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BRIEF REPORT

Emotional expression and vocabulary learning in adults and children

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A great deal of what we know about the world has not been learned via first-hand observation but thanks to others' testimony. A crucial issue is to know which kind of cues people use to evaluate information provided by others. In this context, recent studies in adults and children underline that informants' facial expressions could play an essential role. To test the importance of the other's emotions in vocabulary learning, we used two avatars expressing happiness, anger or neutral emotions when proposing different verbal labels for an unknown object. Experiment 1 revealed that adult participants were significantly more likely than chance to choose the label suggested by the avatar displaying a happy face over the label suggested by the avatar displaying an angry face. Experiment 2 extended these results by showing that both adults and children as young as 3 years old showed this effect. These data suggest that decision making concerning newly acquired information depends on informant's expressions of emotions, a finding that is consistent with the idea that behavioural intents have facial signatures that can be used to detect another's intention to co-operate.

Keywords: Vocabulary learning; Happiness; Anger; Emotional development; Testimony.

Given the role played by emotions in daily interactions and communication, one can expect that individuals recruit emotional cues in learning situations, in particular when they have to learn new words. To test if emotional cues are recruited by the subjects in learning situations, we adapted the "conflicting sources" paradigm developed to evaluate the use of true and false statements, generally for children (Koenig, Clément, & Harris, 2004). This paradigm has been used in different studies to test how a source's reliability is evaluated by presenting participants with two conflicting testimonies (for example two different labels for the same unknown object). This has been studied notably for new word acquisition (Birch, Vauthier, & Bloom, 2008; Kim, Kalish, & Harris, 2012; Koenig & Harris, 2005; Koenig & Woodward, 2010; Scofield & Behrend, 2008). However, to the best of our knowledge, the role

that emotions play in this process has never been investigated, either in children or adults.

More generally, many studies have highlighted the importance of facial and vocal expression perception for social cognition. For instance, in daily interactions, adults automatically scrutinise others' faces, trying to get relevant information about how they appraise the current situation (Scherer & Grandjean, 2008), how they feel (Scherer & Grandjean, 2008), what they pay attention to (see Sander, Grandjean, Kaiser, Wehrle, & Scherer, 2007), and what they are about to do (Frijda, Kuipers, & Ter Schure, 1989). These signal exchanges lead to the formation of impressions about others (Macrae & Bodenhausen, 2000) and to biased neural representations of identities even when faces are presented without any expression (Vrtička, Andersson, Sander, & Vuilleumier, 2009). In the highly social environment of the human species, one of the main functions of this "face reading" is to rapidly evaluate how willing our conspecifics are to collaborate (Ekman, Frisen, & O'Sullivan, 1988; Fiske, Cuddy, & Glick, 2007; Reed, Zeglen, & Schmidt, 2012).

Given the importance of learning for human species (Bruner, 1990; Tomasello, 1999), it would be surprising if individuals did not take into account facial emotions in order to increase their knowledge about their environment. Indeed, it has been shown that even infants use social information to evaluate uncertain situations (Baldwin & Moses, 1996; Kim & Kwak, 2011; Moses, Baldwin, Rosicky, & Tidball, 2001). In the famous "visual cliff" experiment, 12-month-old infants approaching the edge of a Plexiglas surface providing invisible support over an apparent drop turn their attention toward their mother. When she expressed fear, none of the 17 infants crossed the "cliff". On the contrary, when their mother displayed a happy face, 14 of the 19 infants crossed over the drop (Sorce, Emde, Campos, & Klinnert, 1985). Other studies investigating this "social referencing" effect demonstrated that positive information (vocal or facial for instance) facilitated approach behaviour when directed specifically at an ambiguous object such

as a novel toy, for example, while specific negative information promoted avoidance of the target object (Klinnert, 1984; Stenberg & Hagekull, 1997; Vaillant-Molina & Bahrick, 2012).

All these studies targeted processes where participants use information from another person to evaluate stimuli. By the same token, the question may be asked whether subjects use facial cues when they have the opportunity to acquire specific knowledge from other people, notably in the case of word learning. When people are learning vocabulary, they have to grasp the relationship between linguistic utterances and entities in the world (Koenig & Echols, 2003). These relationships, being conventional, rely entirely on testimony. Different cues can be used to identify the "what goes together" between words and objects in the world (Baldwin & Moses, 2001). For instance, the speaker's line of sight and body posture help the learner to determine that a novel label refers to a given object (Baldwin, 1993; Tomasello, 2003). Given the importance of facial expression for human communication, it could be expected that learners are sensitive to displayed emotions when they evaluate different potential sources of information.

As happiness and anger are emotions capable of informing individuals about the intention of a social partner to co-operate, they are likely to play an important role in this "filtering" process of information gathering. Verbal communication depends, indeed, on a form of co-operation: a speaker is transmitting potentially useful information to a recipient (Sperber et al., 2010). If action tendencies are an essential part of emotions (Frijda, 1989), observers can be expected to use expressions of emotion to anticipate the behaviour of potential collaborators or competitors. Behavioural intentions have facial signatures that can be used to detect another's intention. The expression of happiness, in particular, can be seen as an advertisement of a co-operative disposition (Keltner & Haidt, 1999; Mehu, Grammer, & Dunbar, 2007). In contrast, anger seems to signal negative behavioural intentions (Adams, Ambady, Macrae, & Kleck, 2006; Kuppens & Van Mechelen, 2007).

For instance, it has been shown that an interaction partner's expressions of anger, compared to expressions of happiness, led observers to construe hypothetical situations as less co-operative (Van Doorn, Heerdink, & Van Kleef, 2012).

To study the impact of happiness and anger on word learning, we designed an experiment inspired by the "conflicting sources" paradigm. In Experiment 1, this decision-making paradigm enabled us to test the hypothesis that adults learn more from an individual displaying a happy facial expression than from someone else displaying an angry facial expression. Adult participants were presented with pictures of two informants, each of whom was either neutral or displayed an emotion (happiness or anger) while giving a specific label for an unknown object. Adult participants were then invited to say which label they felt corresponded to the object. The rationale was that the decision made by the participant would reflect an implicit evaluation of the informant as a function of his/her facial expression. To avoid preferences based on any other facial properties, we created these stimuli using the Facial Action Coding System (FACS)-Gen software (see Cristinzio, N'Diaye, Seeck, Vuilleumier, & Sander, 2010; N'Diaye, Sander, & Vuilleumier, 2009), an extension of FaceGen software (FaceGen Modeller **AQ1** 2.0). FaceGen software has been used in several previous studies in which the neural substrates of face processing were investigated (e.g., Oosterhof & Todorov, 2008). The FACSGen extension (Roesch et al., 2011) exploits the 3D face rendering processor of FaceGen, but is designed to manipulate the expressions of faces with strict control of the time course of animation on the basis of the FACS developed by Paul Ekman and colleagues to describe facial motor behaviour (Ekman, 1978).

In Experiment 2, this decision-making paradigm also enabled us to test whether such an effect appears early in development. Some studies seem to indicate that children use social information in order to learn new words (Baldwin & Moses, 2001) but, to the best of our knowledge, there is currently no data about the role of specific facial emotions on word learning in children. To

test this role, we proposed similar decision-making task for both adults and young children. Participants were as young as 3 years old, an age when it has been demonstrated that children are able to take part in this kind of task (Koenig et al., 2004), and as old as 5 years old to see if there were any developmental differences.

EXPERIMENT 1

Method

Participants

Forty-one undergraduate students at the University of Geneva (29 women, $M_{age} = 24.2$ years, $SD = 5.66$, age range 19–45 years) were recruited.

Materials

Conflicting sources task. A first picture displayed two men (avatars) with neutral expressions, which were presented with their respective names, Arthur and Remy. For each of the next six trials, these two men labelled (using a French pseudo word such as *blidu*) an unknown object that both of them were gazing at in the middle of the screen. The six trials corresponded to two trials per condition, with the three following conditions: "happiness/anger" pairs, "anger/neutral" pairs, and "happiness/neutral" pairs. The avatars and the facial expressions were created using the FACSGen software. Both Neutral faces and facial expressions of happiness and anger were similar to those validated and used in previous experiments (Cristinzio et al., 2010; Mumenthaler & Sander, 2012; N'Diaye et al., 2009; Roesch, Sander, Mumenthaler, Kerzel, & Scherer, 2010). More specifically, following our experience from this previous work, the facial expression of happiness was created by using the generic happiness expression as provided by the FaceGen software (FaceGen Modeller 2.0) with a with a semi-closed **AQ1** mouth and with the muscle activity corresponding to a typical phoneme "ah" at an intensity of 50% and the action unit (AU) 26 (Jaw Drop) at an intensity of 50%. The resulting expression was close to an authentic (Duchenne-like) smile.

Again, following our experience from previous work, the facial expression of anger was created by using the following FACS-based action units pattern: AU4 (Brow Lowerer) at 80% of intensity, AU6 (Cheek Raiser) at 28% of intensity, AU9 (Nose Wrinkler) at 50% of intensity, and AU19 (Tongue Show) at 20% of intensity. Although AU9 and AU19 are not typically used to represent expressions of anger, previous research suggest that AU9 can be a sign of anger (see Scherer & Ellgring, 2007), and we used AU19 at a very low intensity in order to have a semi-open mouth with the tongue visible similar to the happiness expression. The facial qualities used in constructing the avatars were similar across both faces in order to avoid non-emotional effects, but with still sufficient distinctiveness so that the identities were perceived as different. In addition, the facial identities were counterbalanced so that they appeared with all the facial expressions and in all the conditions, therefore controlling for the possibility that the effect might be purely driven by facial quality or by an interaction between identities and expressions rather than the expression itself. The labels were written in two bubbles, one linked to Arthur and the other to Remy (see Figure 1).

Procedure

The experimenter distributed an anonymous response paper with the two different object labels for each trial. For each trial, participants were asked to choose one label from the two options. Stimuli were presented on a projector screen and the experimenter said, for instance: "What would you call this object? A *blidu*, like Remy says or a *neota*, like Arthur says?" (forced choice). Emotions, objects' labels and sides of presentation (left–right) were counterbalanced across faces.

Scoring

For each condition, we therefore obtained an average proportion of chosen labels as a function of the expressions. For instance, a proportion of 0.50 for Anger in the "Anger–Neutral" condition would mean that the participant had chosen the label provided by the angry face in one trial of this condition but the one provided by the neutral face
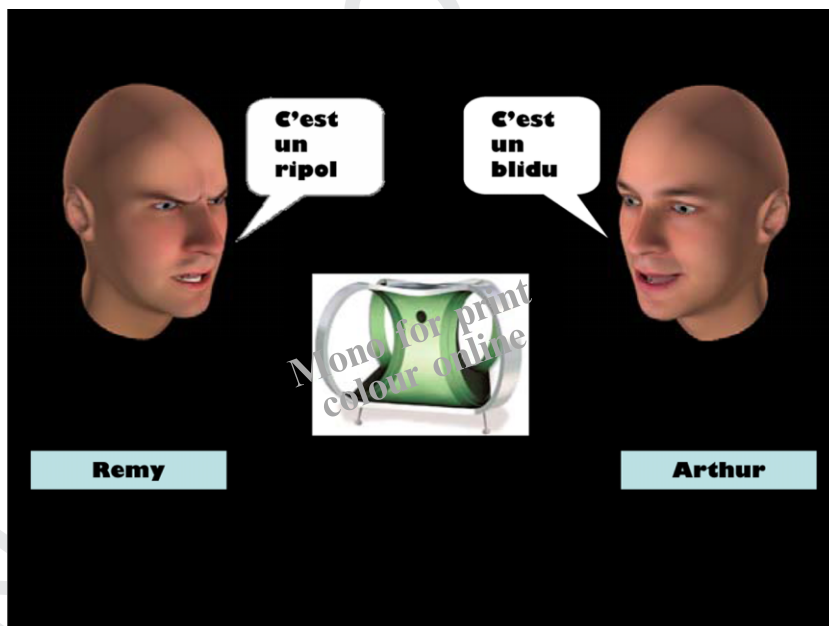

Figure 1. *Example of anger/happiness pair.*

in the other trial. We then averaged these proportions across participants.

Analysis

The data analysis strategy consisted in using the average proportion of choices for each expression in each condition and then testing these proportions against chance level (0.50) with a one sample t-test.

Results

Analyses showed that participants' choice for the name suggested by the avatar displaying a happy face over the name suggested by the angry face was significantly above chance (happiness/anger pair: $M = 0.61$, $t = 2.04$, $df = 40$, $p = .048$; see Figure 2). However, choices were not significantly different from chance level when an emotional expression was contrasted to a neutral expression (choice of name suggested by the angry face in the angry/neutral pair: $M = 0.57$, $t = 1.43$, $df = 40$, $p = .16$; choice of the name suggested by the happy faces in the happiness/neutral pair: $M = 0.51$, $t = 0.21$, $df = 40$, $p = .83$).

EXPERIMENT 2

The first aim of the second experiment was to replicate these findings in another adult popula-tion. The second aim was to test whether such an effect would be observed in children as young as 3 years old.

Method

Participants

This experiment involved 99 children: 35 3-year-olds (14 girls, $M_{age} = 43.94$ months, $SD = 2.95$, age range 38–47 months), 33 4-year-olds (15 girls, $M_{age} = 54.45$ months, $SD = 3.23$, age range 49–59 months), and 31 5-year-olds (18 girls, $M_{age} = 64.90$ months, $SD = 3.71$, age range 60–71 months) from three schools in Lyon (France). Most children came from middle- and upper-middle-class families. Thirty-seven univer-sity-aged adults were also tested (28 women, $M_{age} = 23.5$ years, $SD = 3.72$, age range 19–33 years).

Materials

Conflicting sources task. Children were presented with an adapted version of the conflicting sources task described in Experiment 1. First, the experi-menter presented the two neutral faces and said: "Here are two men, Remy and Arthur. This is Remy [pointing] and this is Arthur [pointing]". Next, for each trial, the experimenter said: "This is a very strange object [pointing]. We are going to hear what Remy and Arthur call this object".
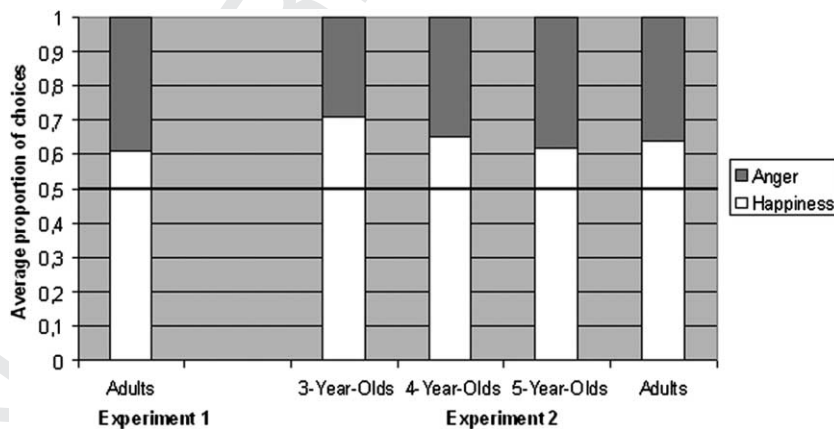

Figure 2. *Average proportion of choices for happiness and anger in anger/happiness pairs in Experiments 1 and 2 (the chance line is at 0.50).*

A bubble appeared (without voice recording) and, for instance, the experimenter continued: "Remy says it's a blidu" and when the second bubble appeared: "Arthur says it's a neota". The experimenter then asked the child to choose between the two options: "What would you call this object? A *blidu*, like Remy says or a *neota*, like Arthur says?" (forced choice). The order of objects' labels, bubbles' activations, pseudo words used as labels, face positions (right vs. left), and emotions displayed by each face were counterbalanced across participants.

For adults, we used the same conflicting sources task described in Experiment 1.

Free labelling task. This task was adapted from Widen and Russell (2003) and used to control the emotion perception, i.e., to determine that happy and angry faces were recognised per se. Children were randomly presented with nine plastic cards, each displaying happiness, anger, or fear facial expressions with three levels of intensity (100%, 75%, and 50%). Happiness and Anger facial expressions at 100% corresponded with happiness and anger facial expressions used in the conflicting sources task. Data on the intensities were collected for another study. The experimenter introduced the faces by saying: "I brought some pictures of a man named Paul. Here is a picture of Paul [showing the neutral expression]. Now Paul is going to show us how he feels sometimes. Let's see if you can tell me how Paul feels in each case". For the first face, the experimenter said: "One day, Paul felt like this [pointing to the face]". For the other faces, the experimenter said, "One week later, Paul felt like this [pointing to the picture]".

After each picture, the experimenter asked, "How do you think Paul feels in this picture?"

For adults, the experimenter said: "I will show you some pictures. Tell me how the character feels in each picture".

Only children and adults who labelled the happy and angry faces at 100% intensity correctly have been included in the following analyses. Six 3-year-olds, three 4-year-olds, and two 5-year-olds failed in the control free labelling task either because they did not answer (five 3-year-olds and two 4-year-olds) or because they did not correctly recognise the expression of anger according to the criteria developed by Widen and Russell (2003; one 3-year-old, one 4-year-old, and two 5-year-olds). All the children correctly categorised happy faces. Therefore, 88 children were included in the analysis of the main experiment: 29 3-year-olds (10 girls, $M_{age} = 44.58$ months, $SD = 2.62$, age range 39–47 months), 30 4-year-olds (13 girls, $M_{age} = 54.43$ months, $SD = 3.29$, age range 49–59 months), and 29 5-year-olds (18 girls, $M_{age} = 64.48$ months, $SD = 3.44$, age range 60–71 months).

Procedure

Each child was seen individually in a quiet room of the school for about 15 minutes. Children were first presented with the conflicting sources task and after with the free labelling task. Adults were presented with these two tasks in the same order, but in a laboratory setting.

Data analysis strategy was identical than one used in the Experiment 1.

Table 1. *Average proportion of choices, t-tests and p-values for Experiments 1 and 2 as a function of age groups for Happiness in the happiness/anger pairs (H–A), Anger in the anger/neutral pairs (A–N), and Happiness in the happiness/neutral pairs (H–N)*

		Happiness (H–A)	Anger (A–N)	Happiness (H–N)
Experiment 1	Adults	$M = 0.61$ ($t = 2.04$*)	$M = 0.57$ ($t = 1.43$, $p = .16$)	$M = 0.51$ ($t = 0.21$, $p = .83$)
Experiment 2	3-year-olds	$M = 0.71$ ($t = 3.27$**)	$M = 0.40$ ($t = -1.43$, $p = .16$)	$M = 0.45$ ($t = -0.68$, $p = .50$)
	4-year-olds	$M = 0.65$ ($t = 2.07$*)	$M = 0.47$ ($t = -0.44$, $p = .66$)	$M = 0.42$ ($t = -1.31$, $p = .20$)
	5-year-olds	$M = 0.62$ ($t = 2.05$*)	$M = 0.43$ ($t = -1.28$, $p = .21$)	$M = 0.50$ ($t = 0$, $p = 1$)
	Adults	$M = 0.64$ ($t = 2.52$*)	$M = 0.56$ ($t = 1.15$, $p = .26$)	$M = 0.51$ ($t = 0.21$, $p = .83$)
	All groups	$M = 0.66$ ($t = 4.95$***)	$M = 0.47$ ($t = -0.85$, $p = .40$)	$M = 0.47$ ($t = -0.84$, $p = .40$)

Note: *$p < .05$; **$p < .01$; ***$p < .001$.

Results

With respect to our main research question, analyses again showed, as in Experiment 1, that participants' choice for the name suggested by the avatar displaying a happy face over the name suggested by the angry face was made significantly above chance when considering all participants, including children, together (happiness/anger pair: $M = 0.65$, $t = 4.95$, $df = 124$, $p < .0001$). This effect was indeed found to be significant for each group (3-year-olds: $M = 0.71$, $t = 3.27$, $df = 28$, $p = .0029$; 4-year-olds: $M = 0.65$, $t = 2.07$, $df = 29$, $p = .048$; 5-year-olds: $M = 0.62$, $t = 2.05$, $df = 25$, $p = .05$; adults: $M = 0.64$, $t = 2.52$, $df = 36$, $p = .016$; see Figure 2). However, when considering the two other pairs, that is, when an emotional expression was contrasted to a neutral expression, no significant effect was observed, either when considering all participants together or when considering any of the age groups (all results and tests are displayed in Table 1).

GENERAL DISCUSSION

The objective of this paper was to assess the role played by facial expression in a decision-making task concerning word learning. Our hypothesis was that emotions could lead individuals to build expectancies about the level of informants' co-operativeness. Our results confirm our hypothesis: participants selected preferentially the label for an unknown object proposed by an avatar displaying a happy face over another one displaying anger. Moreover, this preference was not only displayed by adults (Experiments 1 and 2) but also by 5-year-olds, 4-year-olds and even 3-year-olds (Experiment 2). Such precocity seems to indicate that facial expressions are spontaneously recruited by individuals to evaluate others' testimony. When participants do not possess any other information about the competence and benevolence of two informants, they use facial emotional expressions as a guide to decide who gave the appropriate label and they choose the character displaying happiness over the one displaying anger. However, happy expressions significantly influenced the choice only when they were contrasted with an avatar displaying an angry face. The preference was not significant when an expressive face (angry or happy) was opposed to a neutral face. The remaining question is therefore to understand why positive results have been obtained only when participants were confronted with contrasting expressed emotions.

First, it is important to highlight the fact that the experimental task was not to identify emotions but to guess which label corresponded to an unknown object: emotions were not the central target of the participants' attention. The main issue is the status of the "neutral" face because it is very difficult to understand how subjects interpret a neutral expression when it is contrasted with another face expressing either anger or happiness. Very few studies have investigated this topic and their results were mixed. Russell and Fehr (1987) have shown that a neutral face, when presented after a happy face, was judged as sad (35 of 60 participants) but also as happy (3), surprised (4), afraid (5), angry (4) and disgusted (9). In Tanaka-Matsumi, Attivissimo, Nelson and D'Urso (1995), participants were asked to judge a neutral face presented to them after another face expressing an emotion. Their task was to evaluate how much this neutral face looked happy, sad, angry, afraid, disgusted, and interested on 5-point scales ranging from 1 (Not at all) to 5 (Very strongly). After a happy face, the mean rating for happy was at 1.54, 2.13 for sad, 2.04 for angry, 1.63 for afraid, 2.17 for disgusted and 2.04 for interested. After an angry face, the neutral face was judged at 2.27 for happy, 1.80 for sad, 1.35 for angry, 1.20 for afraid, 1.51 for disgusted and 2.27 for interested.

In other words, not only were "neutral" expressions interpreted as conveying an emotion but the nature of this emotion was equivocal. Considering Tversky's (1972) elimination-by-aspects model of choice, participants in our studies would concentrate on the most relevant aspect supporting their choice—maybe an action tendency from which co-operation could be inferred—and eliminate options that do not include this aspect. In trials containing a neutral expression, given the presence of another face

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expressing either anger or happiness, one could speculate that it was difficult for the participants to infer willingness to co-operate from this neutral face, which makes the elimination-based choice difficult. In a pair opposing a happy face to an angry face, the choice is easier as elimination-by-aspect is facilitated: the aspect "willingness to collaborate" is more likely to be absent from someone expressing anger than from someone expressing happiness, therefore allowing the elimination of the "anger" option. Further research is needed to directly test: (1) the hypothesis that such effects are more likely to be found when two emotional expressions are contrasted than when only one emotional expression is contrasted to a neutral face; and (2) to what extent the intensity of the emotional expressions might play a role in the weight of each emotional expression in the decision process. Future studies could therefore systematically manipulate the nature and the intensity of the two expressions, and have participants explicitly rate the expressed emotions.

To conclude, it is interesting to compare our results with recent works on trustworthiness. On one hand, Todorov and his colleagues have discovered that the cues to trustworthiness could lie in some facial characteristics that highlight similarities with emotional expressions; indeed, Oosterhof and Todorov (2008) showed that the more similar faces were to happy faces, the more trustworthy they were judged. Inversely, the closer they were to an angry expression, the less trustworthy they appeared (Oosterhof & Todorov, 2008). On the other hand, the burgeoning field of research on testimony in developmental psychology (Clément, 2010; Clément, Koenig, & Harris, 2004; Fusaro & Harris, 2008; Harris, 2007, 2012; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007; Sabbagh & Baldwin, 2001) highlighted the fact that children selectively learn from others. In particular, they choose labels for new objects from sources that have been reliable in the past. The present study therefore brings together two important lines of research and shows that, in line with Todorov's hypothesis, even 3-year-old children decided to follow the suggestion of an informant displaying a

happy face over an angry one, as if the former were probably judged as more trustworthy. The ability to detect emotional expressions seems therefore fundamental to the way we socially acquire information.

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