Happiness and Fear: Using Emotions as a Lens to Disentangle How Users Felt About the Launch of Facebook Reactions

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In February 2016, Facebook launched Reactions, an interactive feature expanding the Like button to include five additional emotional responses: Love, Sadness, Anger, Wow, and Haha. In this article, we examine users' feedback about this new feature and identify important design implications of this significant modification of Facebook's interface. We did this by applying theories of human emotion and emotion-specific influences on cognitive appraisals to conduct a heuristic evaluation of Facebook Reactions and a thematic content analysis of the 3,000 "top" comments posted by Facebook users on the official pre- and post-launch announcements about Reactions. Prior to launch, many users were concerned that the addition of a Dislike button would lead to abuse; thus, they favored the more nuanced design of Reactions. After launch, users were more positive about the feature as many of their misconceptions were clarified through actual use. Overall, we identified several design constraints of this new feature, including users' inability to express conflicting emotions. We conclude the article by discussing the implications of our findings and the challenges around research and design for sociotechnical systems that involve complex human emotions.

CCS Concepts: • **Human-centered computing** → *Human computer interaction (HCI)*; *Empirical studies in HCI*;

Additional Key Words and Phrases: Facebook Reactions, social media, emotion, heuristic evaluation, sociotechnical design

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1 INTRODUCTION

Facebook's *Like* button has become the most recognizable icon associated with the Social Web [19], and was one of the first features that allowed users to socially engage with friends through a low-cost mechanism that required only a fraction of the time compared to commenting. Such single-click features are considered paralinguistic digital affordances (PDAs) [21] that provide meaningful

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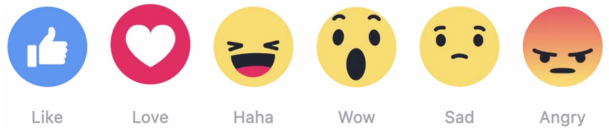


Fig. 1. Final Facebook Reactions Design, February 2016.

social cues when interacting with others through social media. Micro-interactions, such as the *Like* button, serve important social grooming and relationship maintenance purposes, which include signaling to other users one's presence, providing social and emotional support, and influencing access to resources within one's social network [16].

While Facebook's interface has undergone many changes over the last decade [17, 39, 50, 52], the means for interacting with other users have remained largely unchanged since the release of Facebook's *Like* button in 2009—Facebook users could *Like* a post, comment on it, or Share it (publicly or within their friend network). Yet, a number of researchers [1] and users [8] have questioned whether the simplicity of the *Like* button is adequate for the wide range of emotions Facebook users may want to express when interacting with others. For example, *Liking* a post may not always feel appropriate. Should someone Like a post about a friend losing a job or their pet dying? This debate about the *Like* button versus alternative design solutions (i.e., adding a *Dislike* button) has been an ongoing and unresolved topic of interest for years [8, 12].

In late 2015, Facebook proposed their own solution to this debate with the announcement of Facebook Reactions. First announced in a public post [54] by Facebook's CEO Mark Zuckerberg in October 2015 (4 months before Reactions was implemented), six new Reactions (in addition to the *Like* button) were intended to reflect the major psychological emotions of *Happiness, Sadness, Anger*, and *Surprise*—as well as *Humor*—through animated icons. In February 2016, a second announcement marked the worldwide rollout of Reactions, showing a slightly different design (removing the proposed *Yay* Reaction) that featured six emotional icons: *Like, Love, Haha, Wow, Sad*, and *Angry* (Figure 1). Facebook later shared a detailed account of their design process in a Medium post [44], highlighting the questions and principles the designers used to guide the design of Reactions, as well as challenges they faced in designing new features that were universal across Facebook's large and diverse userbase.

In the first announcement, Zuckerberg reassured users that Facebook did their research and was beta testing Reactions prior to the worldwide rollout. With two major announcements about Reactions, including one 4 months before most people could use the feature, Facebook appeared to be aiming for more transparency and higher levels of user acceptance, while providing additional opportunities to obtain feedback from their user base. This new strategy may have been a response to the extremely negative backlash Facebook received after launching Timeline, their last major interface change that occurred in 2011 [50]. The question, however, is how well this strategy worked and if the design of Reactions was truly a solution that met users' expectations. In this article, we evaluate the following research questions:

- **RQ1:** Does the design of Facebook Reactions align with existing theories of human emotions?
- **RQ2:** How did Facebook users evaluate this new feature? Did their appraisals change between anticipated and actual use of Reactions?
- **RQ3:** How can the Reactions launch inform future research and design that interprets complex human emotions within sociotechnical systems?

Given the extensive history of social-psychological research on emotions [13, 23], we apply theories about emotion and the influence of affect on individuals' cognitive judgments [28] to perform an expert heuristic design evaluation [30] of Facebook Reactions. To triangulate our evaluation, we also present an analysis of the "top"[1] 1,500 comments posted by Facebook users on each of the two official Facebook announcements regarding Reactions ("pre-launch" and "post-launch"). For our qualitative analyses, we used a hybrid approach [18] to code the data, which combined a deductive, theory-based analysis of *emotions* and *valence* with an inductive, thematic content analysis [6] to understand the key rationale and differences in users' responses pre- and post-launch of Facebook Reactions.

Overall, we found that the design of Facebook Reactions does not (and could not) adequately capture the full range of human emotions. More importantly, it does not capture the difference between emotional valence and one's emotions. Indeed, the Facebook design team noted that more options would negatively impact users' ability to consume content in the News Feed [44]. Still, users' responses to Reactions tended to be positively valenced and expressed happiness over the interface change. In this way, having more options to express one's emotions—even if that list was incomplete—was viewed as beneficial to one's user experience. An unanticipated finding, however, was the interplay between happiness and fear, which was the underlying force behind most positively valenced user appraisals. These mixed emotions were often due to users comparing Reactions to the controversial option of adding a *Dislike* button. We also identified a difference in appraisals after the worldwide launch of Reactions, which might imply that some of users' pre-launch anxieties may have been alleviated after they were able to interact with Reactions. We discuss these findings and make the following research contributions:

- —Apply theories of human emotion and cognitive appraisals to conduct a heuristic design evaluation of a new social media feature designed to convey emotion (i.e., Facebook Reactions).
- —Conduct an empirical evaluation of users' responses to the launch of Facebook Reactions prior to and soon after launch.
- —Illustrate and discuss the challenges of evaluating and designing for complex human emotions from the dual perspectives of interface design and social computing research.

Our findings are specific to Facebook Reactions but are also directly generalizable to any social platforms that embed features to help users convey emotion. Therefore, we believe our methodological approach—combining a content analysis of user data with a novel, inductive, and theory-driven heuristic evaluation of Facebook Reactions—is broadly applicable to social computing research in which the goal is to evaluate the design and/or users' perceptions of the design of sociotechnical systems that are meant to convey emotion.

2 BACKGROUND

2.1 Likes and Other PDAs

Numerous researchers have examined users' motivations for using and the meaning behind the use of single-click, lightweight social media interactions, such as Likes, Favorites, and Upvotes. Motivations to use such PDAs include social bookmarking [22], relationship maintenance [16], and social affirmation [38]. Hayes et al. [21] found that PDAs carried different meanings across different social media platforms and are interpreted differently by different users. Ahmadi et al.

[1]Top Comments" is described by Facebook as "the most relevant comments" and is determined by the number of likes and replies, as well as accounting for comments marked as spam [55].

[1] found that using *Likes* may be inappropriate in many contexts; in these cases, alternate PDAs, like "hugs," may be better at expressing more nuanced emotions such as social support or empathy.

Much of the work on understanding social media PDAs has focused on users' perceptions (via interviews, surveys, and focus groups [1, 16, 21]) or behaviors (via scraped comments or server logs [22, 38]). Indeed, early and frequent user feedback is one of the key principles of user-centered design for ensuring that technical solutions meet end-users' needs [20]. However, research in other domains has also highlighted the value of combining user studies with expert-led heuristic evaluations [30, 32], where researchers apply relevant design guidelines or principles to evaluate an interactive system and identify potential usability problems [45, 47]. Therefore, our work contributes to the existing literature on PDAs by combining users' appraisals of Facebook Reactions with an expert design evaluation [30] conducted by the authors that applies a theoretically grounded lens of human emotions to improve the design of future emotive sociotechnical features, like Reactions.

2.2 Facebook Reactions

On October 8, 2015, Facebook announced the impending launch of Facebook Reactions with a 30-second video posted publicly to Zuckerberg's Facebook Timeline [54]. Within hours, the video was a trending topic on Facebook. The video showed a person scrolling through six Reactions icons—representing *Anger, Sadness, Happiness* (*Love* and *Yay*), *Surprise*, and *Humor*—on a mobile phone. Zuckerberg described the new Reactions as a "more expressive *Like* button." He also explained that many people had requested a *Dislike* button over the years, and Reactions were the result of these requests. He also said Reactions provided users with an easier way to express empathy, while keeping the experience "simple and respectful." It was noted that Reactions were being beta tested in Ireland and Spain [54]. On February 24, 2016 (4 months later), Zuckerberg publicly announced the worldwide rollout of Reactions, showing a slightly different design featuring five animated icons in addition to *Like*: *Love, Haha, Wow, Sad*, and *Angry* (Figure 1).

Since the launch of Reactions, researchers have exploited this new feature to demonstrate opportunities for mining Facebook user data to improve algorithms that infer meaning and sentiment. For instance, Badache and Boughanem [3] used Facebook Reactions in combination with IMDb Top Box office movies to improve search ranking performance. Tian et al. [46] scraped posts from popular news media outlets on Facebook to show a high correlation between users' Reactions and their use of textual emojis in comments, suggesting that Reactions can be a useful way to detect users' sentiments without having to extract textual comments. Pool and Nissim [35] also found that using Reactions without employing traditional text-based lexicons was a comparable approach in detecting emotions within publicly available user data on Facebook. While this body of recent research clearly shows how Reactions may be a game changer for mining Facebook user data, to our knowledge, no published studies have conducted a design-based evaluation or user study of Facebook Reactions from a sociotechnical perspective.

2.3 Reactions versus Emojis

The launch of Reactions expanded on existing options for expressing a quick and sometimes emotionally laden response to online content, most notably emojis, which are defined as "popular digital pictograms that can appear in text messages, emails, and on social media platforms" [43:1]. Reactions carry many similarities to emojis; therefore, it is worthwhile to examine prior work focused on the use of emojis in online interactions. For example, researchers have found that the inclusion of face-based emoticons [41] and object-based emojis [36] in text messages increase positive emotional affect in the recipient of the message. Similarly, Barbieri and colleagues found that temporal information can help improve the interpretation and prediction of emojis [5]. Therefore, they propose an improved emoji prediction system that considers an emoji's semantic and usage across different seasons of the year. Looking at senders' intention for using emojis in text

messages, Cramer and colleagues [9] identified a number of motivations, including adding emotional or situational meaning. Emojis may be used to reify the emotional intent of a message's text-based content, and some users see them as superior to words for expressing complex emotions. Emoji use can also transcend language barriers, with researchers finding that some emojis retain consistent meaning across different languages [4].

On social media platforms like Facebook, emojis have been available to users for many years, and are commonly included in conversations, either supplementing a text-based message or as a standalone. Yet, Facebook designers felt that making Reactions similar to emojis, where users have hundreds to choose from, would be overwhelming and difficult to consume [44]. We argue Reactions differ from emojis in several important ways. First, emojis are largely used in dyadic interaction, where one person uses an emoji to convey emotion to another. On the other hand, Facebook's Reactions are aggregated, thus providing a group-level emotional sentiment regarding a post or comment. We acknowledge that other platforms, such as Slack [42], allow users to select from emojis to react to posts and aggregate these emojis in a similar manner to Facebook's Reactions. Yet, research shows that the diversity of choice creates higher cost in time and effort because of the large number of options to choose from [37]. For instance, a popular post may have hundreds or thousands of comments and/or emojis that would be increasingly difficult to parse; in contrast, Reactions provide a simpler viewpoint of how content makes others feel.

In thinking about the benefits of low-cost interactions in conveying emotions and connection [16], Reactions are an extension of the Like button and thus reflect a quick and simple method for responding. In this way, the limited number of options may make engagement even more likely, compared with having to select from dozens of emoji options. Finally, the designers of Facebook Reactions argue that Reactions provide a universally understood subset of emotional responses that allows cross-cultural communication, using emotions as a shared vocabulary [44]. While custom skins have been developed [56], and Facebook itself briefly extended Reactions for Gay Pride [57], Facebook Reactions (by default) have largely been consistent across Facebook's large user-base. This is important because prior work has highlighted that operating systems (e.g., iOS vs. Android) render some emojis differently, leading to variations in interpretation of the intended sentiment [29]. Such differences in the visual appearance of emojis could lead to misunderstandings or miscommunication. We would not expect to see those misunderstandings in interpretation of Reactions because their appearance does not vary across viewing platforms.

3 A THEORETICAL LENS OF HUMAN EMOTIONS

We apply Ekman and Cordaro's theory of human emotions [13, 15] as well as Lerner and Keltner's theoretical model of emotion-specific influences on judgment and choice [28] as the framework for our heuristic evaluation and to interpret how users responded to the introduction of Facebook Reactions. This research on emotions and cognitive appraisals suggests that both emotions and emotional valence have significant effects on human judgment when individuals make appraisals and express preference or choice [28]. Below we discuss these theoretical constructs in more depth and explain how we apply them in our analyses.

3.1 Human Emotions

Quite a bit of theoretical work exists on understanding primary human emotions [15, 23, 48]. Emotions are "discrete, automatic responses to universally shared, culture-specific and individual-specific events" [15:364]. Ekman and Cordaro's foundational work on emotions [13, 15] identified six basic emotions: happiness, sadness, fear, anger, disgust, and surprise, which appear to have inspired both the emotions included in the design of Facebook Reactions [54] and the popular Disney movie "Inside Out" [11]. In Table 1, we provide brief definitions for these six basic emotions

Table 1. Ekman's Six Basic Human Emotions

Emotion	Definition
Happiness	A positive and enjoyable state of being
Sadness	A feeling triggered by the loss of a valued person or object to which one is attached
Fear	An unpleasant emotion typically caused by psychological or physical threats of harm
Anger	Intense, negative emotional response often triggered by an interference with one's goals
Disgust	An emotional response to something repulsive or offensive
Surprise	An emotional response to something that is sudden or unexpected

[15], which informed our heuristic evaluation and the qualitative codes for our empirical analyses of users' comments. The term "basic" here can be interpreted as "elemental" emotions that can be combined to form more complex emotions (e.g., smugness as a combination of happiness and contempt). However, Ekman [14] argues against the notion that emotions only differ based on level of "intensity" and "pleasantness." Instead, both positive and negative emotions differ in respect to appraisals, antecedents, behavioral responses, and physiology. The link between appraisals, or how people evaluate stressful environmental changes or life events [14, 25], is important. According to Lazarus [25:191–192], "once the appraisals have been made, the emotional response is a foregone conclusion." In other words, emotional responses can help us disentangle how people make cognitive appraisals about change. In our case, we apply this lens of emotion to understand how users appraised the interface change of Facebook Reactions.

3.2 Emotional Valence and Cognitive Appraisals

Appraisals are usually characterized as positive or negative [26]. Valence refers to positively or negatively charged attitudes toward a particular situation, and these attitudes have a strong, affective influence on individuals' judgments and choices [28]. According to Lerner and Keltner, "most theories of affective influences on judgment and choice take a valence-based approach, contrasting the effects of positive versus negative feeling states" [28:473]. However, they criticize valence-based-only approaches and argue that *valence combined with specific emotions* can lead to different outcomes and cognitive appraisals. For example, they found that two emotions—*anger* and *fear*—both have a negative valence but often result in different appraisals [28]. They hypothesize that different emotions activate cognitive predispositions that lead individuals to appraise future events based on the same emotional response that was triggered by the original appraisal. They call this response "appraisal tendency," which suggests that emotions have a direct effect on an individual's judgment. They note that both dispositional emotions and those that are more ephemeral can influence cognitive appraisals. Therefore, Lerner and Keltner [28] urge researchers to examine specific emotions, especially those that are highly differentiated, when they are trying to interpret how individuals judge and appraise different life situations or scenarios.

We drew heavily from the theoretical literature on cognitive appraisals, emotions, and valence when conducting our expert evaluation of the design of Facebook Reactions, as well as interpreting the empirical feedback provided by users. First, theory was used as heuristic guidelines for evaluating how well Reactions aligned with existing theories of human emotion (RQ1). Second, theory also helped guide our empirical analysis of users' comments (RQ2). We combine the results from these two perspectives to provide informed implications for future interface design and social computing research (RQ3). In the next section, we describe our research methods in more detail.

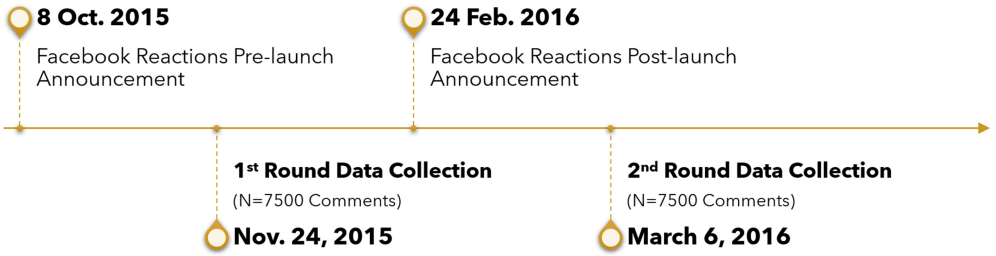


Fig. 2. Timeline of Facebook Reactions announcements and data collection.

4 METHODS

We modeled our data collection procedures on those employed in previous studies [39, 50, 52] analyzing user comments posted to Facebook's "Newsroom" and official blog after the release of Facebook's "New" Profile (2010), Friend Pages (2010), and Timeline (2011). For example, Wisniewski et al. [50] examined 1,149 user comments posted to Facebook's Timeline blog and used stress appraisal and coping theory [27] to show how the perceived level of control users' had over the interface change had a strong impact on how they adapted to the new interface. Their results highlighted the importance of providing users a sense of agency in the design process and openly communicating information about interface changes so users could understand its consequences and effectively cope with the change. Then, sometime after the launch of Timeline in 2011, Facebook replaced their blog with "Newsroom" [17] as a carefully curated source of Facebook news media that no longer allowed commenting.

4.1 Data Collection Process

We first collected a large dataset ($N = 15{,}000$) of pre- and post-launch comments about Facebook Reactions. Then, we scoped this dataset to 3,000 pre- and post-launch comments for qualitative analyses. We describe this process in more detail below.

4.1.1 Initial Data Scraping. Facebook took a new approach when introducing Reactions by posting the announcements publicly via Zuckerberg's personal Facebook Timeline, which again allowed user comments. Seeing this opportunity, on November 24, 2015, we downloaded the HTML source code of the Facebook page and used JavaScript to expand and extract the comments into a comma separated text file. This process allowed us to extract the "top" 7,500 comments. Facebook defined "top" comments as those that are most relevant based on the number of likes and comments [55]. In other words, top comments are the ones that receive the most support and/or attention from the broader Facebook community. We also observed that these comments represented a wide range of opinions—positive, neutral, and negative sentiments about Facebook Reactions—suggesting that the overall sentiment was expressive of the diverse sentiments across Facebook users. Therefore, we proceeded to capture this data. On March 6, 2016, after the worldwide rollout of Reactions was announced, we implemented the same data collection procedure, collecting the "top" 7,500 post-launch comments. The timeline of Facebook Reactions announcements and our data collection is summarized in Figure 2 below.

4.1.2 Data Scoping Process. Similar to the aforementioned Facebook Reactions research [3, 35, 46], we originally tried to use sentiment analysis [34] to classify users' comments and Reactions automatically across the 15,000 comments based on linguistic cues. After multiple attempts, we confirmed that using automated techniques for this dataset was impossible due to the nuance inherent in user comments. Users were *emoting about emotions*, which created layers of complexity

that proved too difficult for machine learning algorithms to disentangle. For instance, LIWC [58] classified the following comment as containing no sentiments of anger and with positive and negative emotion words: "*I want a dislike button not empathy or show love! A dislike button is for something I didn't like plain and simple!*" (Comment #32, pre-launch, 42 likes). However, we manually classified this comment as "anger" toward Reactions. Similarly, another person commented: *"Great it will be better than dislike button that might hurt the others feeling"* (Comment #7, pre-launch, 2,024 likes). In this comment, the user uses both positively valenced (e.g., great, better), negatively valenced (e.g., dislike, hurt), and equivocal (e.g., might) emotions; automated approaches could not properly disentangle. Therefore, we abandoned this automated approach and manually coded the data for *emotion, valence*, and *emergent themes*.

Given this decision, it was infeasible to manually code all 15,000 comments across these dimensions. Therefore, we reduced the sample size by selecting the "top" 1,500 comments from each subset of pre- and post-launch announcements (for a total of 3,000 comments, which was more than twice the number of comments from previously published research, e.g., [50]) to facilitate our qualitative analysis. In summary, we scoped our dataset down from 15,000 pre- and post-launch "top" comments (7,500 each) to 3,000 pre- and post-launch "top" comments (1,500 each) and compared these comments to a random holdout sample of 200 comments (100 each) to ensure that the smaller sample was representative of the larger dataset. Of the 3,000 comments, 98.37% (2,951 comments) were from unique users. Seven individuals posted multiple times pre-launch, and five individuals posted multiple times post-launch. Four Facebook users posted both pre- and post-launch, only leaving one comment each. Comments ranged in length and averaged a total of 158 characters with a standard deviation of 90 characters.

4.2 Data Analysis Approach

We provide further details about our heuristic evaluation and qualitative analysis in the sections that follow. Our qualitative approach was conducted in two-phases: (1) structured coding and (2) grounded thematic analysis.

4.2.1 Heuristic Design Evaluation of Facebook Reactions. A heuristic evaluation is a usability technique where experts (e.g., either in interaction design [30] or experts in the domain of the software being evaluated) apply heuristic guidelines to informally evaluate the design of a user interface [32]. The evaluators form opinions that can be aggregated to identify potential usability problems prior to deploying the system to end-users. While this technique is not meant to identify all usability issues, it has been found effective in identifying 20–51% of the problems with only three to five evaluators and a low rate of false positives [32]. One key component of a heuristic evaluation is the subset of heuristics or guidelines the evaluators use to assess the user interface. Traditionally, universal usability guidelines, such as Nielsen's "Ten Usability Heuristics" [31] or Shneiderman's "Eight Golden Rules of Interface Design" [40] are used as best practices for interaction design. However, a drawback of these heuristic guidelines is that they are overly general and not designed to specifically evaluate designs for socio-emotional user interfaces, such as Facebook Reactions. For instance, Facebook Reactions meets the Nielsen guideline of "aesthetic and minimalist design" [31], but this guideline may conflict with what we know about the complexities of human emotion. Therefore, a novel contribution of our work is applying existing theories related to human emotions and cognitive appraisals to conduct a specialized heuristic evaluation of Facebook Reactions.

First, it is important to note that the co-authors of this article are not affiliated with Facebook, nor were we part of the original design team for Facebook Reactions. We represent a team of four Human-Computer Interaction (HCI) and social computing researchers who performed a heuristic

evaluation of Facebook Reactions by examining the new interface, synthesizing the existing literature on theories of human emotion and cognitive appraisals, operationalizing these theories into a structured codebook, and using this codebook to qualitatively analyze a dataset of comments from Facebook users reacting to the launch and subsequent rollout of Facebook Reactions. We present our expert and empirical evaluations as the results of this article and discuss the implications for design based on these results. In the next section, we describe how we performed our structured analysis.

4.2.2 Structured Coding Based on Emotions and Valance. First, we qualitatively coded user comments deductively for *emotional valence* toward Reactions, as well as for *emotions* that were expressed by Facebook users. The theoretically grounded structured codes allowed us to interpret our analysis based on a pre-validated lens of cognitive and social-psychological research on human emotions. We created a structured codebook for emotions (i.e., *happiness, sadness, fear, anger, disgust, surprise, no emotion*) and valence (i.e., *positive, negative, unsure*) based on theoretical underpinnings discussed earlier (also see Table 1). We then used an inductive approach to conduct a thematic content analysis based on the user comments to identify emergent themes and compare pre- and post-launch emotional responses and appraisals of Facebook Reactions.

Codes for both emotions and valence were treated as mutually exclusive, such that only one code could be applied to each comment based on the *best* match. This methodological decision was made to explicitly mirror the design of Reactions, which only allows users to select one Reaction at a time. This decision also helped us conduct our heuristic evaluation of the design of Facebook Reactions, highlighting the usability issue of treating emotions as mutually exclusive from one another. Two rounds of structured coding occurred. Prior to the post-launch announcement, four research assistants (one graduate and three undergraduate students) coded a random sample of 1,350 pre-launch comments based on an initial codebook. We calculated inter-rater reliability (IRR) using Cohen's kappa [7] for *emotion* and *valence*; however, the IRR values were too low to proceed. The authors evaluated the disagreements across coders and re-operationalized and merged some of the codes. For example, there was a high level of disagreement between the emotions *anger* and *disgust*. Psychological researchers have found that these two emotions are easily confounded [24], and the distinction between the two was not relevant to our analysis. Therefore, we merged disgust into *anger* in our codebook. We identified other secondary emotions in the comments (e.g., *annoyance, disappointment, contempt*), but the prevalence of these emotions did not warrant deviating from our theoretically grounded and design-driven codes. We did add one additional emotion that emerged from our analysis—*humor*—which was decidedly different from happiness (e.g., an off-colored joke versus an expression of joy). The final mapping between theory, design, and our codebook for *emotions* is summarized in Table 2. In addition to these codes, we included an additional code for *no emotion*.

After updating the codebook, the authors split up the comments among themselves and recoded the data. Each of the 3,200 comments (main dataset and holdout sample) was independently coded by two authors. Again, we calculated Cohen's kappa. The IRR for *valence* was good ($\kappa = 0.71$), while the IRR for *emotions* was just below the threshold of acceptability ($\kappa = 0.59$; whereas 0.60 is considered "good" inter-rater reliability [20]). The confusion matrix for coding conflicts is shown in Table 3. Overall, the coders agreed 66% of the time when coding for emotion, and 20% of conflicts were due to one coder applying a code for an *emotion* while the other coder indicated *no emotion*. Aside from these conflicts, *happiness* was most often confused with *fear*, and *anger* with *sadness*. Upon reviewing the comments and themes associated with these conflicts in more detail, we realized they represented interesting intersections and highlighted how conflicting emotions were often present in the responses of the Facebook users. For example, Facebook users who had

Table 2. Mapping Five Emotions Across Theory, Design, and Structured Qualitative Analysis

Ekman's Emotion	Facebook	Final Codes	Example Quotations
Happiness		Happiness; Humor	*"i am happy to hear about feelings reactions. Much better than simple dislike! Looking foward to use this new feature"*
Sadness		Sadness	*"Sad that humans have to rely on emojis to express their feelings....miss conversation human to human without technology in the middle"*
Fear	N/A	Fear	*"It's scares me...when you uploaded some photos of fun of you and some people who doesn't like you will gives you "Sad and Angry" button"*
Anger, Disgust		Anger	*"I'm ANGRY that there's not a dislike button."*
Surprise		Surprise	*"Whoaa that's what I call innovation we really appreciate the way you keep "Facebook" different as compare to other social networking sites. No one has this yet but you."*

Table 3. Inter-Rater Reliability Confusion Matrix for Emotion Codes

Emotions	HAPPINESS	FEAR	ANGER	SADNESS	HUMOR	NONE	Total
HAPPINESS	**1,047**	23	19	18	21	90	1218
FEAR	51	**63**	18	15	1	21	169
ANGER	16	17	**456**	42	23	69	623
SADNESS	33	10	74	**45**	4	67	233
HUMOR	10	1	23	5	**63**	22	124
NONE	129	24	112	33	23	**299**	620
(blanks)*	5	0	2	1	3	2	13
Total	1,291	138	704	159	138	570	3,000

*One coder left a few comments uncoded because they were unsure about the emotions being expressed.

positively valenced attitudes about Reactions often expressed *happiness* that Facebook chose this solution instead of implementing a *Dislike* button, which they *feared* would have negative consequences. The results in this article, therefore, include the conflicting primary emotions as they were coded by the researchers (rather than resolving these conflicts) to show the true nuance in users' appraisals of Reactions.

4.2.3 Grounded Thematic Analysis for Understanding Users' Rationale for Appraisals. Next, we employed a grounded, inductive approach by coding emergent themes within the comments. This analysis provided flexibility, so that we could identify emergent themes and analyze patterns regarding users' rationale for the cognitive appraisals of Facebook Reactions in relation to the structured codes for emotions and valence. Themes were open coded so that multiple themes could be applied to each comment. We followed Braun and Clarke's [6] six-phased process for conducting thematic analyses. First, we familiarized ourselves with the data, discussed and

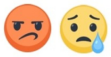
Table 4. Final Codes for Grounded Thematic Analyses

Major Themes	Definition	Example Quotations
EXCITED	Positive response to launch without having any additional reason	"I am so excited I just love so many things!!!heart emoticon"
EMPATHY	Being able to show empathy to others	"I like it it is the best way to express love sorrow sadness and empathy with respect."
DISLIKE	Explicit mentioned of a Dislike button	"I think a simple dislike would have been good. There are already emojis that you can leave in the comments if that's your thing"
CONSEQUENCE	Potential negative behaviors or use of FB Reactions or a Dislike button (e.g., cyberbullying; consequences are presented as a sub-theme associated with DISLIKE)	"The amount of bullying that will happen if there's a dislike button anyone who wants it should consider that social media is bad enough without adding a dislike button…"
DESIGN CRITIQUE	Criticizing the new interface design, suggesting alternative designs, and/or emotions that should be included in Reactions	"Just a plain "no expression" face might be better than angry." Or "One thing's missing and a very important one—a virtual hug."
CHANGE/ CONTROL	Users don't want the interface to change; site is fine like it is; they want more control over what change occurs	"I'm disturbed that we were not given a 'heads up' about a week in advance of this change. I don't react well to surprises even when they are ultimately good!"
INFO	Asking for more information (such as about roll out) without an emotional response	"So if I have a friend in Ireland that likes my comment with this new emoji will I be able to see it in the US?"
SPAM/ IRRELEVANT	Bad data, spam, incomprehensible, trying to derail the conversation to something completely irrelevant	"Can I borrow a million bucks? Bro?"

generated our initial codebook, iteratively coded the data through a consensus among authors, aggregated codes into themes, collapsed overlapping themes (e.g., we merged a code for cyberbullying into consequences, as both represented negative outcomes associated with Reactions), and developed formal definitions. Finally, we reviewed the codes and organized them into the final themes presented in our results. We allowed for double coding for the different rationale(s) users gave for their appraisals of Facebook Reactions. Thus, the percentages shown in our results across these themes often sum to more than 100%.

Our final codebook for these themes, definitions, and exemplar quotations are shown in Table 4. Interestingly, even though the codes did not change across differently valenced and emotionally charged comments, the meaning of the themes themselves shifted in relation to these structured codes. For instance, when users' cognitive appraisals of Facebook Reactions were positively valenced, and users were happy about the interface change, the "DISLIKE" code denoted their preference toward Reactions over having the alternative of a *Dislike* button. In contrast, when users had negatively valenced appraisals of Reactions and were angry, the same code represented a different theme, which expressed their frustration that Facebook did not implement a *Dislike* button. A key implication that arose from our structured and grounded hybrid analyses was that emotion and valence had a strong association in terms of users' cognitive appraisals of the design of Facebook Reactions, influencing the themes for why users were for or against Facebook Reactions. Different users appraised the *same* design *differently* when their emotional responses differed. In particular, users' feelings about the *Dislike* button often evoked strong emotions, which correlated with either

Table 5. Reactions Themes by Valence and Emotions

Valence	Positive (49%)	Negative (33%)	Unsure (18%)
Emotions	Happiness (82%), Happiness/Fear (5%), and Fear (3%) 	Anger (57%), Anger/Sadness (10%), and Sadness (9%) 	No Emotion (48%) and Humor (12%) 
Themes for User Appraisals	• General **Excitement** over the new Reactions interface (46%) • Preference over the alternative of having a **Dislike** button (36%) • Appreciation over the ability to express **empathy** to others (27%)	• Anger that Facebook did not implement a **Dislike** button (72%) • **Critiques** of the design of Reactions (20%) • Frustration in users' lack of **control** over and aversion to interface **change** (20%)	• Request for more **information** (56%) • **Spam** or sarcastic/ humorous remarks that were **irrelevant** to Reactions (13%)

positively or negatively valenced appraisals of Reactions. We describe this nuance in more detail in our results. The frequency of our themes across the different structured codes for valence and emotion are summarized in Table 5.

4.3 Ethical Considerations

Collecting publicly available digital trace data from social media platforms is a topic of increasing importance within the HCI community [49, 53] and should be handled with care. We confirmed with our university's Institutional Review Board (IRB) director that IRB review was not required. The IRB determined that this study was not considered human subjects research, because there was no intervention or interaction with individuals and the data was deidentified and public. We then submitted an application to Facebook for "Automated Data Collection"[2] and spoke with a representative from Facebook's Academic Relations team to confirm that our data collection process did not violate Facebook's Terms of Service. We confirmed that it did not because it was not considered an "automated" method. Yet, we believe that publicly accessible data collected from unknowing Facebook users does not give us the right to disclose their personally identifiable information. Even though Facebook profile names and other personally identifiable information were collected, we do not include this information in our analyses or results.

5 RESULTS

In the next section, we first present our heuristic evaluation of the design of Facebook Reactions followed by our empirical results organized by our structured codes for valance and emotion, then by users' rationale for why they appraised Reactions as they did.

5.1 Expert Evaluation of Facebook Reactions

Prior to presenting the results from our empirical analysis of Facebook user comments (Sections 5.2–5.4), we conducted our own heuristic evaluation of Reactions based on the cited literature

[2]See https://www.facebook.com/apps/site_scraping_tos_terms.php.

on emotions, valence, and cognitive appraisals. We determined that Reactions are a mixture of different *valence*s and *emotions*, which include two positively valenced emotions (*Love* and *Haha*), two negatively valenced emotions (*Sad* and *Angry*), one emotion without a clear valence (*Wow*), and one positively valenced attitude that does not explicitly imply a particular emotion (*Like*). Prior work has shown that senders and recipients of *Likes* may interpret many different meanings and emotions behind this action [21]. With the addition of five emotionally charged response options, the likelihood of ambiguity and user misinterpretations increases. Is a *Love* Reaction in response to a sad post an expression of warmth toward the aggrieved person or a mean-spirited positive appraisal that this person experienced something sad? Similarly, *Anger* can be directed at a person or the context of a post; thus, can be used to bully or provide support.

Meanwhile, *Wow* may be interpreted as surprise, but is generally unclear whether this reaction is good or bad [33]. *Wow* may be problematic as it could be interpreted either positively (e.g., "Wow, that's great!") or negatively (e.g., "Wow, that's horrible!"), and other Reactions may be better fitting (e.g., *Love* for amazing and *Anger* for disgusting) depending on the context. Very few of the comments in our empirical analysis below were coded with *surprise*, suggesting the Reaction of *Wow* was underused compared to the other Reactions.

Our structured coding process further served as a basis for our heuristic design evaluation of Facebook Reactions and found that the emotion set included within the design of Reactions does not—*and could not*—capture the full range of emotions individuals experience. Overall, we found that trying to quantify, limit, or render emotions mutually exclusive from one another was problematic. Yet, given the current design, Reactions do just that. Currently, Reactions require users to choose between their potentially conflicting emotions (e.g., *anger* and *sadness*), and in other cases, lack the ability to express primary human emotions at all, such as *fear*, which emerged frequently during our empirical analysis, but is absent in the design of Reactions. This omission would require users to articulate their concerns in text or to use the *Wow, Sad,* or *Angry* Reaction, which may be incongruent with their actual feelings of *fear*.

In many cases, the comments we coded did not exhibit a clear valence or emotion. From a design perspective, this supports Facebook's decision to decouple the ability for users to comment and/or select a corresponding Reaction, as valence and emotion are not required when expressing a thought. This was especially evident when users were requesting more information. If Facebook would have chosen to couple Reactions with the corresponding user comments, it would have been much easier for us to interpret the users' intended meaning.

In the next sections, we present our empirical analysis of Facebook users' comments in response to the launch of Reactions. We present our results based on the frequency of valence, emotions, and coded themes in descending order.

5.2 User Appraisals of Reactions—Positively Valanced

Forty-nine percent of comments were positively valenced toward Reactions, 33% were negatively valenced, and 18% were coded as unsure, meaning the comment's valence was unclear or ambivalent. We chose to focus on the emotions that emerged most prominently for each category of valence. Therefore, less frequently occurring emotions are not included in our results. For example, the occurrence of surprise was extremely low, with the code only applied 23 times within all 3,200 comments. In this section, we focus on the majority of the comments, which were positively valenced.

The majority (82%) of positively valenced comments unequivocally expressed *happiness* as the primary human emotion. Meanwhile, for 5% of the comments, coders disagreed whether the primary emotion expressed reflected *happiness* or *fear*. Another 3% of the positively valenced comments emoted *fear,* representing a combined total of 90% of all positively valenced comments.

Below, we describe the three most prevalent themes that emerged within the positive user appraisals: (1) Excitement (i.e., EXCITED from Table 4) over the new Reactions interface (46% of comments), (2) Preference over the alternative of having a *Dislike* (i.e., DISLIKE) button (36%), and (3) Appreciation over the ability to express empathy (i.e., EMPATHY) to others (27%). We describe each of these themes with illustrative quotes and show how they evolved across the pre- and post-announcements of Reactions.

5.2.1 Excitement over Reactions. Many users expressed sheer *happiness* because they were excited about Reactions. In the pre-launch comments, users eagerly anticipated using this new feature, with many comments reflecting the sentiment that users had been wanting a way to better express themselves for a long time. Facebook was finally listening: *"This would be the beginning of a great way to express more on Facebook. I am really excited about this." (Comment #337, pre-launch).*

Users responded with even more specificity in their post-launch excitement after they were actually able to use the feature, commenting more concretely on their experiences: *"I like how there are only 2 negative emotions and the rest are all positive." (Comment #493, post-launch).*

Overall, these users were happy about having more options to express a wider range of emotions but also glad that Facebook gave more emphasis to positive emotions.

5.2.2 A Better Alternative to a Dislike Button. A number of positive user appraisals directly compared Reactions and the controversial alternative of having a *Dislike* button. In the pre-launch comments, Facebook users were happy Facebook chose not to include a *Dislike* button: *"A dislike button can create a lot of negativity and enmity. There are range [sic] of emotions in dislike. The various reaction symbols suggested should cover enough of the emotions from like to angry… I am happy with the proposed buttons of emotions." (Comment #34, pre-launch).*

With this comparison, we frequently saw mixed emotions of *happiness* and *fear* based on our conflicting codes, as well as the singular emotion of *fear*. Users expressed complex thoughts that touched on both the fear of negative consequences that could result from a feature like Reactions with satisfaction that Facebook chose to emphasize more positive emotions within their design. Thus, a sub-theme about cyberbullying often accompanied comparisons of Reactions to a *Dislike* button. Users saw Reactions as less likely to promote cyberbullying: *"I see the key is to be more specific with the emotions instead of having a general dislike button that could foster hate and bullying!! It's a very smart idea! I love it!" (Comment #10, pre-launch).*

The vast majority of comments that solely expressed *fear* occurred before the worldwide rollout of Reactions. Many users erroneously assumed Reactions would include a *Dislike* option, which they thought could lead to abuse: *"As a teacher I'd be worried to see a dislike button. Imagine being a teen with social and self image issues already add in Facebook…and thus cyber bullying and then add a DISLIKE button?! Why do we need so much negativity?" (Comment #123, pre-launch).*

Once users could engage with Reactions, references to the *Dislike* button decreased; fearful post-launch comments focused more on potential negative consequences of Reactions themselves, especially for younger users. For instance, some users who were generally happy about Reactions also expressed fear that the *Angry* reaction could promote bullying, disagreements, or other types of negativity: *"I love the LOVE button–and the others that allow you to enjoy and share happiness or sadness with your friends. I HATE the Angry button because this is going to get used in a negative way every time someone disagrees with a post." (Comment #43, post-launch).*

Overall, the post-launch comments comparing Reactions to the *Dislike* button were less frequent but more reflective. These commenters often defended Facebook for designing a better solution, noting that the designers carefully thought through the range of outcomes that the feature could cause: *"Great work. It's amazing the amount of research and thought that has to go into what so many*

people view as simple. A 'simple' dislike button could have disrupted the whole flow and perception of so many posts and the larger realm of Facebook." (Comment #1296, post-launch).

Such reflections may have resulted from Facebook users reading strongly worded pro-*Dislike* button comments (included later in our analysis), leading commenters to realize how complex and controversial the decision really was. In summary, direct comparisons to a *Dislike* button often corresponded to positive appraisals of the design of Reactions, helping users see the benefits of the new feature.

5.2.3 Finally! A Way to Express Empathy. Providing a simple mechanism for easily expressing empathy was embraced by many users. The pre-launch comments showed how users were looking forward to interacting with this new feature to express their emotions in a more appropriate way: *"I like the idea of being able to put different emotions. Especially when people post sad things and I want to show empathy and comfort." (Comment #1459, pre-launch).*

Post-launch, users' comments reflected a sense of empowerment for having a way to appropriately respond to sad posts, such as tragedies, without having to comment. Many users acknowledged that Liking a negative post seemed "awkward," "strange," or "gross:" *"Now we can show our reaction much easier because I was always wondering how to respond sad news shortly... And it always feels gross to watch 1M likes for a tragedy..." (Comment #21, post-launch).*

These comments confirmed what past research has suggested—these users felt the Like button fell short of adequately expressing more complex emotions, such as empathy [1].

5.3 Negatively Valenced User Appraisals of Reactions

Approximately 33% of all comments were negatively valenced, meaning these Facebook users were against Reactions. Of these, 76% of the comments expressed a combination of *anger* and/or *sadness*. The majority (57%) expressed *anger* as the primary emotion. For another 10% of the comments, coders disagreed whether the primary emotion expressed reflected *anger* or *sadness*. The remaining 9% of the negatively valenced comments indicated the primary emotion of *sadness*. The following three themes emerged as the rationale behind users' negatively valenced emotions: (1) Anger that Facebook did not implement a *Dislike* button (72%), (2) critiques of the design of Reactions (20%), and (3) frustration in users' lack of control over and aversion to interface change (20%).

5.3.1 Anger Over No Dislike Button. In contrast to the positively valenced comments, an overwhelming complaint among negative user appraisals was the absence of a *Dislike* button. In pre-launch comments, Facebook users often expressed outright *anger* that a *Dislike* button would not be part of Reactions. These users felt strongly that they were being silenced and not allowed to express how they really felt about posts: *"Are you serious? Still no DISLIKE button????? We've expressed ourselves very clearly. Dislikeing [sic] something is a very common human feeling. Just because you're the boss doesn't mean you can DICTATE to us that we can't dislike something." (Comment #1169, pre-launch).*

Angry commenters felt they were being perceived as too emotionally immature to handle the negativity that comes with a *Dislike* button and saw this as patronizing: *"To think that peoples [sic] opinions should always be marshmallow moments is unrealistic." (Comment #973, pre-launch).*

Sadness was more often detected in comments post-launch, with a sense of resignation over the new feature dominating comments. These users expressed a sense of disappointment that requests for a *Dislike* button continued to be "ignored." Users expressing *sadness* over Reactions often justified their support for a *Dislike* Button by comparing it as a less offensive alternative to the *Angry* Reaction. From their perspective, it made more sense to dislike something negative

than to respond with anger, which could be misinterpreted as anger at the person rather than the event: *"PLEASE. Would rather see 'dislike' button instead of the 'angry'... Angry is too unsettling confrontational and endangering! Dislike conveys the same in a more civilized manner." (Comment #722, post-launch).*

In the post-launch comments, users' *anger* was more directed toward the *Angry* Reaction, which users felt was inferior to a *Dislike* button because it did not capture how emotional valence can differ from one's emotions: *"A simple 'dislike' button—Mark what is the problem with you guys? 'Angry' and 'sad' is not the same as 'dislike.' You can like the posting and be angry and sad at the same time." (Comment #1236, post-launch).*

Overall, proponents of the *Dislike* button expressed a mixture of *anger* and *sadness* that Facebook did not include this option as one of the new Reactions.

5.3.2 Design Critiques of Reactions. Other users gave more specific critiques of the design of Reactions. For instance, after the initial announcement about Reactions, many users compared the new feature to already-existing emoticons and stickers and did not see the interface as novel or addressing their needs: "*Emoticons and Stickers are already there to express our feelings. We want something else." (Comment #73, pre-launch).*

Design critiques seemed to increase from pre- to post-launch and often referenced the "childish" look of the animated faces and how the buttons "cluttered" the site. More broadly, other criticisms addressed specific design choices made by Facebook, such as the absence of racial diversity. Regardless of users' stance about having or not having a *Dislike* button, these users simply did not like the new look and feel of Reactions or how they would be used.

5.3.3 Aversion to Change and a Lack of Control. Other users expressed mixed emotions of *anger* and *sadness* that the interface had to change at all and that Facebook gave them no control over these changes. A number of users suggested that new features were not necessary, and Facebook functioned fine as is. Thus, why change the interface at all? Many users specifically referenced the Comment feature as a preferred alternative to using a Reaction to express complex emotions: *"Why mess with what works? If you don't like something then feel free to keep scrolling... If you feel the need to show emotion... Leave a comment or inbox a message. I think that having all the options is not always the answer." (Comment #427, post-launch).*

Some commenters directly criticized the increasingly complicated feature set and preferred the more straightforward set of interaction tools already in place. Other users vented their frustration about not having control over the new interface and said they would like more agency in when and how Facebook updates the site, even requesting they have approval power over new features: *"Why don't you have a 'no' button for anything Facebook wants to do on our site without our permission?... Ask us yes or no." (Comment #517, post-launch).*

The frequency of design critiques seemed to increase post-launch; we also noted a sizable increase in the number of *sad* comments post-launch, likely due to the locked-in nature of the features after the beta testing had been completed. Some speculated the design change would have the unintended consequence of increasing people's "laziness" in interacting with others by taking "the simple way out." For example, clicking a *Sad* Reaction instead of posting an empathetic comment was viewed as a poor replacement for more meaningful interaction: *"Oh Mark must you make it even easier for people not to use their words to talk to each other. Tis a sad day indeed. The world needs less emoticons. Yes my smile is upside down today." (Comment #33, post-launch).*

Overall, these comments were reminiscent of Wisniewski et al.'s [50] findings regarding how Facebook users find major interface changes (i.e., Timeline) stressful, especially when there is a perceived lack of control over the change.

Table 6. $N = 3{,}000$, Pre vs. Post Chi-Square Test for Independence

Major Themes	Pre Total (%)	Post Total (%)	Chi-Square Test Result
Excited	249 (8.3%)	375 (12.5%)	$\chi^2(1) = 32.12$, $p < 0.001$, $\Phi = 0.10$
Empathy	172 (5.7%)	231 (7.7%)	$\chi^2(1) = 9.98$, $p < 0.01$, $\Phi = 0.06$
Dislike	861 (28.7%)	443 (14.8%)	$\chi^2(1) = 237.01$, $p < 0.001$, $\Phi = 0.28$
Design Critique	122 (4.1%)	215 (7.2%)	$\chi^2(1) = 28.91$, $p < 0.001$, $\Phi = 0.10$
Change/Control	93 (3.1%)	138 (4.6%)	$\chi^2(1) = 9.50$, $p < 0.01$, $\Phi = 0.06$
Cyberbullying	99 (3.3%)	39 (1.3%)	$\chi^2(1) = 27.35$, $p < 0.001$, $\Phi = 0.10$

5.4 Unsure Valenced Facebook Reactions

Approximately 18% of all comments were *unsure* (neutral or unclearly valenced) about Reactions. The primary emotions coded in these comments were *no emotion* (48%) and *humor* (12%). *Happiness, anger*, and *sadness* also had a decent representation (8–10%); however, these emotions without a valence toward or against Reactions were largely irrelevant. The majority of these comments that expressed *no emotion* were requests for more information, spam, or ambivalent comparisons with the *Dislike* button. For example, in the pre-launch comments, users often asked for information on the choice of Spain and Ireland for beta testing. After Reactions launched, users' questions shifted more to the interface itself. They began asking questions about how to use Reactions or problems they were encountering: *"How long do you have to press and hold on the Like button? I'm doing this through the iPhone app and the reactions aren't popping up." (Comment #36 post-launch).*

Approximately 12% of the comments that were unsure about Reactions expressed *humor*. Many of the pre-launch comments had a tone of sarcasm when asking for more information or clarification. Adding additional emotions to Reactions was also a common theme for humor. New Reactions users joked about adding included: "*sarcastic*," "*YOU KNOW YOU LYING BUTTON*," "*learn to spell dumbnut*," "*I feel embarrassed for you*," and "*are you NUCKEN FUTS*." Some comments attempted to use humor to lighten the mood around the *Dislike* button controversy: *"I just flip my phone 180 and hit the thumbs down button been disliking stuff for ages. Duh." (Comment #1156, pre-launch).*

The analysis of these unsure valenced comments illustrated how the theme of comparing Reactions to a *Dislike* button was consistently prevalent across positive, negative, and unsurely valenced comments, as well as how *humor* emerged as a common *emotion* without any particular valence.

5.5 Pre- vs. Post-Launch Theme Differences

In our qualitative analysis, we found differences between users' pre- and post-launch comments based on each theme; therefore, we conducted a post-hoc analysis to see if any of these differences were statistically significant. To do this, we considered an individual post to reflect a theme if at least one coder applied the theme during the open coding process. Using chi-square tests of independence, we compared the frequency of each of our main themes between the pre- and post-launch comments. Chi-square tests of independence are between group (rather than within group) tests used when one has two or more nominal variables, each with two or more possible values [59]. Therefore, when significant differences are found, this suggests that the categorical codes in our qualitative analyses significantly differed between pre- and post-launch comments. However, it does not suggest that the overall sentiments of Facebook users, in general or as individuals, changed between pre- and post-launch announcements.

Statistically significant results are displayed in Table 6. Direct comparisons to the *Dislike* button changed the most significantly, decreasing by nearly 50% post-launch. In contrast, users' general excitement, appreciation over being able to express empathy, critiques of the design, and

comments regarding change and control were all significantly more common after Reactions launched. None of the other main themes showed significant differences between the pre- and post-launch announcements. However, references to the sub-theme of cyberbullying, which was part of the negative consequences theme decreased pre- versus post-launch. These results suggest that users were generally more positive about Reactions post-launch, and discussions around the *Dislike* button decreased. This may have been related to a number of users incorrectly assuming that Reactions included a Dislike button in their pre-launch comments, which was cleared up post-launch. Additionally, users had more critiques about Facebook Reactions after they were able to interact with the new interface design.

We also analyzed the pre- and post-launch comments from the four Facebook users who commented both pre- and post-launch. Overall, these users did not change their stance about Facebook Reactions over time. Users who were happy about the interface change were still happy, and those who were unhappy about it still expressed their fustration. For example, one poster commented pre-launch about their desire for a "support" Reaction: "*You may be able to cover several of these with a simple 'Support' button. (For those cases where 'like' is not appropriate but you still appreciate/support the position of the poster.)*" The same user reiterated their earlier suggestion post-launch: "*Needed but still lacking – 'Support' or similar (to express support for the poster though the subject may be unlikeable) and something stronger to express support for the poster bringing something to our attention though the subject matter is unsupportable.*" This suggests that while overall sentiments across the pre- and post-launch posts may have shifted, the viewpoints of individuals largely remained unchanged.

6 DISCUSSION

Below, we relate back to our original research questions and discuss the theoretical and practical implications of our results.

6.1 A Heuristic Design Evaluation of Reactions (RQ1)

A key contribution of our work is that we demonstrate how an application of human emotions and cognitive appraisal theories can aid in the direct interpretation of user evaluations in empirical research. We framed user comments about Reactions as a type of emotion-specific cognitive appraisal made about a system. In taking this novel approach (i.e., structured coding for emotion and valence combined with thematic analysis), we found an important yet unanticipated result: Applying a theoretical lens based on human emotion and cognitive appraisals helped us to better interpret the evaluations made by users, which in turn, helped us to inform design.

Based on our heuristic evaluation of Facebook Reactions, potential design recommendations to improve Reactions would be to allow users to select multiple Reactions at a time and contextualize each comment with different emotional states. This would be similar to how FB already allows users to tie how they're "feeling" to a post; but, moving this feature to the comment level. This design change would address the problem that emotions in comments are hard to interpret and may change over time. In fact, in November 2018, Facebook recently added a similar feature that makes it easier for users to add emojis to comments via the mobile app. As shown in Figure 3, when a user interacts with a post to make a comment, a subset of emojis or stickers are now shown above the comment bar. These emojis and/or stickers change dynamically based on the content of the post or the other comments on that post. However, the algorithm used for determining what emojis and stickers are shown is not made transparent to the user. Therefore, future research could explore whether trying to predict users' emotional responses to posts (e.g., making positively or negatively valenced suggestions) has an influence on their overall commenting behaviors.

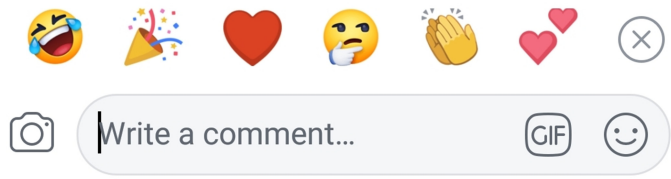


Fig. 3. Facebook Mobile Predictive Emojis/Stickers within Comments, November 2018.

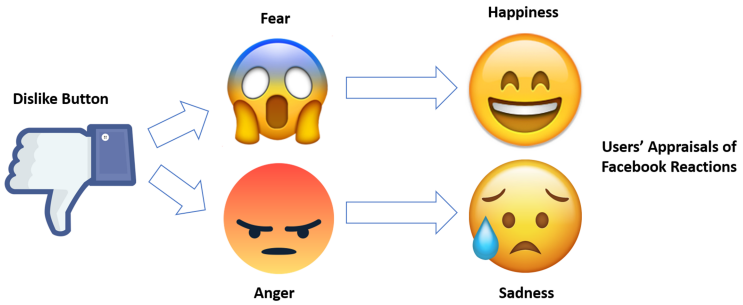


Fig. 4. Applying Lerner and Keltner's model of emotion-specific influences on judgment and choice to users' appraisals of Facebook Reactions.

6.2 An Empirical Evaluation of Users' Comments (RQ2)

Unlike the launch of Facebook Timeline [50], where Facebook users could only compare the new feature to their existing *Wall*, the prevalent theme that cut across all valences and emotions for Reactions was a direct comparison to the alternative of having a *Dislike* button. As many of the most popular social media platforms employ different interactive features—and several include a *Dislike* button or the equivalent (e.g., YouTube, Reddit), it is unsurprising that we saw references to this alternative feature so frequently.

Importantly, users' underlying emotions had a direct impact on how they appraised the interface design. For example, the interaction between positively valenced comments that expressed fear as their primary emotion was initially surprising; however, closer examination of the data revealed this was because the *Dislike* button seemed to invoke a sense of fear in many users, and this fear seemed to push more users to favor design solutions that avoided a *Dislike* feature. Conversely, the lack of a *Dislike* option made others feel *anger* and *sadness*, leading to critical appraisals of Reactions. To better interpret these results, we return to Lerner and Keltner's [28] model of emotion-specific influences on judgment and choice. They explain that fearful individuals tend to make pessimistic judgments (due to heightened perceived risk), while angry people tend to make more optimistic judgments (due to low levels of perceived risk). As shown in Figure 4, if users felt fearful about the prospect of having a *Dislike* button (e.g., due to negative potential consequences, such as cyberbullying), they tended to be more positive and happier when they appraised Facebook Reactions. In contrast, when users were angry about Facebook not providing a Dislike button, they were more negative about Reactions.

Figure 4 applies Lerner and Keltner's [28] model of emotion-specific influences on judgment and choice to better interpret the rationale behind many Facebook users' appraisals of the new Reactions. In our analysis, most of the angry responses implied optimism by not deeply considering the negative consequences associated with a *Dislike* button, especially as it relates to more

vulnerable populations, such as teens [51]. This also helps explain why the mixed emotions of *happiness* and *fear* manifested in the positively valanced comments about Facebook Reactions. Within the fearful comments, users were clearly pessimistic about how the *Dislike* button would be used maliciously. Those who were fearful expressed relief that Facebook provided a better alternative. Without our theoretical grounding in theories cognitive appraisals, emotion, and valence, such nuanced insights would have been missed. The implication that human emotion acts as a salient individual difference that directly impacts user acceptance is far reaching. Future work must determine potential unintentional consequences of such design decisions that depart from what we know theoretically to be true about the complexity of human emotions.

Another theme we identified in the comments both pre-launch and post-launch was that many users felt frustrated by the lack of control they had with the new changes occurring on their Facebook pages. The videos were posted to Mark Zuckerberg's page and the changes appeared to occur overnight for many users. Similar to the launch of Timeline [50], Facebook users did not seem to appreciate the lack of agency over this change. Some users explicitly mentioned the inability to opt out of this new addition. However, to some extent, the shift in attitude between the pre- and post-launch comments suggests Facebook was able to alleviate some of these concerns. After users were able to interact with Reactions, they realized that how they used to "Like" things did not really change. If they simply wanted to "Like" a post, they could, but if they hovered or did a "long press" on "Like," Reactions would appear. While users described some problems with the design choices, others expressed appreciation of how Facebook implemented the change in the most minimalistic way.

The thematic analysis of users' comments generally corroborated our own evaluations of the potential limitations inherent in the design of Facebook Reactions. Overall, most users felt that Reactions was at least an improvement over only having a *Like* button. However, many users pinpointed a number of the same design limitations of the new interface that we identified ourselves; they too wanted the ability to dual code their emotions using Reactions. The mixed emotions of *happiness* and *fear* or *anger* and *sadness* in users' comments made a lot of sense to us (and apparently to users as well), showing that choosing a single Reaction may not always be adequate: *"I wish you could choose two reactions!" (Comment #11, post-launch, 462 likes).*

This comment speaks to both limitations in Facebook's design choices and in our analysis of the comments. Facebook chose a simple design by constraining users to allocate a single Reaction to a post; however, a single emotion does not always capture how we feel in a given context. Perhaps this is why so many of the negatively valenced comments talked about the superiority of writing a response to using a PDA that could be misconstrued or incomplete [1]. For instance, while the ability to emote *empathy* was a common desire expressed by users, the available Reaction for *Sadness* was only one component of empathy. Facebook recently implemented a "Care" Reaction button to help users express their responses during the COVID-19 crisis. However, users in our study also suggested adding other emotions, such as "*dislike*," "*disagree*," "*disgust*," "*dismay*," "*thanks*," "*maybe*," "*displeased*," "*I'll drink to that*," "*prayers*," and "*hugs*." These suggestions highlight that, from users' perspectives, the emotions captured in Reactions are not all encompassing.

6.3 Implications for Social Computing Design and Research (RQ3)

Our work applies relevant theories of human emotions and emotion-specific influences on judgment to inform design from two inter-related perspectives: (1) a theoretically grounded heuristic evaluation by HCI experts (i.e., structured coding of appraisals by emotion and valence) on a feature designed to support the expression of human emotion, and (2) an empirically driven design evaluation of users' responses to Facebook Reactions (e.g., thematic analysis of comments). Our novel, hybrid, and somewhat recursive approach combines these two perspectives to produce

deeper insights than if we had employed either method in isolation. Therefore, a main contribution of our work is that we supplemented a traditional thematic content analysis of user data with a novel, inductive, theory-driven heuristic evaluation of a specific socio-emotional user interface. While our findings are directly generalizable to other social platforms that embed features to help users convey emotion, our methodological approach is applicable to any social computing research that evaluates design and/or users' perceptions of design. Further, we make contributions beyond the evaluation of Facebook Reactions by generalizing our approach to inform future social computing research involving design evaluations, cognitive appraisals, and the design of interfaces that support the expression of complex human emotion.

For instance, one emergent finding is that our themes shifted significantly between the pre- and post-launch announcements. A key difference seemed to be the difference between *hypothetical discourse* about what "might" happen versus more *concrete discussion* of what "did" happen. Facebook users were able to appraise Reactions in more depth once they were able to explore the new feature. Therefore, Facebook may have been able to avoid some of the negative pre-launch responses if the initial video had shown a tutorial of *how* users would interact with Reactions with specific use cases instead of just showing the emoticons. A methodological implication of this finding is that researchers should carefully consider the timing of the user responses analyzed in future studies regarding changes in social media interfaces.

Our research process also highlights an important methodological challenge in HCI and the wider social computing community. When analyzing digital trace data that includes personal disclosures and/or expressions of complex emotions, automated methods like NLP (Natural Language Processing) [34], or more qualitative approaches like the ones employed here, have different strengths and weakness that need to be considered when choosing an appropriate research method for the given data. We offer no easy solution to this challenge; in our own study design process, we tried to avoid manual data coding for as long as possible until it became clear that identifying emotional affect via automated methods would be highly inaccurate. Due to our human limitations, we then had to reduce the dataset (N = 3,000 vs. 15,000 comments that were collected) to facilitate the manual coding process and had to apply rigorous safeguards to ensure the reliability of our analysis (e.g., having two independent coders code all 3,000 comments, calculating IRR, iteratively improving our codebook, and comparing our results to a holdout sample of the larger dataset). Even still, we struggled to quantify human emotions with a high level of reliability and, thus, chose to interpret these conflicting emotions as part of our results. Yet, this more nuanced interpretation gave us stronger insights into both human emotions and the challenges of designing interfaces to account for human emotions than if we had not gone through this process.

Therefore, we end with a word of caution when using automated approaches for evaluating social media trace data, which researchers have begun to do since the launch of Reactions [3, 35, 46], especially in cases where people are emoting about emotions, which was the unusual case in our dataset. Previous studies have noted the challenges of automatically classifying emotion, including low inter-annotator agreement for supervised models and the dynamic context-dependent nature of the manifestation of emotions that are difficult for automated methods to detect [2, 10]. Therefore, while all social computing approaches are valuable when applied across different contexts, researchers must weigh the tradeoffs between different methodological approaches to ensure the robustness of their results, as we did in our analyses.

6.4 Limitations and Future Research

We would like to acknowledge the limitations of our work and suggest some areas for future research. First, we applied rigorous safeguards to ensure the reliability of our analysis (e.g., iteratively improving our codebook, calculating IRR, comparing our results to a holdout sample). This

does not guarantee that our analyses were without bias. For instance, our choice to analyze "top" comments means that Facebook's algorithm for filtering these comments may have influenced our results. To mitigate concerns that analyzing top comments introduced bias, we generated a random sample of 100 comments each from the remaining 12,000 pre- and post-launch comments as a holdout comparison. We qualitatively coded and compared this holdout sample to our dataset of 1,500 pre- and post-launch comments to confirm theoretical saturation (i.e., that trends from the holdout sample were consistent with our results). Overall, the patterns across our coded dimensions were similar when comparing our dataset to the holdout sample and all statistically significant differences could be attributed to the holdout samples having a higher proportion of irrelevant posts. For *valence*, chi-square tests revealed that the holdout sample had more "unsure" posts ($\chi^2(1) = 9.74$, $p < 0.05$, $\Phi = 0.08$). For *emotion*, the holdout sample had a significantly higher proportion ($\chi^2(1) = 12.46$, $p < 0.01$, $\Phi = 0.06$) of posts coded with humor and without any discernable emotion ($\chi^2(1) = 13.86$, $p < 0.01$, $\Phi = 0.09$). For our themes, the holdout sample included more spam ($\chi^2(1) = 6.09$, $p < 0.05$, $\Phi = 0.06$), informational ($\chi^2(1) = 6.21$, $p < 0.05$, $\Phi = 0.06$), and tongue-in-cheek posts that suggested new emotions to add to Reactions ($\chi^2(1) = 5.83$, $p < 0.05$, $\Phi = 0.05$). As such, the increase in irrelevant posts in the holdout sample supported our decision to analyze the "top" 3,000 pre- and post-launch comments, which increased the relevancy and representativeness of the larger sample of comments.

Second, we struggled ourselves to quantify human emotions with a high level of reliability and, thus, chose (against convention) to interpret the conflicting emotions as part of our results. Yet, explicitly coding for emotion gave us stronger insights into both users' emotional response to Reactions and the challenges of designing Reactions in a way that accounts for these emotions. As such, we suggest that future research should consider conducting interviews with Facebook users to ask them about their sentiments regarding Facebook Reactions and other emotive interfaces, rather than relying solely on our analysis of social media trace data.

Third, mirroring Facebook Reaction's interface design in our decision to use mutually exclusive codes for emotion was both a strength and a weakness of our research. It was useful for identifying potential usability problems from a design perspective; however, it constrained our empirical analysis of users' comments. Thus, our word of caution is that, at times, tradeoffs must to be made between rigor and nuance to best interpret complex datasets. We mitigated this weakness by combining our theoretically grounded heuristic evaluation of emotions with a more grounded thematic analysis of user comments. Yet, a limitation of this approach was that Facebook users who responded to the announcements about Reactions may have more extreme opinions and emotions than typical users. We tried to mitigate this weakness by conducting our own heuristic evaluation as a point of comparison. Thus, our hybrid qualitative approach served the dual purpose of strengthening and triangulating the findings presented in this article. We encourage other researchers and designers to similarly consider combining theory with empirical user data when evaluating socio-emotional interfaces in the future.

Finally, since the pre- and post-launch comments were made by different subsets of Facebook users, we could not draw any within-subjects' comparisons to help better understand how individual users' sentiments shifted before and after the launch of Facebook Reactions. Therefore, future research should examine user experiences when first being introduced to new interfaces like Reactions, as well as examining long-term usage and changes in users' perceptions of the interface over time.

7 CONCLUSION

On sites as popular as Facebook, which proclaims to have more than 1.7 billion daily active users [60], even the smallest design change can create chaos and confusion. With the launch of Reactions,

Facebook tried to minimize these outcomes through multiple announcements prior to and at the time of launch. In this article, we extended prior work evaluating how users respond to such design changes by evaluating the *valence* and *emotional* response of Facebook users before and after the worldwide rollout of Reactions. Our findings provide important insights into the complexity of emotions expressed on Facebook, and more generally within social media platforms, and highlight the tradeoffs that arise when trying to distill complex human emotions for the sake of design simplicity. Our work illustrates the challenges of evaluating complex human emotions from the perspectives of both HCI research and design evaluations of sociotechnical systems.

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