analyzing the distribution of question types, we can begin to see some general trends in how people describe emotions. The categories we used are a descriptive way of generalizing the data, not precise classes. Certain questions could have been classified into into multiple categories. In particular, the social, behavioral, causal, and situational questions all referred to various types of real-world knowledge and so these categories tended to run together. For example "are you more likely to experience the emotion when around good friends?" was labeled social, whereas "Would you feel this emotion at a birthday party?" was labeled situational, even though these two examples are very closely related. Therefore, these categories should be interpreted in a general, descriptive sense apart from the theory we aim to crowd-source.

The EMO20Q game requires that an emotionally intelligent agent can understand emotions without observing them, thanks to natural language and empathy. Empathy, which we consider to be the ability to understand emotions that are not one's own emotions, is an important aspect of this game. This game explores a computational type of empathy and that can be thought of as empathy removed of its humane connotations. Just as intelligence tests often seek to isolate verbal intelligence from mathematical or creative intelligence, emotional intelligence may have also a verbal aspect and EMO20Q could provide a way to test for such a component of emotional intelligence.

There were a few behaviors and game states that we did not anticipate when formulating the rules, and these will be incorporated in future data collections. One issue was that of synonyms. Several times, a questioner would get a very close word and oscillate between related synonyms, for example "mad" and "angry". In the future, we will deal with this by changing the stopping criteria from guessing the exact word to guessing a synonym that cannot be distinguished by any type of explanation. However, even though it may seem that two words are closely related, there may still be some differences. For example, one player was unsure about whether "proud" and "pride" would be considered equal (native speakers of English generally feel that "pride" has a negative connotation, whereas "proud" has a positive connotation).

6 Conclusion

In this paper, we proposed the EMO20Q game as an experimental methodology to collect *natural language descriptions of emotions*. These descriptions, extracted from the questions asked in the game, were used to construct player-specific theories of emotions. Although we made the distinction of scientific-versus-natural-language descriptions of emotions, we feel that our approach can in fact be used to scientifically study the social behavior of communicative agents, humans or computers, who may have different knowledge, memory, and experience that they draw upon when conveying emotional information to each other.

Automating a computer agent that plays EMO20Q poses many interesting challenges and opportunities. The ultimate test of whether the theories collected with our methodology are valid is if they can enable an automated agent to simulate a human player, as in a Turing test. The main challenge to automating a player of EMO20Q is robust natural language understanding. The questioner agent needs to select questions and process yes/no type answers, but the answerer agent would need to understand an open set of questions that can be asked of any emotion, so we consider the questioner role to be easier to automate than the answerer role. Our initial work on designing a questioner agent is described in [17,18] and [18] includes an interactive demo. For automating the answerer role, the computer would need a way to understand a wide variety of questions. We have undertaken previous research on how to answer questions about dimensional representations for emotions and similarity and subsethood judgments [12,13,19], which, according to our pilot data, make up nearly 25% of the total questions. Moreover, questions about the unknown emotion's identity accounted for a significant portion (42%) of the questions we observed. These emotion identity questions could be understood by template matching questions in the form of "is it X?" or simply "X?". However, the remaining question types in Tab. 2 will be relatively more difficult because they require real world knowledge.

In conclusion, this paper examined how one can experimentally derive a theory of emotions from relatively unconstrained natural language interaction that is focused to the domain of emotions using the EMO20Q game. Our pilot data led to descriptive results that can inform practitioners of affective computing about how people understand emotions and communicate about them with natural language. Our future work will aim to collect more data to expand coverage of emotions, broaden the population of players, and to continue development of automated agents that play EMO20Q. We also endeavor to make our data and methodologies accessible to the community. These can be found at http://code.google.com/p/emotion-twenty-questions/.

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