Factors influencing children's display of surprise

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Abstract

Earlier studies found a discrepancy between the display and feeling of surprise. Therefore, we assessed what factors influence the display of surprise in children of two age groups: 8- and 11-year-olds. We manipulated the social setting (children either competed or collaborated), and the cause of surprise (a surprisingly positive or negative event). We found that children used more features to express negatively caused surprise, compared to positively caused surprise and that 11-year-olds used more facial features than 8-year-olds. In a subsequent perception study, adults judged video clips with surprised and neutral reactions, for the degree of surprise that was displayed. We found higher ratings of surprise for negatively vs. positively surprised children, competing vs. collaborating children, and 11-year-olds vs. 8-year-olds. These results confirm that in addition to the feeling of surprise, its cause, the social setting, and age also affect the display of surprise.

Keywords: Emotions; facial expression; surprise; collaboration; competition; social development.

Introduction

According to Ekman (1997), surprise is prototypically displayed through a combination of three facial features: people who are surprised raise their eyebrows, open their mouth and widen their eyes. However, when researchers try to elicit the expression of surprise with participants, this prototypical display is rarely shown (e.g., Reisenzein, Bördgen, Holtbernd & Matz, 2006). There appears to be a low emotion-facial display ratio, which means that when participants indicate they feel surprised, they do not frequently use the complete set of Ekman's features to express their emotion. We focus on two possible reasons for this.

First, earlier research often assumes that there is only one sort of surprise (e.g., Scherer, Zentner, and Stern, 2004). However, some studies have shown that surprise can be differently expressed, depending on its cause (e.g., Shepperd & McNulty, 2002). For example, when someone is surprised by a positive event, like giving an unexpectedly correct answer to a difficult question, his or her facial expression would differ from the facial expression of someone who is surprised by a negative event, like giving an unexpectedly incorrect answer to an easy question. This could be a reason for not finding a general full facial expression of surprise. Therefore, in our studies, we look at different causes of surprise and its accompanying facial expressions.

Second, there may be contextual effects as well, in the sense that the expression of surprise could depend on the setting in which it is elicited, something which is often ignored in earlier studies. Research on surprise usually takes place in a nonsocial situation, sometimes even deliberately, to get a "clean" view on the expression of surprise (Reisenzein et al., 2006). However, we think that the social setting might be an important indicator for the expression of surprise. People tend to exaggerate, minimize, neutralize and fake expressions, depending on the social situation they are in (Matsumoto, Hee Yoo, Hiramaya & Petrova, 2005). For example, people probably express their surprise about an incorrect answer differently in the company of a teammate than in the company of an opponent. Such social factors may represent a second reason for a low emotion-facial display ratio. Hence, in this research, we examine the possible effect of the social situation on the facial expression of surprise more closely. We created a quiz game that could be played in two conditions, namely a collaborative or competitive setting. In this way, the participants' goals and interests varied in each condition and thus a different social context was created.

Adjusting behaviour and expressions to a social context is something people learn gradually. Children need time to acquire the social display rules, which means that younger children are not as skilled in that respect, compared to older children (Piaget, 1950). Earlier studies on children and surprise involved mainly perception and understanding of the emotion based on the theory of mind (e.g., Hadwin & Perner, 1991); they rarely concerned children's expression of surprise. Research that did study at children's expression of surprise involved merely infant participants (e.g., Scherer, Zentner, and Stern, 2004). We think it is important to study the expressions of surprise with older, more socially skilled, age groups as well. Saarni (1979) showed that children's adjusting behavior to social contexts doubles between the ages of 8 and 11. Therefore, we included both age groups (8 and 11 years old) in our studies.

In sum: the aim of this research is to study children's expressions of surprise, caused by different events (positive and negative events), in different social situations. To assess the influence of social setting and age on facial expressions of different sorts of surprise, we conducted three studies. The aim of the first study was to examine whether

participants actually experienced the different kinds of surprise differently. In our second study, we wanted to know whether features of the full facial display of surprise appeared, and whether there was an effect of age and social setting. In our third study, we focused on the perception of the facial expressions of surprise.

Study 1: Production of surprise

We wanted to elicit different kinds of surprise using a natural elicitation procedure. Therefore, we created a game-based experiment in which two participants simultaneously had to play a knowledge quiz. In this quiz, we manipulated various questions to induce situations in which a quiz partner's answer was unexpectedly correct, or unexpectedly incorrect, in order to elicit either a surprised feeling with a positive cause, or a surprised feeling with a negative cause.

Method

Participants. In total, 90 children participated in this study. We selected participants from two age groups; 8-year-old children (42 children in total, 45% girls) and 11-year-old children (48 children in total, 56% girls). The participants had to play a knowledge quiz in self-selected pairs. These pairs were randomly divided across two experimental conditions; half of the pairs played the game in a competitive setting and half of them in a collaborative setting. The experiment was conducted in two primary schools in Zoetermeer, the Netherlands. Beforehand, we informed parents about the experiment and asked for their signed permission for their child to participate.

Stimuli. The knowledge quiz consisted of 30 questions, which participants had to answer by taking turns, such that each of them responded to 15 questions. Both participants saw a question on their respective screens, but only one participant had to give an answer, while the other just listened to the response. For the next question in the list, they changed roles so that the other participant would answer a question, and vice versa. These questions were selected from the children's edition of the game Triviant Pursuit and a Dutch version of the "Wechsler Intelligence Scale for Children". We made sure that both easy and hard questions were included, in order to elicit both correct and incorrect answers. An example of an easy question is "Which month follows March?", an example of a difficult question is "What is glass made of?"

The participants were asked to sit behind two separate computer screens, which were arranged in such a way that they were not able to see each other or each other's computer screen (see Figure 1), but they were able to hear each other's answers. Participants were led to believe that they both saw the same list of questions on their computer screens. However, unknown to the participants, in order to elicit a surprise reaction, the questions posed were different for the two participants. In doing so, we could manipulate various questions to create situations in which the speaking participant's answer was unexpectedly correct, or unexpectedly incorrect, according to the knowledge of the listening participant. More specifically, we aimed to elicit reactions of two types of surprise.

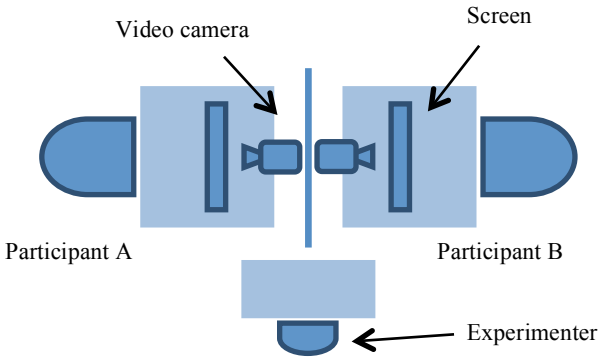

Figure 1. *Experimental setting*

First, we manipulated questions in such a way that participants were positively surprised. We showed the answering participant a question that was easy to answer, while the listening participant saw a question that was extremely difficult to answer. For example, the answering participant was given the question: "Which year follows 1933?", a question that is likely to be very easy to answer. However, simultaneously, the listening participant saw the question: "In which year was the city Tilburg established?" which is a difficult question. So to the listening participant, it would probably come as a positive surprise that his/her partner would give a quick and confident sounding response to this complex question.

Second, we also tried to elicit what we call surprise with a negative cause. We showed an easy question to both answering and listening participants, but these questions were not similar. For example, the answering participant was given the question: "Which animals live on a farm and roll in the mud?" while the listening participant saw the question: "Which animals live in an aquarium?" So to the listening participant, it would probably come as a negative surprise that his/her partner would give an incorrect answer to a relatively easy question.

For each pair of participants, we manipulated four questions to elicit surprise with a positive cause, and four questions to elicit surprise with a negative cause. This means that each participant answered two positively manipulated questions and two negatively manipulated questions, and listened to two positively manipulated answers and two negatively manipulated answers.

Procedure. Before the start of the quiz game, the pairs of participants were randomly assigned to a competitive or collaborative condition. Participants were told that they were going to play a knowledge quiz together and that they had to take turn in answering the questions that appeared on a screen. They were told to answer as many questions correctly as possible together (collaborative setting), or that they were playing against each other, and that they had to

compete to get the most correct answers (competitive setting). To emphasize this social setting, participants wore same colored T-shirts in the collaborative setting, and T-shirts with different colors in the competitive setting. Apart from the color of the T-shirts and the introduction given by the experimenter, the procedure was exactly the same for both conditions.

The participants' face and upper body were filmed by a video camera. After each answer, both participants had to indicate how certain they were about its correctness. In this way, we could see whether children indeed thought that the answers given by their opponent or team member were correct or incorrect, and check whether our manipulations worked properly. Participants had to indicate this certainty of correctness on a five-point Likert scale, by pointing out specific facial representations of the items to the camera. For example, a very unhappy face (corners of the mouth pulled down) represented a score of 1 (very uncertain about the correctness), and a very happy face (corners of the mouth pulled up) represented a score of 5 (very certain about the correctness). These facial representations of Likert scales are fairly standard for studies involving children (e.g., Lockl & Schneider, 2002) and our participants acknowledged that they are easy to use.

All pairs of participants began the experiment with a training part to ensure they were familiar with the quiz and the social setting they were in. This training phase consisted of ten questions with different levels of difficulty (five for each participant, without using any manipulations). To stimulate participants to try their best and to emphasize the social setting pairs were in (competition or collaboration), they were told that (depending on the condition) the best individual or the best team of the class would receive a prize. In addition, after participating in the experiment, all participants received a pencil and eraser as appreciation for their contribution.

Results

We first checked whether our manipulations to elicit different types of surprise had worked by computing a difference score from the certainty scores of both answer-giving and listening participants. We expected these difference scores to diverge, in such a way that with a negative manipulation, the answering participant was sure that his/her answer was correct, and the listening participant was sure the answer was incorrect. For positive manipulations, we expected the answering participant to believe that his/her answer was correct, and the listening participant not to know the correct answer, which means that the listening participants would have to be less certain about the correctness. In the baseline condition, we expected both participants' certainty scores to be approximately the same.

We used analysis of variance (ANOVA) with the surprise manipulation (baseline, positive manipulation and negative manipulation) as between-subjects factor and the difference score as dependent variable. As shown in figure 2, there is an effect of the surprise manipulation, as reflected in the differences between speaker's and listener's certainty scores, $F(2,43) = 80.101$, $p < .001$. A Bonferroni post hoc test showed that for the baseline condition ($M = 0.22$, $SD = 0.77$), the difference in speaker and listener's certainty score is significantly smaller, than with both the surprise manipulations. Moreover, the difference score for positive manipulations ($M = 1.60$, $SD = 1.12$) is in turn significantly smaller than for negative manipulations ($M = 3.07$, $SD = 1.32$).

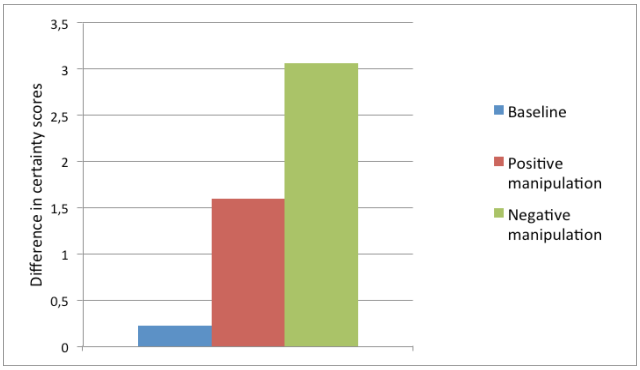

Figure 2. *Differences in certainty scores for surprise manipulations.*

Discussion

While participants played a knowledge quiz in pairs, we tried to elicit expressions of surprise by manipulating the situation in which a partner's answer would be unexpectedly correct or unexpectedly incorrect. From comparing the certainty scores for both manipulated questions and regular questions, we can presume that the manipulations generated situations that differed regarding the experienced degree of surprise. For negative manipulations, there was a large difference in certainty scores, positively caused surprise resulted in a smaller discrepancy between participants' certainty scores, and finally, certainty scores for baseline answers hardly differed from each other.

Next, we wanted to know whether the type of surprise had any effect on the facial expressions of the participants. Therefore, in the next part of this research, we investigate how children express the two differently caused emotions of surprise and whether this differs for the two age groups and social settings.

Study 2: Expression of surprise

The aim of the second study is to gain insight into children's facial expression of surprise caused by different events. We investigate the presence of Ekman's full facial display of surprise in the data collected from our game based experiment.

Method

Stimuli. We selected 96 video clips of children listening to the answer to a question by the other participant during the

quiz game, with an equal distribution of positively and negatively caused surprise manipulations and baseline condition (no manipulation), and with an equal distribution across age and social settings. This gave a 3 x 2 x 2 design (surprise x age group x social setting). We randomly selected three questions per couple for labelling purposes. For the positively caused surprise manipulation, we used all video clips with reactions to the answer to the "1933" question (in which the answering participant was given the question: "Which year follows 1933?", a question that is very easy to answer. Simultaneously, the listening participant saw the question: "In which year was the city Tilburg established?" which is a difficult question) and for the negative surprise manipulation, we used the reactions to the answers to the "pigs in an aquarium" question (in which the answering participant was given the question: "Which animals live on a farm and roll in the mud?" while the listening participant saw the question: "Which animals live in an aquarium?"). As a baseline condition, we used the reactions to a third, easy, question without manipulation. For thirteen pairs the manipulation did not work properly, according to the comparison of the feeling of correctness scores of both participants, therefore we used data from 32 out of 45 pairs.

The selected video clips contained the listening participants' reactions to the speaking participants' answers, from the moment the question appeared on the screen until the next question was shown. For the purpose of labeling, all certainty scores presented by the children on the smileys were blurred and the video clips were presented without any sound.

Figure 3. *Stills illustrating the three labeled features (left: eyebrow movement, middle: eye widening and right: mouth opening)*

Labeling and annotation. Two independent labellers, who were blind for experimental condition (age, manipulation and social setting), manually coded all selected clips of listening children. Following an explicit procedure, they labeled the presence or absence of the features that represent the full facial display of surprise. According to Ekman (1997), this full facial display of surprise consists of three features: 1) moving the eyebrows, 2) dropping jaw or opening the mouth and 3) widening the eyes. For representative examples of the labeled features, see figure 3. Before labeling, coders had a short training phase, to make sure both coders labeled the video clips in the same way. All Kappa's indicated acceptable inter coder agreement (Kappa's were .64 for brow movements, .70 for eye opening and .69 for mouth opening). Inconsistent labels were discussed until consensus was reached.

Results

We used an ANOVA for analyzing the appearance of features belonging to Ekman's (1997) full facial display of surprise in the video clips, with our surprise manipulations, age and social settings as between subject factors. Analysis of the full facial display of surprise (by counting up scores of separate features) shows an effect of the sort of surprise, $F(2,96) = 27.836$, $p < .001$. A posthoc test (Bonferroni method) reveals a significant difference in the appearance of the full facial display of surprise between all three conditions (Baseline: $M = .19$, $SD = .134$; Positive manipulation: $M = 1.00$, $SD = .134$; Negative manipulation: $M = 1.59$, $SD = .134$).

When we take a closer look at the features, they all appear to be affected by the surprise manipulation. Table 1 shows that both brow movement and mouth opening are significantly more present in manipulated conditions than in the baseline condition, while a similar trend can be observed for eye widening.

Table 1. *Percentages of appearance features in baseline condition, positive and negative manipulations.*

	Baseline	Positive	Negative	Chi^2
Brow movement	6.2%	40.6%	68.8%	$p < .001$
Eye widening	6.2%	21.8%	28.1%	$p = .069$
Mouth opening	6.2%	37.5%	62.5%	$p < .001$

We also found an effect of age on the overall appearance of the facial display of surprise, $F(1,96) = 5.255$, $p < .05$. Older children ($M = 1.10$, $SD = .109$) use more features to express their surprise than younger children ($M = .75$, $SD = .109$). We found no effect of social setting on the overall appearance of the facial display of surprise, $F(1,96) = .017$, *ns*.

Discussion

We found a significant difference in the frequency of use of the facial features between the three conditions. Participants who were surprised by a negative cause showed most facial features, compared with the other conditions. A closer look at the features reveals that mainly opening of the mouth and brow movement are used more with negatively caused surprise than with positively caused surprise. It seems that there is no difference in the features that are used in our created sorts of surprise, although there is difference in their relative frequency. We also found that older children used more features for showing surprise. An explanation for this could be that 11-year-old children show more surprise because they are more aware of the social situation (Saarni, 1979). We did not find a significant difference between the social settings. However, it is conceivable that the social

setting is important for expressing surprise, since *perception* of surprise is important for the function of self-presentation in a social setting. According to Feldman Barrett, Mesquita and Gendron (2011), facial features might carry affective information, but emotional meaning is rather contingent on context. Therefore, we decided to conduct a perception test using the same video clips as in study 2.

Study 3: Perception of surprise

The third study consisted of a rating experiment to test how video clips from study 2 are perceived in terms of different sorts of surprise as a function of social setting and age group.

Method

Participants: Thirty students from Tilburg University (16 female) participated as judges in the perception experiment (age range: 18- 48 years old, $M = 22.07$, $SD = 5.42$).

Stimuli: The same 96 video clips that were labeled for the presence or absence of surprise features in study 2 were used in the perception test as stimuli.

Procedure: All 96 video clips were shown to the participants in one of two random orders. First, the identification number of the stimulus was presented (1 through 96), followed by the actual stimulus. During an inter-stimulus interval of three seconds the screen turned black, and participants were asked to rate the child's level of surprise, on a five-point Likert scale. To ensure that participants were familiar with the perception task, the experiment was preceded by a short training phase.

Results

We conducted a 3 x 2 x 2 ANOVA with sort of surprise, age and social setting as within-subject factors and the perceived level of surprise as dependent variable.

We found a main effect of social setting on the perceived level of surprise, $F(1,29) = 72.023$, $p < .001$. Competing children ($M = 3.93$, $SD = 0.48$) were rated as more surprised than collaborating children ($M = 3.48$, $SD = 0.51$). Age did not have an effect on the perceived surprise level, $F(1,29) = 3,494$, *ns*.

We also found an effect of sort of surprise on the perceived level of surprise, $F(2,28) = 132.9$, $p < .001$. A Bonferroni post hoc test showed that children in the baseline condition ($M = 3.01$, $SD = 0.54$) were perceived to be less surprised than the children in both surprise manipulation conditions. Children with a negatively caused surprise ($M = 4.54$, $SD = 0.64$) were perceived to be more surprised than children with a positively caused surprise ($M = 3.57$, $SD = 0.64$).

We found two interaction effects involving sort of surprise. First, there is an interaction between age and sort of surprise, $F(2,28) = 43.476$, $p < .001$. After running split analyses, were we looked at the perception of surprise for both age groups separately, we did not find a significant difference in perceived surprise for the 8-year-old children between the baseline condition and the positive manipulation, but only a difference between these two conditions and the negative manipulation. For the perceived surprise of 11-year-old children there was a significant difference between all three conditions, see figure 4.

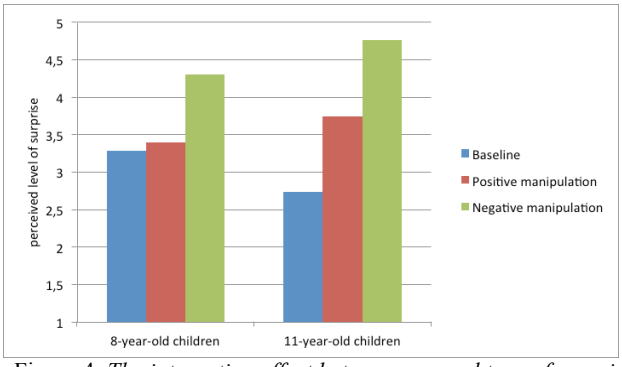

Figure 4. *The interaction effect between age and type of surprise, on perceived level of surprise.*

Second, we found an interaction effect between social setting and type of surprise on the perceived level of surprise, $F(2,28) = 26.190$, $p < .001$. Post hoc analyses (Bonferroni method) reveal that in collaboration, there is a larger difference between the perception of positive and negative surprise than in competition. In the competitive setting, children are, overall, perceived to be more surprised than in the collaborative setting, see figure 5.

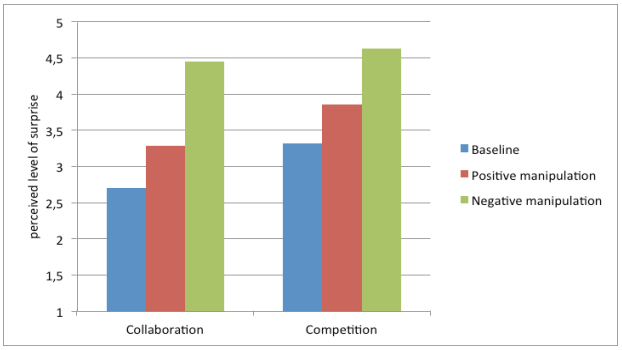

Figure 5. *The interaction effect between social setting and type of surprise, on perceived level of surprise.*

Discussion

The perception test showed that surprise was perceived differently between the three types of surprise. We found that positive surprise was perceived as less prominent than negative surprise. Furthermore, we found that 11-year-old children's expressions of surprise were perceived to be more distinct among the different conditions. This could mean that children express their surprise more accurately as they grow older. We also found that competing children are perceived to show more surprise than collaborating children, at least for the baseline condition and positive caused surprise.

General discussion and conclusion

Earlier research has had difficulties in extracting a full facial display of surprise with participants (Reisenzein et al., 2006). The aim of the studies presented in the current paper was to examine two possible reasons for this; firstly the false assumption that there is only one kind of surprise and secondly the lack of taking contextual factors into account.

First, we assumed that surprise could be expressed differently, depending on its cause. We manipulated various questions in the knowledge quiz to extract reactions of surprise, either with a positive or negative cause. Analyzing the difference scores of participants' certainty judgments showed that the manipulations worked as intended (study 1). After annotating the facial features (study 2) and conducting a perception test (study 3), we can conclude that we found significant differences in expressing and perceiving surprise. Participants who were surprised by a negative cause showed most features of the full facial display of surprise, compared to the other conditions. Although we did find that manipulation affected the frequency in use of features, the different kinds of surprise were not related to certain specific features. It seems that the cause of the emotion leads to different *degrees* in surprise expressions, instead of a *different* surprise expression. Possibly, negative events cause more surprise than positive events. We must note, however, that the created social settings may have interfered with the concept of positive or negative surprise. For example, in competition, an incorrect answer on an easy question probably does not evoke an absolutely *negative* feeling of surprise with the opponent, as an error of the opponent is actually good for the other player. However, we still think that although the naming of the two kinds of surprise (positive versus negative) might be somewhat inaccurate, their difference in cause remains. In our research, we elicited feelings of surprise with two distinctive causes, and results show us that the cause of the surprise affects the expression of the emotion. However, future research should consider these causes in respect of the social settings participants are in.

Second, we wanted to study if the expression of surprise could depend on this social setting. Therefore, our participants played the knowledge quiz in either a collaborative setting, or a competitive setting. From study 3 we can conclude that children in competition were perceived to be more surprised than collaborating children. This may be due to the fact that children in competition are more aware of their social environment, because self-presentation is more important in this setting. Expressing surprise could be beneficial for the players' progression in the game. We can conclude that the social setting appears to be important for the expression of surprise.

Since 11-year-old children appear to adjust to social situations far more than 8-year-old children (Saarni, 1979), we also expected to find age to affect expressions of surprise. This was confirmed by our data analyses: 11-year-old children were more expressive and were perceived as more surprised than 8-year-old children. It seems that older children can make a more accurate distinction between expressions of surprise with different causes than younger children.

We can conclude that the expression of surprise is affected by several factors, like age, social setting and the cause of the surprise. Therefore, we think future studies should consider these factors when studying surprise. Our data suggest that the expression of surprise is more than a mere reflex to an unexpected stimulus, and that it can be moderated by contextual factors.

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