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EmotionPrism: A Design Tool that Communicates 25 Pleasurable Human-Product Interactions

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Abstract

The range of positive emotions experienced in human-product interactions is multifarious. Differentiating positive emotions (e.g., joy, love, hope, and interest) and having an awareness of associated expressive interaction qualities (e.g., playful, careful, persistent and focused interaction) can support designers to influence users' interactions in a favourable way. This paper introduces the development and application of EmotionPrism, a tool for designers to gain a better understanding specific positive emotions and related expressive interaction qualities. EmotionPrism is a collection of movie-sets that represents 25 different positive emotions in dynamic hand-object interactions, combined with theoretical descriptions of the emotions. Designers can use the tool to envision and discuss what kinds of interactions would be appropriate or desirable to incite and to select a set of relevant positive emotions accordingly by referring to the set of information as a repertoire to choose from. The paper first describes characteristics of positive emotions with a focus on expressive behaviour and then discusses considerations for the tool development. The second section reports the process of developing the tool. Thirdly, we present the results of a design workshop in which the tool was used and evaluated.

Keywords

Design for emotions; positive emotions; user-centred design; user experience; design tool

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Biographical notes

JungKyoon Yoon is PhD candidate in the Department of Industrial Design at Delft University of Technology, and lecturer at the University of Liverpool. His research focuses on experience design, mainly concerning how the differentiated nature of emotions can be leveraged in design processes.

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Pieter M. A. Desmet is Professor, chair of the Design for Experience Research Group, and programme director of the Design for Interaction Master's programme at Delft University of Technology. His main research interests are in the fields of design, emotion, and subjective well-being. He is a board member of the International Design and Emotion Society and co-founder of the Delft Institute of Positive Design.

1 Introduction

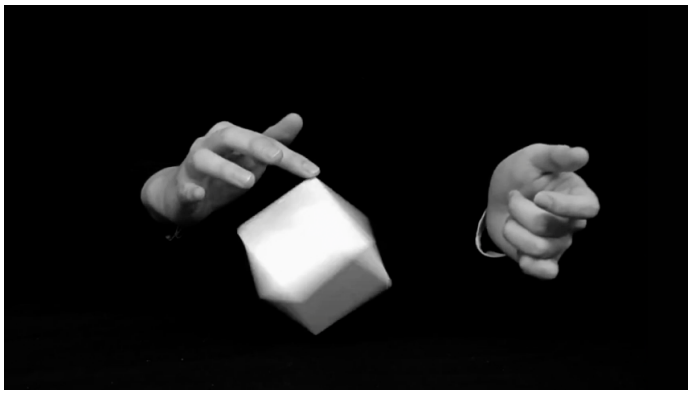
This paper focuses on positive emotions experienced in human-product interactions. Products can evoke a wide variety of positive emotions. We can, for example, be fascinated by an immersive virtual reality interface, have a victorious feeling when completing a video game, and be proud of being a backer of a new gadget development by using a crowd-funding service. Although these emotions are all positive or pleasant, they are characterised by distinct and special behavioural tendencies (e.g., Fredrickson, 2002; 2013). For example, hope stimulates the urge to commit to the activity at hand (Lazarus, 1991), amusement incites to share the joviality (Gervais & Wilson, 2005), and admiration motivates virtuous behaviours and to be more open to others (Algoe & Haidt, 2009). Design research has shown that these behavioural effects also apply to positive emotions in human-product interactions. For instance, Yoon, Desmet, and van der Helm (2012) showed that a feeling of interest induces a user to actively explore the product properties and functionalities, and prolongs the duration of use, resulting in an increased understanding of the product. Ludden, Hekkert, and Schifferstein (2008) found that a product that evokes pleasant surprise draws a person's attention, and has positive effects on product recall and recognition.

In this paper, we explore if positive emotions in human-product interactions are also characterised by distinct (and observable) expressions. The focus is on the expressions of hands in the interaction. In other words, does love stimulate a different 'interaction quality' than joy, fascination, pride, and etcetera? If so, insights in these expressions could act as a source of inspiration for designers who want to influence users' interactions in product use. More specifically, designers could deliberately target certain user emotions by designing for emotion-specific interaction qualities (e.g., careful, playful, or focused interaction). Being precise in terms of the interaction qualities and user emotions can increase the effectiveness of both design processes and design outcomes (Desmet & Schifferstein, 2012; Diefenbach et al., 2016). While several frameworks are currently available that explain how design evokes emotions (e.g., Desmet, 2002; Hassenzahl, 2010; Jordan, 1999; Norman, 2004), the existing theory and methodology do not yet inform the relationship between dynamic and expressive interaction qualities and user emotion.

Our approach was to develop a set of videos that show 25 different positive emotions in hand-object interactions (Figure 1). These videos were used as stimuli in a study that tested the degree to which people can recognise distinct emotions in human-object interactions. In addition, they were used as the basis for a design tool: EmotionPrism. The purpose of this tool is to enable designers to increase their ability to make fine-grained distinctions about positive emotions in human-product interaction and to offer a source of inspiration in emotion-focused design processes.

The paper consists of three parts. The first describes the development of the movie clips and EmotionPrism, including the main considerations in the development process. The second part reports the study that investigated the degree to which people can identify distinct positive emotions in these movie clips. The third part presents the results of a design workshop in which designers used and evaluated EmotionPrism. The paper concludes with a discussion of implications of the work, limitations, and suggestions for future research.

Figure 1 A screenshot of a movie-clip used in EmotionPrism



2 Considerations for the tool development

The development of the tool involved three main considerations: the number of positive emotions to be included, the channels to discriminate between positive emotions, and the medium of the tool. This section describes the insights gained from the literature on the characteristics of positive emotions and related design tools that explain nuanced positive emotional experiences.

2.1 The number of positive emotions to be included

The first issue was to decide on the level of granularity. Although several basic emotion-sets have been proposed (e.g., Ekman, 1999; Frijda, 1986; Izard, 1977; Plutchik, 1980), compared to negative emotions, they tend to include a fewer number of positive emotions, covering one to three such as joy, love, and interest (for the discussion of imbalance between positive and negative emotions, see Fredrickson, (1998). These oversimplified sets are insufficient for representing the wide range of positive emotions experienced in human-product interactions. Desmet (2012) showed that people can experience at least 25 distinct positive emotions while interacting with products, and formulated a typology clustering them in nine categories (see Table 1). We decided to build on this typology because it is concise, yet fine-grained enough to illustrate a variety of positive emotional experiences.

Table 1 Typology of positive emotions categorised in emotion types (adapted from Desmet (2012))

Category	**Positive emotion**	**Category**	**Positive emotion**
Empathy	Sympathy, kindness, respect	Animation	Surprise, being energetic
Affection	Love, admiration, dreaminess	Assurance	Courage, pride, confidence
Aspiration	Lust, desire, worship	Interest	Inspiration, enchantment, fascination
Enjoyment	Euphoria, joy, amusement	Gratification	Relief, relaxation, satisfaction
Optimism	Hope, anticipation		

2.2 Channels to discriminate between positive emotions

Given the aim to communicate expressive interaction qualities of positive emotions, it was decided to show differentiated emotional expressions *in interactions*. Recent research on emotional expression in behaviour has shown that positive emotions are associated with multiple channels like posture, voice tone, and touch (Sauter, McDonald, Gangi, & Messinger, 2014). Campos, Shiota, Keltner, Gonzaga, and Goetz (2013) compared upper body movements such as arm and torso triggered by eight positive emotions, and found that they can be distinguished based on the variability of gestural and postural expressions, e.g., sitting up straight and pulling the shoulders back accompanied by the feeling of pride, and forward leans and head tilts accompanied by interest. Hertenstein, Keltner, App, Bulleit, and Jaskolka (2006) showed that some positive emotions like love, gratitude, and sympathy can be decoded via touch, e.g., love signalled with stroking, and even they can be inferred by merely watching other people communicate via touch.

While useful, these studies only focus on how distinct positive emotions can be distinguished in general behaviour, but not on user behaviour when interacting with a product. Hence, we decided to conduct an exploratory study with actors expressing positive emotions in human-product interactions. In particular, it was decided to use hands interacting with an artefact to demonstrate differentiated expressions since most human-product interactions involve hands.

2.3 Medium of the tool

Various design tools that communicate positive emotional experiences have been proposed. Yoon, Pohlmeyer, and Desmet (2013), for instance, developed a card-set based on the typology of positive emotions (Desmet, 2012) that incorporated definitions of emotion terms, causes, and pictorial behavioural manifestations. Based on Sheldon et al.'s psychological needs (Sheldon, Elliot, Kim, & Kasser, 2001), Hassenzahl, Eckoldt, Diefenbach, Lenz, and Kim (2013) developed a card-set that gives an overview of a design relevant set of seven needs, all of which describe the associated positive emotional experiences with suggestive illustrations. The advantages of these card-based tools are that it is effective to share and spatially arrange the contents, facilitating informal discussions and collective creativity (Stappers, 2006). However, using static visuals is not the optimal means to express interactive behaviour. In Pasman, Boess, and Desmet (2011), it was found that when solely using pictorial and textual information, designers had a difficulty in identifying and communicating the feelings that the interaction with a product should bring for the user. This was because, as was discussed in Haidt and Keltner (1999) and Desmet (2002), emotions are displayed with temporal dynamics of actions, and nonbasic emotions such as sympathy and amusement involve a narrative in the expressions. Therefore, to ensure the rich and dynamic representation of emotions, videos were used as the main medium of the tool to supplement text-based information, e.g., emotion terms and definitions.

3 Development of EmotionPrism

This section describes the process of creating and evaluating movie-clips of manifestations of positive emotions in interactions in five steps: (1) collecting thought-action tendencies of positive emotions, (2) generating, (3) selecting, (4) evaluating the movie-clips, and (5) integrating them into a design tool.

3.1 Phase 1. Collecting momentary thought-action repertoire of positive emotions

All emotions involve action tendencies that characterise certain behaviours (Frijda, 2007). Examples are the tendency 'to care for,' which is stimulated by love, and a tendency 'to oppose,' which is stimulated by anger. Some emotions, like contentment and interest, do not always stimulate immediate (or visible) changes in physical actions. To accommodate for these emotions, Fredrickson (1998) introduced the concept of 'thought-action tendencies,' which expresses the idea that the activities that are influenced by emotions can be both of a physical and a cognitive kind. We decided to develop general expressions of thought-action tendencies in hand-object interactions instead of depicting realistic usage behaviours in order to make the tool independent of particular context or situational meaning. The idea was that this would result in a tool that can be widely used for any design project. For this, the descriptions of thought-action tendencies of the 25 positive emotions were collected from the literature of emotion psychology and positive psychology. The collected thought-action tendencies served as a reference for the tool development, and have been incorporated into the tool. Table 2 describes the collected thought-action tendencies.

Table 2 Thought-action tendencies of 25 positive emotions

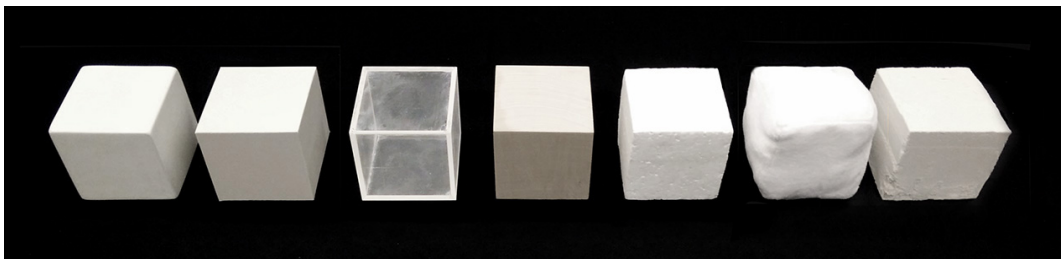
Emotion	**Thought-action tendency**	**Emotion**	**Thought-action tendency**
Sympathy	Be altruistic, be less punitive (Batson & Shaw, 1991; Sprecher & Fehr, 2005)	Hope	Be committed to, continue (Lazarus, 1993)
Kindness	Be tender, protect, monitor (Lishner, Batson, & Huss, 2011)	Anticipation	Eagerly await, be impetuous (Yoon et al., 2013)
Respect	Accept, recognise, emulate, endorse (Desmet, 2012)	Courage	Persist, endure (Desmet, 2012)
Love	Get intimate with, nurture, be approachable (Desmet, 2012; Fisher, Aron, & Brown, 2005)	Surprise	Pay attention to, take in (Smith & Ellsworth, 1985)
Admiration	Uphold, honour, affiliate with, be virtuous (Algoe & Haidt, 2009; Schindler, 2014)	Being energetic	Be lively, be bouncy (Desmet, 2012)
Dreaminess	Be introspective, meditative (Yoon et al., 2013)	Pride	Reward the self, show off, persevere, stay focused (Desmet, 2012; Williams & DeSteno, 2008)
Lust	Seek proximity, allure (Gonzaga, Turner, Keltner, Campos, & Altemus, 2006)	Confidence	Being free from doubt, control (Desmet, 2012; Nicolás, Aurisicchio, & Desmet, 2013)
Desire	Be possessive, get hold of (Desmet, 2008)	Inspiration	Be creative (Desmet, 2008)
Worship	Adopt the ideals and values, adulate (Schindler, 2014)	Enchantment	Be mesmerised, absorbed (Piff, Dietze, Feinberg, Stancato, & Keltner, 2015)
Euphoria	Be carried away, announce what has happened to others (de Rivera & Possell, 1989)	Fascination	Explore, understand (Silvia, 2005; Yoon et al., 2012)
Joy	Play, invent, fool around (Fredrickson, 2013)	Relief	Avoid the source of distress, becalmed (Tong, 2014; Yoon et al., 2013)
Amusement	Play socially, share the joviality (Fredrickson, 2013; Gervais & Wilson, 2005)	Relaxation	Relish, be unworried, indulge (Ellsworth & Smith, 1988)
		Satisfaction	Savour the current situation, take in (Fredrickson, 1998)

3.2 Phase 2. Generating manifestations of thought-action tendencies of positive emotions

3.2.1 Development of stimuli

Two professional actors with more than ten years of experience in theatre play were recruited. The actors were paid for their contributions. Instead of having the actors interact with a specific product such as camera or lamp, we decided to use a neutral cube that could symbolise a product in an abstract manner since the application of the tool should not be limited to the design of a particular product type. Furthermore, the use of a cube was to induce designers to focus on interactions, not being distracted by the stimulus appearance. A set of 11cm-high cubes that are similar in terms of appearance, but different in terms of materials was made. This set was developed to afford a wide range of interactions, e.g., squeezing and caressing. Based on the framework of verbal appraisals with product materials proposed by Karana (2009), seven materials were chosen: plaster, rubber, plastic, wood, Styrofoam, fabric, and sand.

Figure 2 The seven cubes that served as stimuli (from left: plaster, rubber, plastic, wood, Styrofoam, fabric, and sand)



3.2.2 Setup and procedure

Movie-clips that portray the 25 positive emotions were generated with a two-step procedure: (1) sensitising and (2) performing. The sensitisation phase had two aims: to support the actors in having a nuanced understanding of positive emotions and to enable them to prepare for their performance by exploring how the emotions can be effectively portrayed. In this phase, the actors used a sensitising booklet to reflect and write down experiences of the 25 positive emotions in relation to products. They were instructed to describe the situations with texts and drawings. To help them in understanding the target emotions, the booklet provided definitions, thought-action tendencies, and synonyms for all emotions. In addition, they were requested to brainstorm how each emotion can be expressed with hand gestures and body postures. The actors worked on three to four positive emotions a day that were considered similar based on the typology of positive emotions (Desmet, 2012). The booklet was filled in for seven days.

For the performance session, the actors wore black clothes with long sleeves. A table on which the cubes were placed was also covered with black fabric to make the hands and cubes conspicuous. The session was individually conducted and started with a briefing about the general aim of the movies. The actors received the seven cubes and were guided to familiarise themselves with the sensorial properties by making various actions, e.g., spinning, cuddling, and juggling, for five minutes. Next, they acted out the emotions in the set one by one, swapping the seven cubes. The order of the emotion was the same with the one in the sensitisation booklet, and the actors were allowed to repeat a performance until they thought the emotion was explicitly represented.

Figure 3 An actor acting out an emotion

3.3 Phase 3. Selecting the movie-clips that best represent thought-action tendencies

The performance sessions with the two actors resulted in 531 movie-clips (on average 21 per emotion). We presumed that presenting several movie-clips together would help designers grasp what an emotion would look like in interactions because the movie-clip could show a common interaction quality of the emotion with different manifestations. After some explorations, we

decided to show four movie-clips per emotion. This number was found to balance between overview and richness: on the one hand, each emotion should be represented with various movie-clips, but on the other hand, it should be manageable to quickly go through them.

The next step in the development process was to select four movie-clips per emotion. In a pre-selection procedure, the ten best movie-clips were selected for each emotion. This was done in a session with two researchers (the first author and a master-candidate in emotion-driven design) with the use of two criteria: (1) movie-clips in the set should be clear representations of the given emotion, and (2) they should be diverse in terms of gestural and postural expressions.

3.3.1 Participants

The set of selected movie-clips was further reduced with the results of an online survey. 171 native-English speakers living in the United States were recruited for participation. Age ranged between 23 and 69 (M=42, SD=11.83), and the nationalities of the respondents consisted of American (90.7%), Indian (2.3%), British (1.2%), Canadian (1.2%), Georgian (1.2%), Vietnamese (1.2%), Armenian (0.6%), Italian (0.6%), Macedonian (0.6%), and Mexican (0.6%). Respondents were recruited from Amazon's Mechanical Turk, an online survey recruiting service, and they received financial compensation for their participation.

3.3.2 Procedure

Respondents were instructed to select the five movie-clips that best represent a specific positive emotion. The respondents were split into five groups, each of which was assigned five emotions. The group distribution is described in Table 3. After a short introduction that explained the general aim of the study, respondents selected five movie-clips that in their eyes, best represent an emotion. For each emotion, the emotion word, its definition, and ten movie-clips were presented. The procedure was conducted individually, and the order of emotions and presented movie-clips were randomised. It took approximately 18 minutes to complete the task.

Table 3. Group distribution and assigned emotions

Group	Participant	Assigned emotion
1	41 (female: 22)	Surprise, amusement, enchantment, desire, and hope
2	36 (female: 19)	Being energetic, joy, inspiration, worship, and courage
3	31 (female: 14)	Euphoria, fascination, dreaminess, confidence, and sympathy
4	31 (female: 17)	Lust, admiration, pride, kindness, and relief
5	32 (female: 17)	Love, anticipation, respect, relaxation, and satisfaction

3.2.3 Results

On average, 153.32 responses per emotion were given to rate the movie clips (SD=4.25). After data collection, the four movie-clips with highest ratings were chosen for each emotion. Besides the ratings, a diversity criterion also influenced the selection. If there were two similar movie-clips for a specific emotion, the movie-clip that received the lower score was not included in the set, and instead, the movie-clip that was the next in the rank was selected. This procedure resulted in a selection of 100 movie-clips.

3.4 Phase 4. Evaluating the movie-clips

An online survey was carried out to evaluate whether the 100 movie-clips were recognised as expressing the target emotions.

3.4.1 Participants

30 native-English speakers living in the United States (male: 18) were recruited. The age of the participants ranged between 19 and 58 years (M=35, SD=11.37). Their nationalities were:

American (94%), Indian (3%), and Sri Lankan (3%). Respondents were recruited from Amazon's Mechanical Turk and paid for their participation.

3.4.2 Procedure

Respondents were shown 25 movie-sets, each set consisting of four movie-clips that express one positive emotion. On average, the length of each movie-set was 23.52 seconds (SD=6.7). Respondents rated to what extent each movie-set portrayed each of the 25 emotions. The survey began by explaining the aim of the study and by briefly explaining the influence of emotions on behaviours. For each movie-set, all 25 positive emotions were presented with corresponding definitions and a ten-point rating scale (1: not representative, 10: highly representative). The order of movie-sets and emotion words was randomised. Respondents were allowed to replay the movie-sets. It took about 1.5 hours to complete the survey.

3.4.3 Results

In order to examine the extent to which the respondents could recognise the intended emotion in response to each movie-set, the mean values of the scales given to the 25 positive emotions were compared. The mean values are listed in Table 4. Due to space limitations, the table reports the nine highest rated and the two lowest rated emotions. The full data can be reviewed at http://studiolab.ide.tudelft.nl/diopd/emotionprism-data.

A movie-set was considered to be clear when the target emotion was rated highest among the 25 emotions. In addition, when there were other emotions that received higher ratings than the target emotion, if those emotions had even higher ratings in the movie-set that they were originally intended to illustrate, we considered these movie-clips satisfactory too. This second criterion was based on the idea that in the design tool, the movie-sets will be shown in the context of the complete collection of movie-sets. In that context, the users of the design tool will easily pair the emotions with the corresponding movie-sets. For example, although for the movie-set that represents 'confidence,' amusement (7.19) and being energetic (6.48) received higher ratings than confidence (5.3), the movie-sets for 'amusement' and 'being energetic' received even higher ratings in accordance with the intended emotions, respectively (amusement: 8.7 and being energetic: 8.78). Likewise, for the movie-set 'relief,' anticipation received higher ratings (4.11) than relief (3.78). However, the movie-set was considered satisfactory because respondents matched the movie-set of 'anticipation' with even higher ratings for anticipation (7.7). As shown in Table 4, the movie-sets that were matched with the intended emotions with highest ratings (criterion 1) were: admiration, amusement, anticipation, desire, dreaminess, being energetic, fascination, inspiration, pride, relaxation, and respect. The movie-sets that were vested in the second criterion were: confidence, enchantment, hope, lust, relief, and surprise. The eight movie-sets of courage, euphoria, joy, kindness, love, satisfaction, sympathy, and worship did meet neither of the two criteria and could thus not be conclusively linked to the emotions that they were aimed to represent.

Table 4. Mean values of scale ratings of the movie-sets for the intended emotions

AD=Admiration, AM=Amusement, AN=Anticipation, CO=Confidence, COU=Courage, DE=Desire, DR=Dreaminess, EN=Enchantment, ENE=Being energetic, FA=Fascination, EU=Euphoria, HO=Hope, IN=Inspiration, KI=Kindness, JO=Joy, LO=Love, LU=Lust, PR=Pride, RE=Relaxation, REL=Relief, RES=Respect, SA=Satisfaction, SU=Surprise, SY=Sympathy, WO=Worship

: Movie-sets that received highest ratings for the intended emotion

: Movie-sets that were affiliated to a blend of other emotions that received higher rates than the intended one, but those emotions appeared to be matched with the other movie-sets with higher rates.

Movie-set	**Ratings in relation to emotions**											
	1	2	3	4	5	6	7	8	9	10 - 24	24	25
Admiration	AD 5.81	FA 5.67	EN 5.22	RES 5.07	PR 5.04	AN 4.67	WO 4.63	SA 4.48	IN 4.44	…	EU 1.89	LU 1.67
Amusement	AM 8.7	ENE 7.22	FA 7.04	JO 6.3	EN 5.44	EU 4.7	IN 4.67	SA 4.59	CO 4.04	…	SY 1.59	LU 1.48
Anticipation	AN 7.7	ENE 4.67	DE 4.04	FA 4.04	HO 3.7	EN 3.56	IN 3.56	AM 3.33	AD 3.22	…	COU 2.11	LO 2.07

Desire	DE 6.44	FA 5.96	AN 5.78	EN 4.59	AD 4.56	LU 4	RES 3.85	WO 3.59	COU 3.48	…	RE 1.96	REL 1.93
Dreaminess	DR 6.04	RE 5.22	EN 4.3	AN 4.19	FA 3.96	AD 3.52	DE 3.52	RES 3.52	HO 3.37	…	SU 1.81	EU 1.78
Being energetic	ENE 8.78	AM 7.41	FA 5.81	JO 5.3	EU 4.7	CO 4.56	EN 4.56	SA 3.93	IN 3.78	…	LO 1.59	SY 1.33
Fascination	FA 8.56	EN 6.3	AD 5.04	IN 4.63	AM 4.44	AN 4.22	RES 4.15	SU 3.81	DE 3.78	…	LU 2.15	REL 1.81
Inspiration	IN 6.96	FA 6.52	AM 6.04	ENE 5.15	EN 5	SA 4.48	AN 4.41	JO 3.67	CO 3.63	…	COU 1.85	LU 1.85
Pride	PR 5.96	CO 5.7	SA 5.26	FA 5.04	RES 5.04	AD 4.81	IN 4.59	AM 4.3	ENE 4.11	…	SU 1.96	LU 1.74
Relaxation	RE 6.93	KI 4.81	DR 4.7	RES 4.19	SA 4.04	LO 3.89	REL 3.85	SY 3.59	DE 3.52	…	EU 1.85	ENE 1.67
Respect	RES 6.33	PR 5.81	AD 5.74	CO 5.15	SA 4.96	KI 4.89	FA 4.67	LO 4.15	WO 4.15	…	SU 2.41	LU 1.81
Confidence	AM 7.19	ENE 6.48	CO 5.3	FA 5.22	JO 4.67	SA 4.63	EN 4.26	IN 3.89	AN 3.85	…	WO 1.85	LU 1.67
Enchantment	FA 7.96	EN 6.74	DE 5.78	AD 5.74	RES 5.52	AN 4.59	KI 4.37	LO 4.3	WO 4.3	…	COU 2.07	REL 1.85
Hope	AN 6.22	HO 5.89	WO 5.56	AD 4.7	DE 4.67	FA 4.37	EN 4.19	RES 3.96	ENE 3.7	…	REL 2	SY 2
Lust	FA 6.15	DE 5.78	EN 5.37	AD 5.19	LU 4.56	LO 4.56	KI 4.3	AN 4.04	ENE 3.85	…	SU 2.22	REL 2.19
Relief	AN 4.11	REL 3.78	ENE 3.63	FA 3.56	SA 3.41	CO 3	EN 3	AM 2.96	PR 2.7	…	LU 1.67	LO 1.63
Surprise	FA 5.7	SU 5.04	AM 5	AN 4.33	EN 4.07	ENE 4.04	SA 3.48	IN 3.41	AD 3.37	…	LU 2.04	LO 1.56
Courage	FA 5.74	AN 5.56	AM 4.52	EN 4.15	SU 4.11	SA 3.81	IN 3.7	CO 3.41	COU 3.3	…	WO 2.15	LU 1.93
Euphoria	ENE 6.85	FA 6.48	AM 6.41	JO 5.44	IN 4.85	EU 4.52	CO 4.52	SA 4.41	EN 4.22	…	LU 2	REL 1.78
Joy	AM 8.59	FA 7.26	ENE 7.19	JO 6.07	IN 6.07	EN 6.04	SA 5.33	EU 4.67	CO 4.33	…	LU 1.81	SY 1.81
Kindness	RES 6.44	AD 5.89	KI 5.22	FA 5.04	EN 4.74	WO 4.74	PR 4.67	IN 4.33	SA 4.22	…	EU 1.85	LU 1.67
Love	RES 7.3	KI 7.19	LO 6.48	AD 6.07	WO 5.85	EN 5.59	DR 5.41	SY 5.26	RE 4.93	…	COU 2.41	SU 2.22
Satisfaction	FA 7.26	EN 5.3	AD 5.26	AM 4.59	RES 4.56	SA 4.48	CO 4.48	IN 4.41	AN 4.26	…	REL 2.11	LU 1.7
Sympathy	RES 5.44	KI 4.78	WO 4.63	LO 4.33	AD 4.22	DR 4.22	RE 4.22	EN 4.19	SY 4.04	…	COU 1.89	SU 1.81
Worship	RES 6.7	AD 6.59	WO 6.52	EN 6.41	FA 5.85	DR 4.93	AN 4.74	DE 4.48	SA 4.3	…	REL 2.37	SU 2.15

3.5 Brief discussion of tool development

Manifestations of positive emotions in interactions were developed through an exploratory study and selected via an online survey. The results of a further evaluation study suggest that, in general, the distinctiveness of each emotion was captured well in the movie-sets so that several emotions could be identified even without any further information.

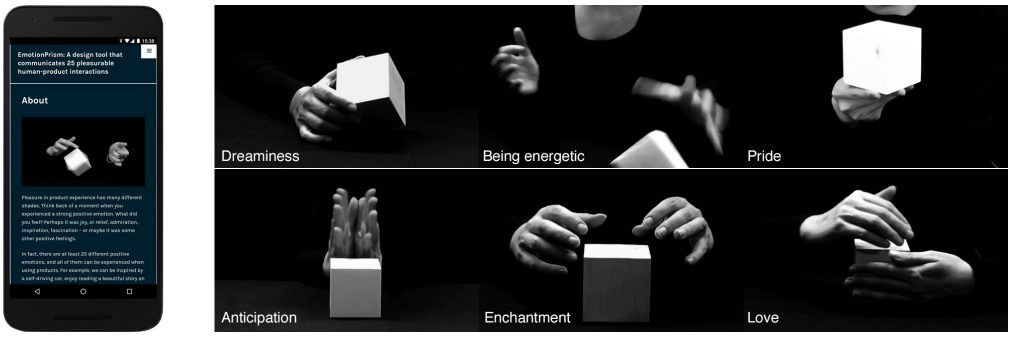
Reflecting on the procedure of developing the movie-sets, we postulate that the sensitisation process was effective to help the actors internalise the nuances of the 25 positive emotions, thus they could act out the emotions in an unambiguous way. The ten preselected movie-clips per emotion were based on the two researchers' decision. While the selection process was guided by the explicit criteria, we cannot discount the possibility of exclusion of some movie-clips that might better represent intended emotions than the chosen ones. For those movie-sets that were not sufficiently recognised in the evaluation study, it could be worthwhile to re-examine if the sets can be improved with alternative movie selections.

The design tool incorporates the movie-sets in combination with supplementary information about the emotions, such as emotion labels and definitions. This means that our validation approach, which was to show the movie-sets in isolation with no additional information, was conservative. Nonetheless, the results indicated that respondents were able to match 17 movie-sets with the intended emotions. While eight 'critical' movie-sets remained that did not meet the two criteria set out previously, we noticed that some of them were not markedly far off. For example, the movie-set 'worship' was closely associated with respect and admiration. These three emotions are fairly similar in terms of thought-action tendency as was found in the literature review. Likewise, in the cases of the movie-sets 'love' and 'kindness,' the corresponding emotions followed similar emotions that shared common qualities in thought-action tendencies. However, the movie-sets of sympathy, satisfaction, courage, and euphoria tended to be blended with variant emotions and the ratings towards the corresponding emotions were relatively low. For the time being, we provisionally include the critical movie-sets in the tool. In a future iteration of EmotionPrism, the eight movie-sets will be revised. We plan to review these with actors to better distinguish them from similar positive emotions.

4 Integration of the developed elements into EmotionPrism

The tool was developed into an online database that includes the generated movie-sets and the descriptions of thought-action tendencies (Figure 4). Besides, the emotion words, definitions, and appraisal themes were incorporated based on the typology of positive emotions (Desmet, 2012) and positive emotional granularity cards (Yoon et al., 2013). The interface displays the 25 positive emotions on top of the screen, by which a designer can navigate the emotions. Clicking an emotion label would bring the designer to the detail page of the emotion. The detail page presents the set of information in which four movie-clips self-run consecutively. The tool can be accessed at http://studiolab.ide.tudelft.nl/diopd/emotionprism. Designers can use the tool to discuss what kinds of interactions would be appropriate or desirable to incite and to select a set of relevant positive emotions accordingly by referring to the set of information as a repertoire to choose from. The usefulness of the information was tested in the application of the tool.

Figure 4 The EmotionPrism interface and examples of the movie-clips



5 Application of EmotionPrism

5.1 Tool in use

A design workshop was conducted to explore how designers can use EmotionPrism. The workshop was used to assess the tool's effectiveness in supporting the use of a nuanced understanding of positive emotions, in envisioning the desired interactions by means of specific positive emotions, as well as in serving as a source of inspiration. The tool was evaluated both qualitatively (i.e., observation and discussion) and quantitatively (i.e., questionnaire). The workshop was planned in a way that a large amount of ideas could be rapidly generated. This was to observe emotional diversity and considered interactions in the ideas.

5.2. Setup

The workshop was carried out with 29 design students in the master level design course 'Design for Emotion' at the faculty of Industrial Design Engineering of Delft University of Technology. The designers were split into three groups, each of which involved three subgroups of three or four members. Each group was assigned a specific product: a lamp (groups 1, 2, and 3); a clothes hanger (groups 4, 5, and 6); a speaker (groups 7, 8, and 9). All nine groups worked on three different contexts: a romantic dinner, a fun workout, and a comfortable flight. The aim of this setup was to observe if the tool could be supportive across different design challenges in which appropriate positive emotions and interactions might differ.

A week before the workshop, a lecture that explained an appraisal approach of emotional design and the relationship between emotion and expressive behaviour was given. The appraisal approach introduced by Desmet (2002) states that the way people appraise an event determines the type of emotion. At the start of the workshop, the tool was introduced. All groups were assigned to create mood boards for the three contexts. This assignment was to guide the designers to be sensitised with the experiences to design for.

5.2.1 Questionnaire

A questionnaire was used to evaluate the tool that was composed of four parts. The items in the first part examined the designers' tool acceptance. The second part was about the helpfulness of the tool for increasing a nuanced understanding of positive emotions. The questions in the third part referred to the degree to which the tool contributed to stimulating divergent thinking. The fourth part examined helpfulness of the tool in facilitating explicit communication about interaction qualities among group members. The question items are described in Table 5.

Table 5 Questionnaire items used in the tool evaluation

Part	**Question**	**Response**
Part 1	1. Indicate in which cycle(s) you used the tool.	1st cycle 1st and 2nd cycles All of the three cycles
	2. During the workshop, I revisited the tool to check whether the ideas would be in line with the effects of emotions on interactions illustrated in the movie-clips.	Yes | No
	3. After the workshop, I used the tool to check whether the elaborated concepts would be in line with the effects of emotions on interactions illustrated in the movie-clips.	Yes | No
Part 2	4. While using the tool, I could understand how different positive emotions differently influence the way a person interacts with a product.	Disagree 1 2 3 4 5 6 7 Agree
	5. The tool enabled me to consider more positive emotions than a few obvious ones while generating ideas.	Disagree 1 2 3 4 5 6 7 Agree
	6. I would have not been able to discern how each emotion differs from another in terms of expressive interaction qualities.	Disagree 1 2 3 4 5 6 7 Agree
Part 3	7. It was supportive to use the differentiated effects of emotions on interactions as the starting points of designs in diverging design directions.	Disagree 1 2 3 4 5 6 7 Agree
	8. I felt my creativity flow dropped as the design cycles proceeded.	Disagree 1 2 3 4 5 6 7 Agree
Part 4	9. It was helpful to use the tool as a reference point to communicate what kinds of interactions to address.	Disagree 1 2 3 4 5 6 7 Agree
	10. The tool enabled our group to explicitly discuss what kinds of interactions and emotions would be appropriate.	Disagree 1 2 3 4 5 6 7 Agree

5.3 Procedure

The workshop consisted of three iterative design sessions in which the designers dealt with one of the three design contexts in turn. Each design session followed a three-stage procedure: selecting positive emotions, generating product ideas, and discussing the generated ideas.

5.3.1 Selecting positive emotions

The groups were guided to discuss what kinds of interactions would be appropriate or desirable for the given context and product and to select three or four positive emotions accordingly by using the tool as a repertoire to choose from. No instructions were given about how the tool should be used, except that the groups were asked to go through the emotions in the tool.

5.3.2 Generating product ideas

Each group member took one emotion out of the chosen emotions and generated a product idea in a way that the design evokes the emotion and stimulates the interaction quality depicted in the tool. The designers were provided with A4-sized sketchpads, and for each idea, they were asked to write down which emotion they aimed to evoke. After every seven minutes, the group members swapped the emotion with the other member until each member goes through all of the chosen emotions.

5.3.3 Discussing the generated product ideas and filling out the questionnaire

The workshop evolved into a discussion of the generated ideas. Within a group, the members had reviewed all ideas, and selected one best idea based on how well it fits the context, the likelihood of eliciting the intended emotion, the novelty of the idea, and the feasibility of production. The workshop ended with a discussion in which all groups openly explained the ways they used the tool for selecting emotions and generating product ideas. After the workshop, an assignment was given; every group was assigned to advance the chosen three ideas into the concrete design concepts considering the appearance of the product, its functions, and how the interactions are conducted. The final concepts were presented after a week and the designers filled out the questionnaire. The collected data per each questionnaire item were averaged for analysis.

5.4 Workshop results

From observing the designers during the workshop followed by a joint discussion, and based on the results of the questionnaire, tool usage and their opinions were analysed. The results are reported in this section, structured by the main objectives of the workshop. In addition to the above issues, other observations from the design outcomes and the remarks from the designers are discussed.

5.4.1 Attitudes towards to the tool

Attention was paid particularly to the designers' openness and acceptance towards the tool since the tool itself and the design approach, i.e., designing for nuanced positive emotions, were unconventional. The designers used the tool many times during the workshop and discussed the contents described in the tool in detail. Regarding the first impression, most designers appreciated having an overview of positive emotions that are explained from the multi-componential perspective, i.e., definition, eliciting condition, and thought-action tendency through a rich representation. They found it practical to watch the generated movie-sets, as they could readily understand how a particular emotion is manifested in human-product interactions.

The first part of the questionnaire was used as an indicator of tool acceptance. Regarding the iteration cycles in which the tool was actually applied, two of 29 designers (7.4%) used it only in the first cycle, and then left aside. Two designers (7.4%) used it till the second cycle, and 23 designers (85.2%) used it throughout all three cycles. 21 designers (77.8%) revisited the tool during the idea generation to refer back to the information described in the tool whereas four designers (14.8%) did not. After the workshop, 13 designers (48.1%) used the tool again when they advanced the chosen ideas, while 14 designers (51.9%) did not. The results indicate that most designers used the tool throughout all iteration cycles, and half of the designers voluntarily reused it after the workshop.

5.4.2 Use of a nuanced understanding of positive emotions

As an indicator of the degree to which the tool supported the designers to consider nuances between emotions, the numbers of the selected emotions were counted. The generated ideas were clustered based on the context, product, and emotion used in the ideas (see Table 6). During the workshop, 22 out of the 25 emotions in the set were used for generating ideas. The unused emotions were sympathy, worship, and inspiration. The chosen emotions appeared to be heterogeneous from context to context, but appeared to be similar within a context across three products. For instance, the most frequently used emotions for a comfortable flight, a fun workout, and a romantic dinner were relaxation, amusement, and enchantment respectively. The remaining emotions varied depending on the product type.

The overall responses to the second part of the questionnaire were positive. The mean values given to the fourth, fifth, and sixth question were 5.59 (SD=0.88), 5.07 (SD= 0.87), and 3.55 (SD=1.31) respectively. Given the diversity of the types of positive emotions used during the workshop and the questionnaire results, we postulate that the tool supported designers to be aware of

differentiated aspects of various positive emotions and to carefully select the emotions to design for.

Table 6 Positive emotion types used as design intentions during the design workshop

Comfortable flights (102 ideas / 11 emotions)	**Lamp**: 56	**Clothes hanger**: 22	**Speaker**: 24
	Relaxation: 11 Dreaminess: 7 Fascination: 12 Anticipation: 6 Confidence: 5 Courage: 10 Satisfaction: 5	Relaxation: 7 Dreaminess: 7 Fascination: 2 Relief: 3 Respect: 3	Relaxation: 10 Dreaminess: 3 Anticipation: 3 Amusement: 3 Kindness: 5
Fun workout (100 ideas / 10 emotions)	**Lamp**: 50	**Clothes hanger**: 33	**Speaker**: 17
	Amusement: 11 Being energetic: 17 Pride: 5 Joy: 6 Confidence: 4 Surprise: 7	Amusement: 5 Being energetic: 9 Pride: 6 Joy: 3 Satisfaction: 6 Courage: 4	Amusement: 4 Being energetic: 3 Pride: 3 Satisfaction: 2 Desire: 3 Euphoria: 2
Romantic dinner (95 ideas / 11 emotions)	**Lamp**: 38	**Clothes hanger**: 32	**Speaker**: 25
	Enchantment: 6 Love: 5 Lust: 7 Dreaminess: 8 Hope: 5 Kindness: 4 Relaxation: 3	Enchantment: 6 Love: 3 Lust: 6 Desire: 6 Anticipation: 7 Admiration: 2 Respect: 2	Enchantment: 9 Love: 6 Lust: 3 Desire: 7

5.4.3 Creativity support

Not surprising, as different emotions arise in different conditions, the selection of multiple emotional experiences appeared to yield a variety of design directions. The different conditions inherent in each emotion diversified the designs. Some designers reported that emotions that could be considered nonobvious helped them to generate no archetypal product ideas.

The mean value for the question seven that evaluated the effectiveness for diverging design direction was 5.48 (*SD*=0.97). The question eight evaluated if the designers felt their creativity flow dropped as the design cycles proceeded. The mean value for this question was 3.77 (*SD*=1.67) (see the questionnaire items in Table 5). The results imply that 25 emotions in the set served as inspirational stimulus, hinting the designers at various alternative design solutions.

5.4.4 Envisioning the desired interactions

The questions nine and ten in the questionnaire assessed the usefulness of the tool to communicate the appropriateness of interactions and emotions to address (see Table 5). The mean values for the questions nine and ten were and 4.66 (*SD*=1.46) respectively. Generally speaking, the tool supported a conscious and purposeful determination of interaction qualities by means of particular emotions. However, the relatively low ratings for the question ten are noteworthy: the process of envisioning the desired interactions appeared to require more than a structured overview of differentiated emotion expressions in interactions. We assume that this was because the design assignments were open-ended and not framed by a clear user group and situations.

5.4.5 Additional observation and opinions on the tool

While observing the generated ideas, we paid attention to the similarity between the interactions depicted in the movie-sets and the interactions the designs intended to incite. We noticed that the movie-sets, which were made abstract and decontextualized, i.e., hands interacting with a cube,

seemed to be open enough to invite many interpretations. Even though the designers referred to the interactions manifested in the movie-sets, most of the ideas utilised variant interactions and the expected usage behaviours illustrated in the sketches were different from the ones represented in the movie-sets while still displaying the same qualities. This implies that the designers could get a grip of what a certain emotion looks like in interactions, and make a transition into product properties.

However, it should be noted that some designers found it difficult to apply the tool to their designs. They proposed that the tool could be more informative if it would show concrete product examples and suggestive situations that evoke certain emotions, mentioning that the movie-sets were somewhat vague for translating the represented interactions into actual interactions, e.g., turning a knob for controlling the volume of a speaker. Besides, since the interactions in the movie-sets were not based on certain situations, they found it difficult to empathise with potential users, which in turn, made the process of selecting emotions difficult. This can be interpreted that it lacked in facilitating empathy with users and was insufficient to support them to make user-relevant design decisions. This may explain the reasons for the relatively low rating of the question on the helpfulness of the tool in envisioning the appropriate interactions.

Finally, some designers proposed improvements for the movie-sets. It was pointed out that since social emotions such as respect, pride, and kindness often arise in the interactions between people, not directly attributed to a product, showing only a single person in the movie-sets was limiting to characterise the emotions. It was suggested to include multiple persons in the movie-sets and illustrate how they would interact together using a product. Besides, it turned out that in some cases, the movie-clips used for one emotion was very similar in terms of expressions. For example, three out of four movie-clips of ‘pride’ were similarly manifested with a gesture in which an actor boastingly grabs a cube with one hand and holds it up high with the other hand. These similar movie-clips were considered redundant.

5.5 Brief discussion of design workshop

Through the workshop, we could see that the tool supported the designers to discern nuances between positive emotions, stimulated divergent thinking, and helped the communications of the interaction qualities to address. At the same time, we could also identify a trade-off of decontextualizing the tool. The tool was equally useful in designing for the three different contexts and product types, proving the benefits of abstract representations of emotion expressions. However, it turned out to be limiting in facilitating empathy with users, which in turn hampered the process of specifying design intentions. It is expected that the tool could provide more actionable insights for designers when the design assignment (problem or brief) includes detailed information on specific user groups and situations.

6. General discussion

In this paper, we have reported the development of 'EmotionPrism', a design tool that aims to support designers (1) to be aware of the relationships between positive emotions and associated expressive interaction qualities, and (2) to deliberately incite particular interaction qualities by means of distinct positive emotions. The strength of the tool lies in its high level of granularity. Based on the typology of positive emotions (Desmet, 2012), it encompasses 25 distinct positive emotions and represents the unique expressive interaction qualities. This fine-grained pallet of positive emotions enables designers to be selective of what particular positive emotions to design for. EmotionPrism is, to our knowledge, the first collection of dynamic representations demonstrating human-object interactions in relation to distinct positive emotions.

We have evaluated the practical use of the tool in a design workshop. The results indicated that the tool enables designers to explicitly communicate the differentiated interaction qualities of positive emotions, and serves as a source of inspiration. Moreover, it was intensively used during the workshop.

However, the current version of EmotionPrism comes with some limitations. The evaluation of the generated movie-sets indicated that some movie-sets could not be unequivocally matched to the related emotions when no further information was provided. Most of these critical movie-sets tended to be perceived as representations of similar positive emotions that share analogous thought-action tendencies. Besides, as was pointed out during the workshop, diversity of expressions in each movie-set needs to be ensured. Note that the low validity of these movie-sets might not be very problematic in the context of the design tool itself because the movie-sets are presented together with the emotion words, definitions, and eliciting conditions, as well as descriptions of thought-action tendencies. However, the movie-sets should not be used alone. The results from the workshop suggest that for the effective use of EmotionPrism for specifying design intentions, it is important to frame the design problem by a clear user group and contexts. In the workshop, design students performed a series of short assignments using the tool. In real design practice, the scope of a design process is much broader and more sophisticated than is described in the workshop. As the process of specifying emotional intentions involve various roles in a product development team (Yoon, Pohlmeyer, & Desmet, 2016), the tool is likely to be used with non-designers such as clients and marketers, but it is uncertain whether they will easily understand the purpose of the tool and adopt it in the same manner. Hence, it is also necessary to test it in a more realistic context and involve other stakeholders in improving the tool and further identifying designers' needs.

Traditionally, facial expressions have been widely used to distinguish emotion types, but for positive emotions, it has proven to be less useful because (with the exception of surprise and interest) most of them simply result in a smile (Campos et al., 2013; Mortillaro, Mehu, & Scherer, 2011). In contrast, the evaluation of the movie-sets suggests that expressive qualities of hands interacting with an artefact can be potentially used as a cue to communicate distinct positive emotions. The respondents could correctly identify 17 different positive emotions from merely watching hands that express emotions in interactions, with no additional information provided. Two reasons for this high degree of recognition seem plausible. Firstly, some gestures illustrated in the movie-sets might remind the observer of certain situations in which a particular positive emotion is likely to arise. Second, hands expressing positive emotions in interactions provides rich information: it involves several cues of emotional expression together such as posture, gesture, physical motion and touch, thereby increasing the chance of recognition. This is unique because aside from touch (e.g., Ebe & Umemuro, 2015; Hertenstein, Holmes, McCullough, & Keltner, 2009), there have been few attempts to use bodily expressions to differentiate specific positive emotions (Sauter et al., 2014). Taking into account that most of human-product interactions involve hands, it is worthwhile to further advance an understanding of how hands in interactions are associated with expressions of positive (and negative) emotions. The resulting findings can support further developments of both design and research tools for emotion-focused design processes.

In this paper, we have mainly focused on momentary effects of positive emotions on interactions, but it should be noted that having an awareness of the long-term impact of positive emotions is also of great value for designers. In one of our studies, it was found that designers wanted to know beneficial effects of positive emotions in the long run, and purposefully design for specific positive emotions, aiming at such effects (Yoon et al., 2016). For instance, explorative behaviour stimulated by interest can result in increased knowledge, and determined behaviour stimulated by hope can contribute to enhanced resilience (for an overview of long term effects of positive emotions and underlying process, see Fredrickson, (2013). However, it has not yet been explored if these effects can be replicated in human-product interactions. Future research and design tools should address this aspect.

7. Conclusion

In this paper we introduced EmotionPrism, the first design tool that visualises distinct positive emotional expressions in human-object interactions. The development and evaluation of the tool were presented and discussed. EmotionPrism is based on the proposition that products can evoke

multifaceted positive emotions, and that interaction qualities can be used to target particular positive emotions. The tool was developed to support designers in developing a nuanced understanding of the relationships between positive emotions and expressions in interactions. Overall, we concluded that EmotionPrism can be a useful design resource by providing designers with a varied repertoire of expressive interaction qualities that correspond to specific positive emotions.

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