Emotion word comprehension from 4 to 16 years old: a developmental survey

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Background: Whilst previous studies have examined comprehension of the emotional lexicon at different ages in typically developing children, no survey has been conducted looking at this across different ages from childhood to adolescence. **Purpose:** To report how the emotion lexicon grows with age. **Method:** Comprehension of 336 emotion words was tested in $n = 377$ children and adolescents, aged 4–16 years old, divided into 6 age-bands. Parents or teachers of children under 12, or adolescents themselves, were asked to indicate which words they knew the meaning of. **Results:** Between 4 and 11 years old, the size of the emotional lexicon doubled every 2 years, but between 12 and 16 years old, developmental rate of growth of the emotional lexicon leveled off. This survey also allows emotion words to be ordered in terms of difficulty. **Conclusions:** Studies using emotion terms in English need to be developmentally sensitive, since during childhood there is considerable change. The absence of change after adolescence may be an artifact of the words included in this study. This normative developmental data-set for emotion vocabulary comprehension may be useful when testing for delays in this ability, as might arise for environmental or neurodevelopmental reasons.

Keywords: emotions, autism, development

The standard view is that there are only a small number of basic emotions that are recognized cross-culturally: *happy, sad, angry, afraid, surprised,* and *disgusted.* All other emotions – often labeled "complex emotions" – are either treated as being blends of the basic 6 or as being culture specific (Ekman and Friesen, 1969; Prinz, 2004). When it comes to developmental understanding of emotional and mental state terms, whereas the development of basic emotion understanding has been extensively studied, only a small number of complex emotions (e.g., *jealous, proud, disappointed, embarrassed*) have been studied developmentally (Harris, 1989; Herba and Phillips, 2004). The study reported here aims to examine a much broader range of emotions and mental states in terms of when children and adolescents understand the words for each of these.

Children's abilities to label emotional expressions start developing from as early as 2 years of age (Izard and Harris, 1995; Denham, 1998). Bretherton and Beeghly interviewed mothers of 28 month old children about their vocabulary, and found that over 60% of the children were familiar with the emotional terms *happy, scared,* and *mad* (i.e., angry), and were able to use them in their language. *Sad* was known to more than 50% of the children at this age, but more than 80% of them knew and used emotion words such as *like* and *love* (Bretherton and Beeghly, 1982). Another study reported that more than 75% of 3 year olds use emotion words for feeling *good, happy, sad, angry, loving, mean,* and *surprised* (Ridgeway et al., 1985). Toddlers are more likely to first use emotion labels to refer to their own emotional state (at about 20–24 months). Later, such labels are used with reference to others' emotions, and by 3–3.5 years of age, children will use emotion terms for imaginary characters or in reference to those in a story (Reilly et al., 1990).

Whereas the early development of emotion and mental state vocabulary is well documented, studies describing complex emotions corpora (Ortony et al., 1987; Storm and Storm, 1987; Johnson-Laird and Oatley, 1989) have not tested the development of emotion vocabulary in older children or adults. One study tested the development of complex (and basic) emotion labels in toddlers and pre-schoolers aged 18–71 months, using a list of 125 emotions (Ridgeway et al., 1985). However, this was not extended into primary school aged children and adolescents. The aim of the study reported here was to collect normative data from children and adolescents aged 4–16 years old, in order to survey which emotion and mental state terms are acquired earlier than others, and how the emotional lexicon grows with age. We used a large corpus of 366 emotion or mental state words.

SAMPLES

Data was collected from 6 age groups (4–6, 7–8, 9–10, 11–12, 13–14, and 15–16), corresponding with UK school year bands (Years 1–2, 3–4, 5–6, 7–8, and 9–10, respectively). Confirmation of age bands was checked using the Annual Schools Census for the academic year 2004/5, provided by the Schools Statistical Unit at the Department for Education and Skills, UK. Participants were all attending mainstream education in the Cambridgeshire area (UK), and included a mix of both state and private schools, in order to attempt to achieve a representative sample of the community. The total sample was therefore $n = 377$, and they comprised an equal number of males and females. There were $n = 30$ age 4–6 years old, $n = 34$ age 7–8 years old, $n = 26$ age 9–10 years old, $n = 87$ age 11–12 years old, $n = 134$ age 13–14 years old, $n = 66$ age 15–16 years old.

METHOD

A search for all "emotion" terms in the English language was conducted, using the electronic thesaurus in Microsoft Word.

WORD SELECTION
Inclusion criteria

1. A word was considered to be an emotion term if it described a mental state with an emotional dimension, that could be preceded by the phrase I feel x, or he/she looks x, or he/she sounds x. This definition was used because this study was linked to the development of an encyclopedia of emotion video or audio clips of emotions, portrayed by actors. The collection of these recordings is available on a separate piece of software called *Mind Reading* (Baron-Cohen, Golan, Wheelwright, and Hill, 2004[1]; Baron-Cohen et al., 2003).
2. Mental states that were epistemic but which nevertheless had an unambiguous emotional dimension were included (e.g., doubting).

Exclusion criteria

1. Mental states that could be a purely bodily state (e.g., *thirsty*) with no necessary mentalistic dimension were excluded, since this was a study of emotion terms.
2. Slang words (e.g., *chuffed*) were excluded, in order to only collect normative data that could be useful to a broad range of English-speaking cultures.
3. Swear words (e.g., *pissed off*) were excluded, again because these vary considerably from one sub-culture or sub-dialect to another.
4. Words which the authors judged to be too difficult for all six age-groups were also excluded (e.g., *schadenfreude*, a word borrowed from German but which appears in the English language and which depicts the emotion of pleasure that one feels at someone else's misfortune).
5. Epistemic states with no emotional dimension (e.g., *reasoning*) were excluded, since this was a study of emotion terms rather than all mental state terms.

POPULATION SURVEY

Every emotion term was listed in a vocabulary checklist. Groups of volunteers from the general population (see "Participants" above) were asked if they knew the meaning of each word. The volunteers ranged from age 4 to 16 years old and were stratified by age. For individuals aged 12–16, self-report was accepted. For individuals age 4–11 years old, parent- or teacher-report was collected. This questionnaire survey method invited the participant to choose one of three response options for each word: *Clearly Understood*, *Not Understood*, and *Possibly Understood*. This method (parent- or teacher-report) was used in the development of the Communication Development Inventory (Fenson et al., 1994) and

[1]Because of such exclusion criteria, the corpora of emotion terms investigated in the present study represent a subset of those found in the *Mindreading* DVD (www.jkp.com/mindreading), which aims to be a comprehensive encyclopedia of emotions.

has been found to be reliably correlated with comprehension tested in the lab. Only those items endorsed as *Clearly Understood* were judged to be within the comprehension of an individual. Finally, words where data was not available from all six age groups were not included in the results, since this was a developmental study[1].

RESULTS

$n = 336$ emotion words met all inclusion and exclusion criteria, and these are listed in **Table 1**. We analyzed the percentage of words understood by 75% or more of each group. Seventy-five percent was selected because the Binomial test indicated that the probability of achieving this level by chance was $p < 0.001$. Of the list of 336 emotion words, 41 words were understood by at least 75% of 4–6 year olds, 88 by 7–8 year olds, 180 by 9–10 year olds, 299 by 11–12 year olds, 320 by 13–14 year olds, and 330 by 15–16 year olds. Thus, between 4 and 8 years old, the number of emotion terms understood doubles. Between 9 and 12 years old, this number doubles again. However, between 13 and 16 years old, emotion vocabulary size hardly changes at all, suggesting the earlier dramatic changes in emotional vocabulary comprehension reach a plateau by early adolescence.

These changes between age-bands are not only apparent by visual inspection (see **Figure 1**) but are confirmed by statistical analysis. A goodness of fit test conducted for the whole sample revealed a significant difference in the proportion of words recognized by at least 75% of participants in each age band ($\chi^2[5] = 999.14$, $p < 0.0001$). Next, five goodness of fit tests were conducted between each adjacent age-band. Using the Bonferroni correction for multiple testing, we chose a p value of <0.002 as a conservative level of significance, to control for the number of comparisons being conducted. The analysis revealed significant differences between 4–6 year olds and 7–8 year olds ($\chi^2[1] = 21.19$, $p < 0.0001$), between 7–8 year olds and 9–10 year olds ($\chi^2[1] = 52.53$, $p < 0.0001$), between 9–10 year olds and 11–12 year olds ($\chi^2[1] = 102.94$, $p < 0.0001$). However, between 11–12 year olds and 13–14 year olds, the difference in number of mental state terms understood by at least 75% of each age-band did not meet our level of significance ($\chi^2[1] = 9.03$, $p < 0.005$), and nor did the difference between 13–14 year olds and 15–16 year olds ($\chi^2[1] = 4.7$, $p < 0.05$). These results confirm that the size of emotional vocabulary increases significantly with age during childhood, but does not develop significantly after adolescence. This pattern is illustrated in **Figure 1**.

In order to examine whether development of the emotion vocabulary varies for different emotion categories, the 336 words included in this survey were allocated to the 24 emotion categories, included in the *Mind Reading* DVD (Baron-Cohen et al., 2004[1]). **Table 2** shows the percentage of words in each emotion category that at least 75% of children understood in each age-band[OG3]. This shows the same developmental trend, of major change across the first 3 age-bands and a leveling off by early teens, especially for the more common (or basic) emotion groups (e.g., *happy, sad, afraid, kind*). On the other hand, the understanding of words from some emotion groups is more delayed (e.g., *disbelieving, touched, romantic*), and understanding of words from others (e.g., *bored*) is incomplete even in the highest age band. This may reflect an ongoing development of the emotional lexicon beyond adolescence years.

Table 1 | Percentage of children in each age band who understood each emotion word.

	Emotion word	Age (years)							Emotion word	Age (years)					
		4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)			4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)
1.	Absorbed	0.0	10.5	50.0	78.0	91.8	90.9	50.	Caring	68.8	84.2	88.9	100	98.5	93.9
2.	Accepting	25.0	63.2	66.7	96.6	98.5	97.0	51.	Cautious	0.0	21.1	61.1	91.4	97.8	95.5
3.	Accusing	6.3	31.6	61.1	93.2	97.8	93.8	52.	Certain	25.0	57.9	88.9	100	98.5	97.0
4.	Adoring	18.8	36.8	77.8	94.9	97.8	90.9	53.	Challenging	12.5	47.4	66.7	93.2	97.8	97.0
5.	Affectionate	12.5	15.8	44.4	76.3	94.7	89.4	54.	Charitable	0.0	10.5	47.1	74.6	91.8	90.9
6.	Afraid	75.0	94.7	100	100	100	98.5	55.	Charmed	0.0	31.6	47.1	89.8	98.5	93.9
7.	Aggressive	6.3	52.6	66.7	93.2	98.5	97.0	56.	Cheated	56.3	78.9	83.3	96.6	98.5	97.0
8.	Agony	6.3	63.2	66.7	89.8	95.5	87.9	57.	Cheered	43.8	73.7	88.9	98.3	97.8	98.5
9.	Agreeable	31.3	50.0	83.3	84.7	95.5	92.4	58.	Cheerful	62.5	89.5	94.4	100	99.3	98.5
10.	Alarmed	18.8	33.3	58.8	91.5	96.3	90.9	59.	Choosing	81.3	84.2	77.8	94.9	96.3	97.0
11.	Alert	0.0	10.5	52.9	96.6	98.5	95.5	60.	Close	62.5	89.5	94.4	94.9	99.3	95.5
12.	Amazed	37.5	89.5	77.8	98.3	100	95.5	61.	Clueless	6.3	42.1	76.5	94.9	98.5	97.0
13.	Amused	12.5	42.1	72.2	100	94.0	95.5	62.	Cocky	0.0	5.3	41.2	84.7	92.5	95.5
14.	Angry	87.5	94.7	88.9	98.3	98.5	95.5	63.	Cold	62.5	57.9	72.2	96.6	99.3	95.5
15.	Annoyed	62.5	89.5	100	98.3	99.3	95.5	64.	Comfortable	81.3	89.5	83.3	98.3	99.3	93.9
16.	Anticipating	0.0	10.5	38.9	69.5	85.0	83.3	65.	Comforting	18.8	52.6	61.1	98.3	97.8	92.4
17.	Anxious	6.3	36.8	72.2	81.4	96.3	89.2	66.	Commiserating	0.0	0.0	5.6	37.3	57.5	63.6
18.	Apologetic	12.5	42.1	61.1	86.4	92.5	90.9	67.	Compassionate	0.0	5.3	44.4	67.8	81.3	83.3
19.	Appalled	0.0	10.5	61.1	88.1	91.8	90.9	68.	Complacent	0.0	0.0	5.6	30.5	46.3	69.7
20.	Appreciated	25.0	52.6	61.1	89.8	92.5	86.4	69.	Complaining	50.0	78.9	94.4	100	98.5	97.0
21.	Approving	12.5	15.8	38.9	89.8	97.0	97.0	70.	Conceited	0.0	5.3	6.3	33.9	56.7	71.2
22.	Argumentative	25.0	68.4	72.2	93.2	97.0	89.4	71.	Concentrating	56.3	78.9	100	100	95.5	95.5
23.	Ashamed	31.3	31.6	83.3	94.9	97.8	93.9	72.	Condescending	0.0	0.0	0.0	55.2	49.6	60.6
24.	Assessing	0.0	5.3	5.6	67.8	86.6	78.8	73.	Confrontational	0.0	0.0	16.7	52.5	72.4	84.6
25.	Assured	0.0	15.8	38.9	84.7	89.6	87.9	74.	Confronted	0.0	0.0	27.8	86.4	91.8	97.0
26.	Astonished	18.8	36.8	61.1	91.5	97.0	89.4	75.	Confused	43.8	78.9	94.4	100	99.3	98.5
27.	Astounded	0.0	10.5	41.2	79.7	86.6	83.3	76.	Considerate	12.5	22.2	50.0	89.8	97.8	98.5
28.	Attacked	56.3	78.9	88.9	100	99.3	92.3	77.	Contempt	0.0	0.0	16.7	64.4	78.4	89.4
29.	Attracted	6.3	42.1	76.5	96.6	97.8	92.4	78.	Content	12.5	22.2	44.4	93.2	95.5	93.9
30.	Aware	18.8	36.8	61.1	98.3	99.3	95.5	79.	Contrary	0.0	5.6	35.3	74.6	79.9	83.3
31.	Bad-tempered	37.5	89.5	83.3	100	100	93.9	80.	Controlled	6.3	38.9	66.7	94.9	98.5	97.0
32.	Baffled	0.0	0.0	33.3	74.6	87.3	89.2	81.	Convinced	0.0	22.2	66.7	96.6	96.3	95.5
33.	Bashful	0.0	10.5	33.3	75.9	83.6	86.4	82.	Cooperative	6.3	26.3	77.8	93.2	99.3	97.0
34.	Battered	31.3	42.1	58.8	94.8	95.5	93.9	83.	Courageous	6.3	11.1	66.7	91.5	92.5	92.3
35.	Begging	18.8	57.9	100	100	99.3	97.0	84.	Cowardly	12.5	22.2	77.8	93.2	97.0	97.0
36.	Betrayed	0.0	10.5	47.1	94.9	97.0	96.9	85.	Crafty	18.8	22.2	66.7	98.3	99.3	98.4
37.	Bewildered	6.3	10.5	35.3	72.9	88.8	80.3	86.	Cranky	6.3	16.7	38.9	76.3	89.6	95.3
38.	Bitter	12.5	15.8	58.8	91.5	96.3	92.4	87.	Craving	0.0	5.6	27.8	78.0	94.8	98.4
39.	Bliss	0.0	0.0	17.6	78.0	91.8	89.4	88.	Critical	6.3	5.6	33.3	86.4	96.3	98.4
40.	Boastful	6.3	31.6	55.6	98.3	96.3	95.5	89.	Cross	81.3	94.4	100	98.3	100	96.9
41.	Bold	18.8	26.3	66.7	94.9	97.0	98.5	90.	Cruel	62.5	94.4	100	100	100	98.4
42.	Bored	81.3	94.4	100	100	99.3	100	91.	Crushed	43.8	50.0	77.8	94.9	100	96.9
43.	Bothered	50.0	73.7	83.3	93.2	99.3	95.5	92.	Cunning	6.3	16.7	44.4	98.3	99.3	96.9
44.	Brave	68.8	89.5	100	100	100	98.5	93.	Curious	18.8	38.9	70.6	100	100	98.4
45.	Broken	75.0	78.9	77.8	93.2	99.3	98.5	94.	Daring	25.0	72.2	83.3	98.3	98.5	95.3
46.	Brokenhearted	25.0	63.2	100	94.9	97.8	97.0	95.	Daydreaming	62.5	77.8	94.4	98.3	100	98.4
47.	Calculating	18.8	21.1	33.3	84.7	91.8	95.5	96.	Dazed	12.5	16.7	44.4	82.8	98.5	96.9
48.	Calm	50.0	73.7	88.9	98.3	99.3	97.0								
49.	Carefree	0.0	10.5	50.0	83.1	94.8	97.0								

(Continued)

Table 1 | Continued

	Emotion word	Age (years)							Emotion word	Age (years)					
		4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)			4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)
97.	Deciding	43.8	77.8	77.8	87.5	97.0	95.3	146.	Easy-going	12.5	26.3	55.6	84.5	93.0	93.8
98.	Defeated	12.5	44.4	77.8	94.9	100	96.9	147.	Embarrassed	50.0	89.5	88.9	76.9	100	95.2
99.	Defensive	0.0	22.2	33.3	75.0	99.2	96.9	148.	Encouraged	18.8	42.1	66.7	82.8	86.0	96.9
100.	Definite	18.8	55.6	77.8	83.1	89.5	90.6	149.	Encouraging	18.8	36.8	66.7	76.7	90.7	96.9
101.	Delighted	37.5	77.8	94.4	81.4	100	95.3	150.	Enjoyment	56.3	73.7	94.4	90.2	97.7	96.9
102.	Demanding	12.5	61.1	72.2	81.8	98.5	93.8	151.	Enthusiastic	6.3	31.6	38.9	83.3	92.7	98.4
103.	Depressed	18.8	38.9	72.2	76.0	99.2	95.3	152.	Excited	75.0	100	94.4	82.0	97.7	96.8
104.	Desire	6.3	10.5	44.4	82.4	98.5	93.8	153.	Fascinated	12.5	52.6	72.2	85.2	90.7	96.9
105.	Despair	12.5	5.3	47.1	91.2	93.2	93.8	154.	Favor	31.3	57.9	83.3	90.9	95.3	95.3
106.	Desperate	50.0	52.6	83.3	79.5	100	96.9	155.	Fear	50.0	94.7	88.9	91.4	100	95.3
107.	Detached	18.8	26.3	38.9	83.3	98.5	93.7	156.	Fed up	81.3	94.7	100	94.6	100	96.9
108.	Determined	12.5	52.6	72.2	86.2	97.0	98.4	157.	Fierce	68.8	78.9	77.8	88.1	97.6	96.9
109.	Detesting	6.3	0.0	33.3	80.4	93.2	96.9	158.	Fine	62.5	73.7	94.4	94.7	100	98.4
110.	Devious	0.0	5.3	29.4	69.4	89.5	93.8	159.	Fired up	0.0	26.3	44.4	81.1	85.7	98.4
111.	Devoted	0.0	0.0	33.3	78.8	97.0	96.9	160.	Flattered	6.3	5.3	38.9	83.9	97.6	100
112.	Dictating	0.0	5.3	11.1	78.9	88.7	87.5	161.	Focused	6.3	31.6	61.1	71.6	100	98.4
113.	Difficult	68.8	94.7	94.4	98.3	100	98.4	162.	Fond	12.5	52.6	88.9	82.8	85.4	98.4
114.	Dignified	6.3	0.0	38.9	72.9	85.0	96.8	163.	Foolish	6.3	63.2	66.7	89.8	97.6	100
115.	Disagreeable	12.5	63.2	83.3	93.3	99.2	96.9	164.	Forbidding	0.0	15.8	33.3	77.8	88.1	98.4
116.	Disappointed	56.3	78.9	88.9	89.4	100	98.4	165.	Forceful	12.5	27.8	55.6	90.7	95.2	98.4
117.	Disapproval	6.3	21.1	55.6	93.1	95.5	96.8	166.	Forgiving	31.3	89.5	100	86.2	100	100
118.	Disbelief	12.5	47.4	77.8	98.2	97.7	95.2	167.	Friendly	87.5	100	100	76.1	100	98.4
119.	Disbelieving	12.5	52.6	88.9	91.4	97.7	96.8	168.	Frightened	87.5	100	100	81.5	100	96.7
120.	Discomfort	0.0	57.9	50.0	96.7	97.7	95.2	169.	Frustrated	6.3	52.6	55.6	89.5	88.1	96.7
121.	Discontented	0.0	10.5	44.4	84.5	86.5	93.5	170.	Furious	25.0	78.9	88.9	85.2	97.6	95.1
122.	Discouraged	0.0	10.5	38.9	96.4	95.5	98.4	171.	Generous	26.7	27.3	84.0	82.3	100	96.7
123.	Discouraging	0.0	5.3	38.9	88.1	94.0	98.4	172.	Gentle	90.0	87.9	96.2	94.4	100	96.7
124.	Disgrace	6.3	26.3	55.6	95.2	97.0	98.4	173.	Giving	80.0	87.9	92.3	92.9	100	98.4
125.	Disgust	43.8	52.6	72.2	98.3	97.0	98.4	174.	Glad	86.7	90.9	100	95.7	100	96.7
126.	Disheartened	0.0	5.3	27.8	73.0	85.7	96.8	175.	Gloomy	33.3	24.2	76.9	91.3	95.2	98.4
127.	Disinterested	6.3	57.9	66.7	79.7	85.0	96.8	176.	Glum	23.3	18.2	61.5	70.0	85.7	96.7
128.	Dislike	43.8	84.2	94.4	80.8	100	98.4	177.	Grateful	41.4	72.7	96.2	91.8	100	96.7
129.	Dismayed	0.0	5.3	38.9	77.6	85.7	90.5	178.	Grave	13.3	15.2	53.8	75.4	93.0	98.4
130.	Dispirited	0.0	0.0	44.4	84.0	82.0	92.1	179.	Grief	3.3	9.1	50.0	65.5	90.7	100
131.	Displeased	6.3	63.2	83.3	86.4	98.5	98.4	180.	Grouchy	20.0	21.2	50.0	82.9	81.4	96.7
132.	Disregard	0.0	0.0	27.8	71.2	78.2	93.8	181.	Grumpy	86.7	93.9	96.2	97.2	100	100
133.	Disrespectful	0.0	52.6	72.2	94.6	97.0	95.3	182.	Guilty	23.3	60.6	96.2	91.5	100	100
134.	Dissatisfied	6.3	42.1	55.6	77.8	93.2	95.3	183.	Happy	96.7	100	96.2	98.6	100	98.4
135.	Distant	6.3	47.4	55.6	88.5	98.5	95.3	184.	Harsh	6.7	6.1	65.4	81.7	97.7	96.7
136.	Distaste	0.0	11.1	27.8	80.4	90.2	90.5	185.	Hassled	6.7	42.4	72.0	85.7	95.3	96.7
137.	Distracted	31.3	57.9	77.8	91.5	96.2	98.4	186.	Hate	93.3	100	96.2	98.6	100	100
138.	Distress	6.3	10.5	50.0	93.3	97.0	98.4	187.	Heartache	13.3	24.2	46.2	73.2	97.7	100
139.	Distrust	12.5	36.8	66.7	77.0	95.5	95.2	188.	Heartbroken	20.0	54.5	65.4	95.8	100	98.4
140.	Disturbed	37.5	52.6	55.6	98.3	97.0	96.8	189.	Heated	20.0	30.3	73.1	74.6	95.3	100
141.	Dominated	0.0	5.3	27.8	76.7	88.0	95.3	190.	Helpful	90.0	97.0	100	100	100	96.8
142.	Doubtful	6.3	36.8	55.6	92.1	99.2	96.9	191.	Helpless	13.3	45.5	80.8	97.1	97.7	93.5
143.	Dread	6.3	26.3	66.7	94.9	98.5	95.3	192.	Hollow	0.0	9.1	38.5	76.1	83.7	95.2
144.	Dreamy	50.0	52.6	88.9	87.9	99.2	96.9								
145.	Eager	6.3	26.3	77.8	76.6	88.4	93.8								

(Continued)

Table 1 | Continued

	Emotion word	Age (years)							Emotion word	Age (years)					
		4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)			4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)
193.	Homesick	30.0	33.3	76.9	95.8	100	95.2	242.	Moved	13.8	32.4	61.5	83.8	95.4	95.2
194.	Hopeful	30.0	57.6	88.5	97.2	100	98.4	243.	Murderous	10.0	23.5	50.0	75.8	72.4	71.4
195.	Hopeless	23.3	48.5	88.5	90.1	97.7	100	244.	Mystified	0.0	0.0	38.5	68.7	63.2	71.4
196.	Horrified	36.7	51.5	92.3	91.5	100	100	245.	Nasty	89.7	100	96.2	98.5	97.7	100
197.	Humiliated	3.3	9.1	50.0	82.6	88.4	96.8	246.	Needed	46.7	76.5	92.3	92.6	96.6	100
198.	Humored	0.0	9.1	23.1	72.5	90.7	100	247.	Needy	3.4	26.5	46.2	73.5	85.1	95.0
199.	Hurried	46.7	69.7	92.3	91.5	97.7	98.4	248.	Neglected	3.3	5.9	64.0	69.6	72.4	100
200.	Hurt	80.0	97.0	96.2	93.0	100	98.4	249.	Nervous	50.0	79.4	96.2	94.2	93.1	100
201.	Ignored	66.7	81.8	96.2	94.4	97.6	96.7	250.	Nosy	56.7	91.2	96.2	97.1	95.4	95.2
202.	Impatient	43.3	60.6	100	90.1	92.9	95.2	251.	Numb	3.3	32.4	65.4	84.1	86.2	85.7
203.	Impressed	46.7	69.7	88.5	91.5	95.2	96.8	252.	Obsessed	0.0	11.8	57.7	81.2	89.7	100
204.	Injured	60.0	87.9	96.2	88.7	97.6	98.4	253.	Offended	6.7	11.8	53.8	85.5	86.2	95.2
205.	Innocent	23.3	33.3	76.9	88.6	90.5	96.8	254.	Outgoing	13.3	14.7	53.8	77.6	82.8	90.5
206.	Inspired	0.0	6.1	57.7	79.7	85.4	96.8	255.	Outraged	3.3	11.8	52.0	83.8	79.3	100
207.	Insulted	6.9	21.2	69.2	87.3	90.5	96.8	256.	Overcome	3.3	11.8	50.0	76.8	83.9	90.5
208.	Insulting	6.7	12.1	73.1	87.3	95.2	98.4	257.	Overjoyed	16.7	47.1	80.8	95.7	86.2	95.2
209.	Interested	73.3	87.9	100	91.5	92.9	98.4	258.	Overpowered	0.0	8.8	50.0	72.5	78.2	90.5
210.	Involved	26.7	63.6	96.2	88.7	93.0	98.4	259.	Overpowering	0.0	8.8	48.0	72.5	77.0	85.7
211.	Irritated	23.3	60.6	92.3	81.7	86.0	96.8	260.	Overwhelmed	0.0	5.9	48.0	75.4	71.3	90.5
212.	Jealous	46.7	75.8	80.8	92.9	96.6	100	261.	Panic	50.0	85.3	92.3	87.5	92.3	100
213.	Joking	96.7	93.9	96.2	95.8	98.9	100	262.	Peaceful	63.3	88.2	92.3	90.5	92.3	95.2
214.	Jolly	60.0	75.8	96.2	97.2	93.1	100	263.	Pity	16.7	32.4	88.5	76.6	78.5	95.0
215.	Joy	60.0	78.8	92.3	97.1	96.5	100	264.	Playful	73.3	79.4	88.5	93.8	95.4	100
216.	Judging	10.0	30.3	69.2	77.5	72.4	100	265.	Pleased	96.7	97.1	100	90.5	98.5	100
217.	Jumpy	20.0	39.4	64.0	88.7	88.5	100	266.	Pleasure	46.7	58.8	88.5	85.7	93.8	100
218.	Keen	36.7	69.7	96.2	93.0	93.1	100	267.	Protective	16.7	47.1	100	85.9	83.1	95.2
219.	Kind	96.7	97.0	100	97.2	97.7	100	268.	Proud	53.3	82.4	96.2	90.6	92.3	100
220.	Knowing	40.0	57.6	88.5	90.1	96.6	100	269.	Puzzled	33.3	61.8	92.3	87.5	90.8	100
221.	Liked	73.3	90.9	100	94.4	100	100	270.	Questioning	26.7	52.9	84.6	82.8	84.6	90.5
222.	Listening	83.3	97.0	100	95.8	100	100	271.	Regret	3.3	26.5	69.2	85.9	81.3	95.2
223.	Lively	30.0	63.6	100	93.0	89.7	100	272.	Rejected	3.3	21.2	73.1	84.1	90.6	100
224.	Lonely	83.3	90.9	96.2	95.7	96.6	100	273.	Relaxed	63.3	82.4	92.3	85.9	92.2	100
225.	Longing	6.9	23.5	50.0	79.7	70.1	95.0	274.	Relief	6.7	38.2	80.8	82.5	93.8	95.2
226.	Lost	83.3	91.2	92.3	94.3	100	100	275.	Respect	10.0	38.2	88.5	81.0	92.2	100
227.	Love	96.7	100	96.2	98.6	98.9	100	276.	Responsible	30.0	67.6	92.3	82.5	90.6	100
228.	Lovesick	13.8	17.6	50.0	81.4	80.2	85.0	277.	Restless	13.3	29.4	76.9	82.8	84.4	95.2
229.	Low	23.3	64.7	76.9	87.1	87.4	100	278.	Sad	100	100	100	98.4	100	100
230.	Loyal	3.4	14.7	69.2	78.6	82.8	95.0	279.	Safe	80.0	82.4	100	95.3	98.4	100
231.	Lying	90.0	94.1	100	98.6	97.7	100	280.	Satisfied	16.7	32.4	80.8	82.3	84.1	100
232.	Mean	73.3	88.2	100	95.7	97.7	100	281.	Scared	93.3	100	100	93.8	95.2	100
233.	Merry	41.4	50.0	88.5	91.3	94.3	100	282.	Secure	13.3	41.2	80.8	76.6	77.8	100
234.	Mischievous	34.5	35.3	80.8	82.6	73.6	81.0	283.	Sensitive	13.3	38.2	80.8	85.9	82.5	100
235.	Miserable	70.0	91.2	92.3	91.2	85.1	100	284.	Serious	56.7	67.6	96.2	85.7	93.4	100
236.	Misjudged	3.3	8.8	65.4	75.4	77.0	81.0	285.	Settled	23.3	67.6	84.6	79.4	87.3	100
237.	Mistreated	10.3	38.2	80.8	82.4	82.8	90.5	286.	Shaken	20.0	38.2	76.9	79.4	90.5	95.2
238.	Misunderstood	16.7	47.1	84.6	83.8	87.4	95.2	287.	Shocked	40.0	76.5	88.5	90.6	92.1	100
239.	Mocking	3.3	0.0	28.0	64.7	62.1	76.2	288.	Shy	80.0	94.1	96.2	93.8	95.2	100
240.	Modest	0.0	0.0	20.0	64.7	72.4	81.0								
241.	Moody	63.3	85.3	88.5	97.1	96.6	100								

(Continued)

Table 1 | Continued

	Emotion word	Age (years)					
		4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)
289.	Sickened	3.3	11.8	53.8	73.4	84.1	95.2
290.	Sneaky	30.0	58.8	80.8	81.3	85.7	95.2
291.	Sorry	100	100	100	82.8	84.1	90.5
292.	Spiteful	36.7	58.8	69.2	79.7	81.0	85.7
293.	Startled	6.7	29.4	53.8	73.4	73.0	95.2
294.	Stupid	80.0	94.1	100	84.4	96.8	100
295.	Sulky	40.0	76.5	80.8	81.3	85.5	90.5
296.	Sure	60.0	70.6	92.3	90.6	93.5	100
297.	Surprised	80.0	94.1	92.3	92.2	90.3	95.2
298.	Tearful	83.3	82.4	92.3	82.8	90.3	95.2
299.	Teasing	80.0	79.4	92.3	87.5	91.9	95.2
300.	Tempted	6.7	35.3	80.8	78.1	91.9	95.2
301.	Tender	6.7	20.6	73.1	67.2	79.0	90.5
302.	Tense	6.7	14.7	61.5	71.9	85.5	95.2
303.	Terrified	46.7	82.4	88.5	85.9	91.9	95.2
304.	Terror	43.3	55.9	80.0	81.3	93.5	100
305.	Thankful	60.0	85.3	92.3	92.2	95.2	95.2
306.	Thinking	76.7	88.2	96.2	90.6	98.4	95.2
307.	Thoughtful	43.3	61.8	88.5	87.5	96.7	95.2
308.	Threatened	10.0	44.1	76.9	87.5	91.9	100
309.	Threatening	13.3	41.2	84.6	85.9	91.9	95.2
310.	Thrilled	6.7	61.8	80.8	84.4	90.3	95.2
311.	Touched	40.0	67.6	88.5	78.1	88.5	100
312.	Trapped	46.7	67.6	88.5	85.9	88.7	100
313.	Troubled	30.0	50.0	80.8	81.3	90.3	100
314.	Trusting	53.3	73.5	88.5	88.9	88.7	100
315.	Uncaring	33.3	64.7	88.5	84.4	79.0	90.0
316.	Uncertain	10.0	32.4	84.6	84.4	87.1	100
317.	Uncomfortable	50.0	70.6	96.2	85.9	88.7	100
318.	Understanding	40.0	70.6	100	87.1	93.5	100
319.	Unfriendly	66.7	79.4	92.3	87.1	90.3	100
320.	Unhappy	93.3	97.1	96.2	93.5	95.2	100
321.	Unsure	36.7	67.6	96.2	89.8	90.3	95.0
322.	Upset	83.3	97.1	100	96.6	96.8	100
323.	Uptight	3.3	11.8	50.0	62.7	75.8	85.0
324.	Useless	36.7	73.5	92.3	89.8	91.9	100
325.	Vain	6.7	14.7	42.3	65.5	69.4	90.0
326.	Wanted	50.0	64.7	84.6	82.8	93.5	100
327.	Warm	66.7	64.7	92.3	90.0	96.8	100
328.	Watchful	13.3	32.4	73.1	75.0	93.5	100
329.	Weary	10.0	26.5	57.7	68.3	83.9	95.0
330.	Weepy	30.0	47.1	76.9	78.3	87.1	95.0
331.	Whining	46.7	70.6	84.6	81.0	79.0	90.0
332.	Wishful	23.3	61.8	73.1	80.0	95.2	100
333.	Wonder	43.3	55.9	88.5	88.3	95.2	100
334.	Wondering	33.3	55.9	84.6	86.7	90.3	100
335.	Worried	76.7	82.4	100	93.3	96.8	100
336.	Worthless	10.0	23.5	65.4	78.3	95.2	100

DISCUSSION

Comprehension of 336 emotion words was assessed using either self-report (from teenagers) or parent- or teacher-report (for younger children), ranging from 4 to 16 years old. The aim of the study was to collect normative data to document when different emotion terms are understood in development, and to measure differences in the proportion of each age group who understand each term. This was undertaken because of gaps in knowledge in how such competence grows with age. Results confirm that complex emotion vocabulary develops dramatically during childhood, doubling in size every 2 years between 4 and 11 years old, but that between 12 and 16 years old there was no significant increase in the number of emotion words understood. Apart from measuring differences between age-bands, this study also provides detailed data on each emotion-term so that these can be ordered according to level of difficulty, for future studies to exploit.

The finding that there is no significant development in this ability after adolescence may be an artifact of three factors. First, that we set a conservative probability level ($p < 0.002$) to control for multiple-testing, and the differences between the adolescent age groups, whilst meeting more relaxed criteria ($p < 0.05$), did not reach these levels. Secondly, we limited the word list to 336 words, and it may be that if a longer word list had been used, with more difficult words, changes between 12 and 16 years old would also have become evident. Lastly, since comprehension of the emotions was judged by different respondents in the younger vs. the older age bands, the lack of significant increase in emotion vocabulary comprehension amongst the adolescents could be related to their reluctance to admit they were not familiar with some emotion words. For these reasons, we do not wish to draw any conclusions about underlying mechanisms (brain development, hormonal changes, etc.) at the onset of adolescence having any special role in the rate of development of comprehension of the emotional lexicon.

One obvious limitation of this study is that the data was collected by self-report (in the case of 12–16 year olds) and parent/teacher report (in the case of children aged 4–11 year olds). There is thus no independent confirmation of comprehension, such as a performance test. This would not have been feasible in a large-scale study of this kind, but the reliability of self or parent/teacher report could be tested in future studies. We chose parent- or teacher-report for the pre-adolescent years because other instruments (such as the McArthur Checklist for Vocabulary Development) have used this method and shown that parent-report correlates well with actual performance measures of language comprehension (Fenson et al., 1994). For this reason, we suggest that the data reported here is likely to be reliable, but this should be tested formally using laboratory measures. Future studies could also look at effects of sex (with larger samples), word frequency, and emotion valence.

Secondly, this study only assessed the comprehension of emotion *words*. Ongoing studies are using this corpora to test the ability to recognize complex emotions and mental states from video-clips of faces and audio-clips of voices, to document
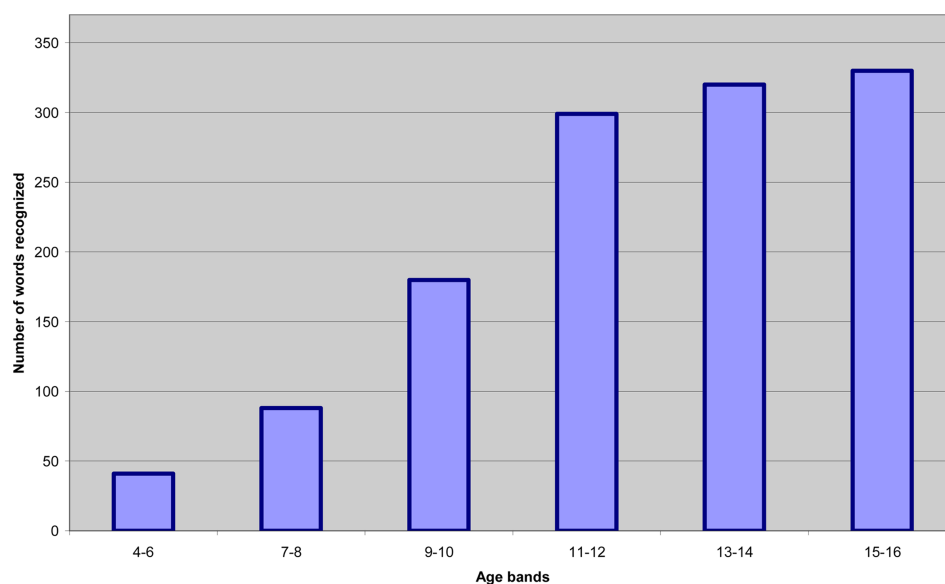
FIGURE 1 | The number of emotion and mental state words understood by at least 75% of participants in each age band.

Table 2 | Percentage of words in each emotion category understood by at least 75% of each age band.

Category	Age (years)					
	4–6 (%)	7–8 (%)	9–10 (%)	11–12 (%)	13–14 (%)	15–16 (%)
Kind (22)	22.7	31.8	59.1	81.8	95.5	95.5
Afraid (19)	21.1	42.1	63.2	100.0	100.0	100.0
Sneaky (5)	20.0	20.0	40.0	80.0	100.0	100.0
Sad (31)	19.4	25.8	45.2	83.9	100.0	100.0
Thinking (11)	18.2	36.4	63.6	81.8	90.9	100.0
Happy (39)	17.9	41.0	79.5	100.0	97.4	100.0
Bored (6)	16.7	16.7	33.3	83.3	83.3	83.3
Bothered (7)	14.3	14.3	71.4	85.7	100.0	100.0
Angry (23)	13.0	43.5	60.9	91.3	100.0	100.0
Fond (9)	11.1	22.2	77.8	100.0	100.0	100.0
Sorry (9)	11.1	22.2	55.6	100.0	100.0	100.0
Excited (9)	11.1	11.1	55.6	100.0	100.0	100.0
Unsure (201)	9.5	14.3	61.9	81.0	90.5	95.2
Hurt (22)	9.1	27.3	50.0	86.4	95.5	100.0
Surprised (11)	9.1	27.3	45.5	90.9	90.9	100.0
Interested (13)	7.7	30.8	53.8	92.3	100.0	100.0
Unfriendly (302)	6.3	21.9	28.1	78.1	87.5	93.8
Liked (6)	0.0	33.3	50.0	100.0	100.0	100.0
Wanting (8)	0.0	12.5	37.5	87.5	87.5	100.0
Sure (187)	0.0	5.6	38.9	83.3	88.9	94.4
Disbelieving (6)	0.0	0.0	50.0	100.0	100.0	100.0
Romantic (2)	0.0	0.0	50.0	100.0	100.0	100.0
Touched (4)	0.0	0.0	25.0	100.0	75.0	100.0
Disgusted (3)	0.0	0.0	0.0	66.7	100.0	100.0

Emotion categories taken from Mind Reading: The interactive guide to emotions. In brackets – the number of emotion words from each category that were included in the developmental survey.

how *recognition* of emotions from facial or vocal expressions develops with age (Golan et al., 2006; Golan and Baron-Cohen, submitted).

We conclude first that this study documents significant changes in rate of emotional lexicon comprehension between 4 and 11 years of age, which should be taken into consideration by researchers and educators when designing developmentally sensitive tests and teaching materials. Whereas at age 4–6 years old only 41 emotion words are understood by more than 75% of children, by 11 years old children understand 299 such words. Secondly, this study allows emotion terms to be ordered developmentally with respect to their level of difficulty.

Finally, the normative data reported here may be useful not only for studies of typical emotion comprehension but also against which to assess emotion-comprehension delays or deficits that may arise either for environmental reasons (e.g., following neglect or abuse; Pollak et al., 2000), or for neurodevelopmental reasons (e.g., as occurs in conditions such as autism and Asperger Syndrome). Although individuals on the autistic spectrum may not show deficits in basic emotion recognition (Loveland et al., 1997; Grossman et al., 2000), they do have deficits in recognizing complex emotions (Yirmiya et al., 1992; Baron-Cohen et al., 2001). The use of a graded developmental scale of emotion comprehension may help reveal such deficits in clinical populations, should they exist, and enable researchers to quantify the degree of developmental delay in emotion lexicon comprehension relative to typical age-matched controls.

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