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FlashReport

The two sides of spontaneity: Movement onset asymmetries in facial expressions influence social judgments☆

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HIGHLIGHTS

- Videos displayed onset asymmetries (OASs) in avatars' emotional facial expressions.
- We also varied OAS timing for the left hemi-face (LHF) and right hemi-face (RHF).
- Perceivers more quickly and accurately detected OASs in targets' LHF expressions.
- Perceivers judged expressions with earlier LHF onsets as more spontaneous.
- LHF anger was more accurately detected at 20 ms OAS (with no bias for happiness).

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ABSTRACT

When forming basic social impressions, it is important to quickly and accurately classify facial expressions (including their spontaneity). Early studies on emotion perception, employing static pictures in the chimeric-face paradigm, demonstrated that expressions shown on the left hemi-face (LHF) were rated as more intense, compared to the right hemi-face (RHF). Interestingly, recent studies on emotion production, using high-speed video recordings, discovered an onset asymmetry (OAS) such that spontaneous expressions start earlier in the LHF, while posed expressions start in the RHF. Here, using highly controlled and dynamically developing video stimuli of avatar faces, we tested whether OASs in perceived faces influence the efficiency with which an expression is classified, as well as judgments of expression intensity, spontaneity, and trustworthiness. Videos of avatars making happy and angry expressions, with OASs of either 20 or 400 ms, were judged on several social dimensions by 68 participants. The results highlight the importance of the LHF for emotion classifications and social judgments: Expressions with earlier LHF onsets were not only judged to be more spontaneous but were also detected more quickly and accurately (a difference that was most evident for angry expressions with a briefly presented OAS, but not for happy expressions). Generally, these findings underscore how adaptive social perception relies on subtle cues in the dynamics of emotional facial expressions.

Introduction

Emotional facial expressions are informative syntheses of individuals' feelings, motivations, and intentions, thus making the efficient decoding of those displays an important social skill (Ekman & Friesen, 1974; Wagner, MacDonald, & Manstead, 1986). One component of decoding accuracy is the ability to distinguish between spontaneous (i.e., genuinely felt) and posed (i.e., intentionally evoked) expressions. Such differentiation is required for smooth social interactions, given that mistaking a posed expression for a spontaneous one (or vice versa) can have serious interpersonal consequences. Accordingly, much research in social psychology and neuroscience focuses on this essential ability (Bernstein, Young, Brown, Sacco, & Claypool, 2008; Maringer, Krumhuber, Fischer, & Niedenthal, 2011; McLellan, Johnston, Dalrymple-Alford & Porter, 2010; Zuckerman, Hall, DeFrank, & Rosenthal, 1976). The present research tested the idea that spontaneity cues lie in left–right asymmetries in the onset of facial expressions.

Considerable evidence suggests that emotional facial expressions are *produced* and *perceived* asymmetrically (Borod et al., 1998). For

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example, research using the chimeric-face paradigm found that individuals rate left–left composite pictures of facial expressions as more intense than right–right composites (Lindell, 2013; Nicholls, Wolfgang, Clode, & Lindell, 2002; Sackeim, Gur, & Saucy, 1978). Such findings support the *right hemisphere hypothesis* for the encoding and decoding of emotional stimuli (Dimberg & Petterson, 2000; Sackeim et al., 1982; Schwartz, Davidson, & Maer, 1975), and on this hypothesis, greater facial expressivity occurs over the left hemi-face (LHF), compared to the right hemi-face (RHF) (Korb & Sander, 2009; Rinn, 1984). Phylogenetic roots of such production and perception asymmetries are suggested by similar results in non-human primates (Fernández-Carriba, Loeches, Morcillo, & Hopkins, 2002; Wallez & Vauclair, 2013).

Newer findings suggest that the *onset* of facial expressions is also lateralized and that the side of this onset asymmetry (OAS) depends on whether the expression is spontaneous or posed. Using high-speed videography to film participants during the production of different facial expressions, Ross and Pulusu (2013) found that spontaneous expressions begin predominantly in the LHF (approximately 20 ms earlier), while posed expressions begin in the RHF (approximately 10 ms earlier)—a pattern that was most robust for upper-face expressions, such as anger. The current research tested the hypothesis that short OASs in the *production* of facial expressions (approximately 10–20 ms) are relied upon in the *perception* of the volitional nature of those expressions. More specifically, we tested the prediction that OAS differences in the production of spontaneous and posed expressions are recruited in judging the spontaneity of perceived expressions, as well.

Crucially though, investigating these subtle markers (such as OAS) is important, especially given that both the production and perception of facial expressions are associated with numerous differences in processing and behavior: As examples, "true" and "fake" smiles differ in both dynamical and morphological features (e.g., Ambadar, Cohn, & Reed, 2009; Hess & Kleck, 1994), specific brain states are associated with both their production and perception (Ekman, Davidson, & Friesen, 1990; McLellan, Wilcke, Johnston, Watts, & Miles, 2012), and our ability to distinguish between these expressions seems to be relatively automatic (McLellan, Johnston, Dalrymple-Alford, & Porter, 2010; Miles & Johnston, 2007). In turn, perceivers may quickly and efficiently use OASs in facial expressions to infer the spontaneity of the displayer, which could then have downstream consequences on the resultant social interaction.

With this framework, we created highly controlled, precisely timed, and dynamically developing avatar video stimuli to test the effects of two OAS durations on participants' perceptions of happy and angry expressions. We were interested in evaluating these effects in conjunction with three major social dimensions: First, the primary judgment of interest was *spontaneity*: As with production (Ross & Pulusu, 2013), we expected that the perception of emotional expressions with earlier LHF onsets would result in higher spontaneity ratings. Second, we also measured perceived *intensity* (or the perceived level of expression activation in the stimulus) to examine whether OAS cues amplify the subjective "strength" of an emotional expression, and to assess whether or not expression OASs and intensities have dissociable effects. Since we objectively controlled for expression intensity across hemi-fields in our high-resolution video stimuli (thereby only manipulating frame rates to vary dynamic asymmetries), it was critical to evaluate whether or not participants subjectively viewed the expressions as more or less intense, depending on OAS—an important consideration, given recent findings using the chimeric-face paradigm, which necessarily varies intensity across hemi-fields (e.g., Indersmitten & Gur, 2003). Finally, we also gathered *trustworthiness* ratings to gauge the impact of OAS cues on higher-level dispositional judgments of character, which have been reported with modern chimeric-face studies (e.g., Okubo, Ishikawa, & Kobayashi, 2013).

Given that the Ross and Pulusu (2013) findings show the most substantial production effects for upper-face emotional expressions (i.e., anger), we expected that the perception of anger would also be most influenced by the lateralization of OASs. Even though this Ross and Pulusu (2013) production effect might be considered surprising in light of the fact that the upper-face is more bilaterally innervated (i.e., by supplementary motor area [SMA] and the rostral cingulate motor cortex; Korb & Sander, 2009; Morecraft, Louie, Herrick, & Stilwell-Morecraft, 2001) than the lower face, other work has highlighted the importance of the upper-face in overall expression production (Ross, Prodan, & Monnot, 2007; Ross, Reddy, Nair, Mikawa, & Prodan, 2007) and in conveying more "true" or genuine emotion (Ross, Shayya, Champlain, Monnot, & Prodan, 2013). As such, any OAS effects on emotion perception should depend on whether the expression starts in the upper-face (i.e., anger) versus lower-face (i.e., happiness), since these regions differ in both neuroanatomical organization and behavioral function (Matsumoto & Lee, 1993; Ross, Prodan, & Monnot, 2007). These demonstrations of production differences for anger suggest that perceivers should pay special attention to the upper-face (along with any OASs) when making spontaneity judgments of target expressions.

Moreover, we also expected these anger effects to be dependent on the timing of the OAS, whereby more differences would emerge for anger expressions with a shorter OAS. This prediction follows directly from the original production finding in Ross and Pulusu (2013), in which OASs usually ranged from only 10 to 20 ms. Further, recent findings highlight that anger expressions capture and guide attention, especially when presented at shorter durations (Blagrove & Watson, 2010, 2014). Such findings are consistent with the notion of more efficient processing of anger expressions, thus corroborating modern demonstrations of the *anger superiority effect* (or ASE; Calvo, Avero, & Lundqvist, 2006; Dickins & Lipp, 2014; Öhman, Lundqvist, & Esteves, 2001; Schubö, Gendolla, Meinecke, & Abele, 2006), which emerges early in development (LoBue, 2009) and occurs robustly when using actual photos, multiple identities, and realistic dynamically developing expressions, such as those used in the current work (Ceccarini & Caudek, 2013; Horstmann & Bauland, 2006; Pinkham, Griffin, Baron, Sasson, & Gur, 2010).

In sum, we expected greater spontaneity ratings and more efficient OAS detection for emotional expressions with earlier LHF onsets, and we predicted that these effects would be amplified for anger (especially when presented for shorter OAS durations).

Methods

Participants

Sixty-eight undergraduate students at the University of California, San Diego ($M_{age} = 21.10$ years, $SD_{age} = 2.25$ years; six males) participated for course credit.[1]

Stimuli

Four fully symmetrical images of avatar faces (two male and two female) were constructed using FaceGen Modeller 3.5 (Singular Inversions, Inc.). We created 32 different dynamic stimuli by crossing the factors Avatar (4), Emotion (2: happy, angry), OAS_Side (2: right, left), and OAS_Time (2: 20 ms, 400 ms), using FacsGen software (Roesch et al., 2011), based on the Facial Action Coding System (FACS; Ekman & Friesen, 1978). The avatars' facial dynamics were manipulated by modifying composites of the alternate hemi-face at different frames (each containing 150 frames, totaling three seconds of video at 50 fps), according to whether the expression exhibited an OAS of 20 ms or 400 ms (see Supplementary Materials). All videos started with a neutral expression, which then converted into expressions of happiness (AU12 = 100%, AU6 = 70%) or anger (AU4 = 100%, AU5/AU7 = 50%).

[1] All statistics presented in the Results section remain significant when excluding the 6 male participants to get an all-female sample.

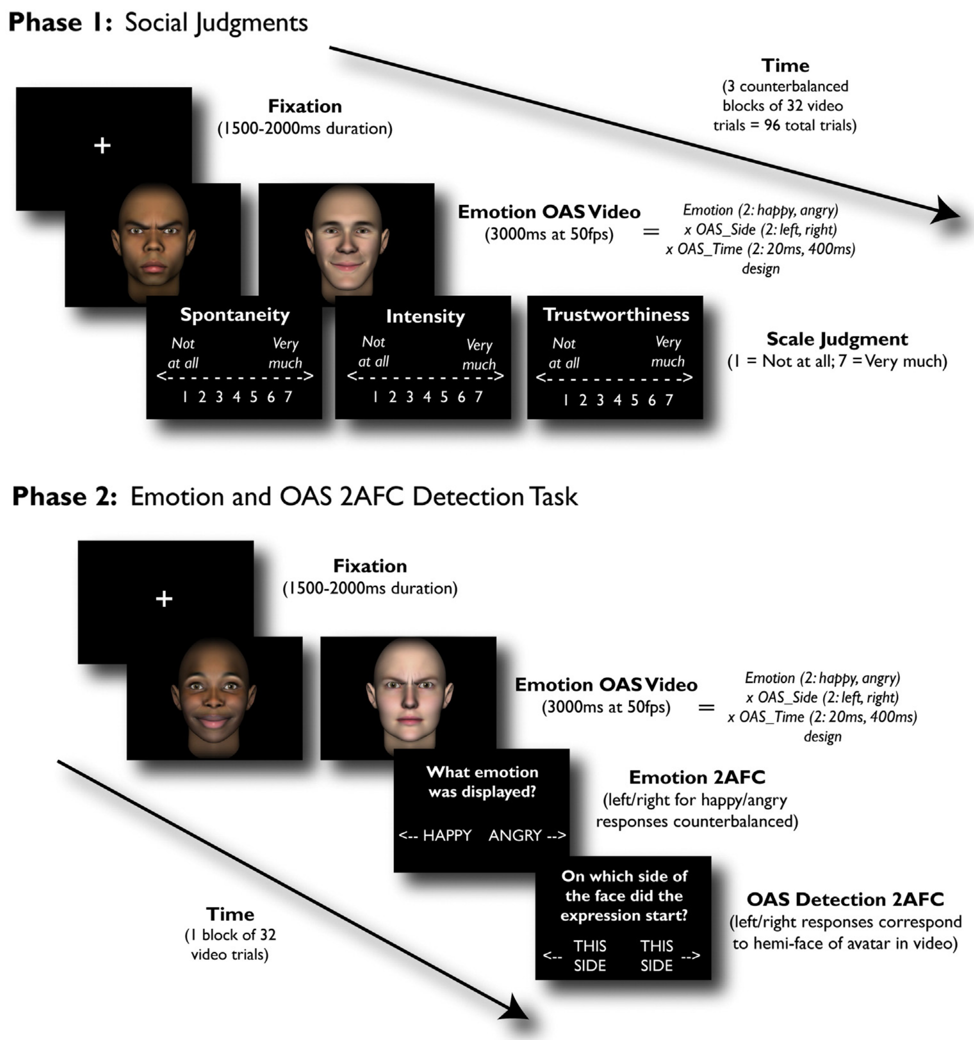

Fig. 1. The experimental design consisted of two phases. To minimize demand characteristics, asymmetry judgments were only asked in the second phase. The order of phases was identical for all participants.

Procedure

The experiment consisted of two phases, completed in the same order by all participants (see Fig. 1).

Phase 1 contained three counterbalanced blocks of 32 trials each, totaling 96 trials. On each block, participants rated the intensity, spontaneity, or trustworthiness of the presented expression with horizontally presented scales from 1 (*not at all*) to 7 (*very much*), using the number keys on the keyboard. Each trial was preceded by a fixation cross (duration between 1500 and 2000 ms), followed by the 3000 ms video stimulus, and the rating screen (see Supplementary Materials for task instructions).[2]

Phase 2 included 32 trials of two different two-alternative forced-choice detection tasks: Participants first reported which emotion the face expressed ("happy/angry," with side of responses counterbalanced) and then indicated the side of the face on which the expression began. Participants made the emotion and OAS judgments with the left- and right-arrow keys (using their left- and right-index fingers, respectively). The OAS measures were not included in Phase 1 and always taken after emotion classifications in Phase 2, in order to minimize demand characteristics. Videos within each phase and block were randomized and counterbalanced.

Results

Social judgments (phase 1)

To evaluate participants' social judgments, we conducted repeated-measures ANOVAs for each of the three ratings, according to an Emotion (happy, angry) × OAS_Side (left, right) × OAS_Time (20 ms, 400 ms) within-subjects model. Note that all three social dimensions (i.e., spontaneity, intensity, and trustworthiness) were analyzed using separate statistical models, each following the same aforementioned factor structure.

Spontaneity

As predicted, participants judged expressions starting on the avatars' LHF to be more spontaneous, as revealed by a main effect of OAS_Side ($F(1,67) = 6.26$, $p = .02$, $d = .43$); see Fig. 2, panel *a*). We also observed an Emotion × OAS_Time interaction ($F(1,67) = 8.21$, $p < .01$),

[2] Note that we separated each social rating dimension (i.e., intensity, spontaneity, and trustworthiness) into individual counterbalanced blocks of 32 trials each, rather than collecting all the ratings on each trial. This was done to ensure that participants could easily complete the task, put full attention toward each specific rating, and to allow for phase 1 instructions to be reiterated before and in-between blocks (also see Supplementary Materials).

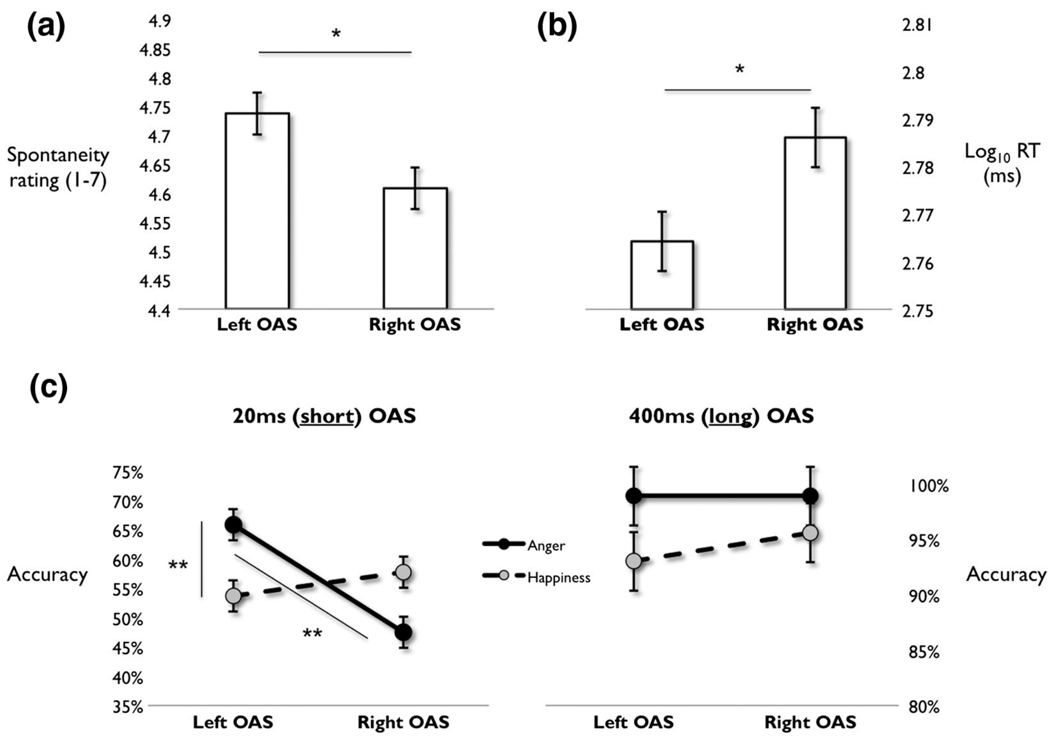

Fig. 2. Expressions starting on the left side of the face (left OAS) were rated as more spontaneous (a), and their onset was detected more rapidly (b), compared to expressions starting on the right side of the face (right OAS). At the shorter 20 ms OAS, participants were most accurate in detecting onsets for anger expressions with a left OAS—both compared to anger expressions with right OAS, and happy expressions with left OAS (c). No such differences were found at the longer 400 ms OAS (**p < .01, *p < .05).

which demonstrated that angry expressions with the 20 ms OAS were judged to be more spontaneous than expressions with the 400 ms OAS ($t(67) = 2.61$, $p = 0.02$ [Bonferroni-corrected], $d = .37$). This was not the case for happy expressions ($t(67) = 1.44$, *ns*).

Intensity

Analysis of the intensity judgments revealed a main effect of Emotion ($F(1,67) = 73.89$, $p < .001$, $d = 1.48$), such that participants rated angry expressions as more intense than happy expressions. No other effects for intensity were found.

Trustworthiness

We also observed a main effect of Emotion for trustworthiness judgments ($F(1,67) = 150.02$, $p < .001$, $d = 2.10$), such that participants rated happy expressions as more trustworthy than angry expressions. No other effects for trustworthiness were found.

Emotion and OAS categorizations (phase 2)

We analyzed the RTs ($\log_{10}$-transformed, to reduce the impact of outliers) and accuracy scores of participants' emotion and OAS categorizations in separate repeated-measures ANOVAs by crossing the factors Emotion (happy, angry) × OAS_Side (left, right) × OAS_Time (20 ms, 400 ms).

Emotion categorizations

Overall, participants' emotion categorizations were both highly accurate ($M_{ACC} = 97.21\%$, $SE_{ACC} = .40\%$) and rapid ($M_{RT} = 791.50$ ms, $SE_{RT} = 13.18$ ms). Specifically, on the simple question about the avatar's emotion (see Fig. 1, bottom panel), no effects were found for $\log_{10}$-transformed RTs (*F*s < 1.40, *p*s > .24) or accuracy of emotion categorization scores (*F*s < 2.08, *p*s > .15).

OAS detection

Importantly, our analyses of participants' speed and accuracy to detect the side of expression onset revealed several more specific effects. Unsurprisingly, when the asymmetry lasted 400 ms, participants were both faster ($M_{RT} = 633.74$ ms, $SE_{RT} = 23.29$ ms) and more accurate ($M_{ACC} = 96.60\%$, $SE_{ACC} = 1.23\%$) in indicating the side of the expression onset, compared to 20 ms ($M_{RT} = 789.59$ ms, $SE_{RT} = 23.29$ ms; $M_{ACC} = 56.20\%$, $SE_{ACC} = 1.23\%$). This was revealed by main effects of OAS_Time for both $\log_{10}$-RTs ($F(1,67) = 64.71$, $p < .001$, $d = 1.41$) and OAS detection accuracy ($F(1,67) = 540.47$, $p < .001$, $d = 4.21$).

Interestingly, analysis of OAS detection RTs revealed that participants were faster in recognizing LHF expression onset (Fig. 2, panel *b*). This is shown by a main effect of OAS_Side on $\log_{10}$-transformed OAS detection RTs ($F(1,67) = 6.10$, $p = .02$, $d = .43$). No other relevant effects on OAS detection RTs were observed.

Critically, when evaluating accuracy scores for OAS detection, participants were more accurate in detecting the side of the expression onset for angry compared to happy expressions, as shown by a main effect of Emotion ($F(1,67) = 4.55$, $p = .04$, $d = .38$). Further, this effect depended on the side of the OAS, as demonstrated by an Emotion × OAS_Side interaction ($F(1,67) = 8.76$, $p < .01$), which revealed that participants were more accurate in detecting LHF anger as opposed to RHF anger ($t(67) = 3.08$, $p = .01$ [Bonferroni-corrected], $d = .53$). This effect was not present for happy expressions ($t(67) = 1.11$, *ns*).

Additionally, an Emotion × OAS_Side × OAS_Time interaction ($F(1,67) = 6.95$, $p = .01$) for OAS detection accuracy revealed a LHF priority for *briefly* presented anger expressions (Fig. 2, panel *c*). Follow-up tests revealed no differences at the longer 400 ms OAS between LHF and RHF angry expressions ($t(67) = 0.01$, *ns*) or between LHF and RHF happy expressions ($t(67) = 0.68$, *ns*). However, participants showed greater accuracy in detecting LHF angry expressions at the shorter 20 ms duration ($M_{ACC} = 65.80\%$, $SE_{ACC} = 2.66\%$)—both compared to RHF angry expressions ($t(67) = 4.88$, $p < .001$ [Bonferroni-corrected], $d = .54$) and LHF happy expressions, ($t(67) = 3.22$, $p < .01$

[Bonferroni-corrected], $d = .43$). No similar differences were observed for happy expressions.

Discussion

In the current study, we used precisely timed video stimuli to investigate how onset asymmetries (OASs) in facial expressions influence participants' social judgments and classifications of those displays. We report the first demonstration that participants are faster and more accurate in detecting expression onsets starting in a target's left hemi-face (LHF), compared to the right hemi-face (RHF), and that they rate those LHF expressions as more spontaneous. These findings are especially informative not only for the empirical study of facial expressions and social perception, but also for broader social psychological theory in emotion (Feldman-Barrett, Niedenthal, & Winkielman, 2005).

In the following, we review and discuss the major findings. First, perceivers more quickly and accurately detected expression onsets in the LHF. This finding is consistent with past results that individuals judge LHF emotions as more expressive (e.g., Failla, Sheppard, & Bradshaw, 2003). Importantly, it extends the current literature by showing a LHF decoding priority when judging the side of onset of emotional facial expressions. Recall that we observed these differences even when controlling for peak expression activation in our stimuli, suggesting that the effects of expression onsets and intensities are dissociable (and that OASs can independently influence emotion classification and perception).

Second, we found that higher spontaneity ratings were given to targets' expressions with OASs starting in the LHF compared to the RHF. While recent work has shown that individuals *produce* spontaneous expressions earlier in the LHF (Ross & Pulusu, 2013), this is the first demonstration that individuals also *perceive* others' expressions as more spontaneous when their onset is in the LHF. Critically, these results suggest that OAS cues may be used to seamlessly infer spontaneity of facial expressions. This is particularly essential, since recent research on spontaneous versus posed expressions relies largely on the analysis of static morphological facial features (and is still debated). For example, the crinkling around the eyes in a *Duchenne smile* has been proposed as a marker of genuineness (Ekman et al., 1990), but this characteristic has also been found to be present in "false" smiles (Krumhuber & Manstead, 2009). Our results suggest that OASs are an important dynamic facial feature that contributes not only to the production of "true" and "false" expressions but also to the *perception* of these displays (Ambadar, Schooler, & Cohn, 2005; Krumhuber & Kappas, 2005).

Third, this LHF priority in OAS detection was especially pronounced for the upper-face emotion (anger), specifically at the shorter duration of 20 ms—in other words, the salience of an expression's OAS depends on both its type and duration. This finding is consistent with recent work on the *anger superiority effect* (ASE; e.g., Pinkham et al., 2010), which is especially pronounced for dynamic stimuli (Ceccarini & Caudek, 2013). Interestingly, participants were about 20% more accurate in detecting anger onsets in the LHF during short 20 ms OASs, while no such effect occurred at 400 ms OASs. This suggests that anger cues may be particularly relevant in capturing and guiding attention when perceived quickly and perhaps unconsciously (Blagrove & Watson, 2010, 2014), since overall accuracy in 20 ms OAS detection was approximately chance-level. However, it is indeed possible that a failure to observe hemi-face differences in accuracy at the longer 400 ms OAS may have been caused by ceiling effects, due to near-perfect performance.

Note that the selective nature of these effects (based on emotion, along with both the side and duration of OAS) demonstrates that our results cannot be a byproduct of a general LHF "side bias." Correspondingly, spontaneity judgments also followed a selective pattern, with anger being rated as more authentic at 20 ms OASs compared to 400 ms OASs (whereas no difference was found for happiness). Even though the effects of the side of OAS on detection accuracy seem to be the most complex, the shared influence of the LHF on spontaneity ratings and OAS detection RTs (along with OAS accuracy) certainly suggests the importance of these dynamic asymmetries in the perception of emotional expressions.

As mentioned, the OASs seemed to mostly influence the perception of the upper-face emotion (i.e., anger expressions) with limited influence on the lower-face emotion (i.e., happy expressions). Such differences can be understood in the context of the distinctive social function and neuroanatomical organization for each of these expressions (Ross, Reddy, et al., 2007; Ross, Prodan, & Monnot, 2007; Ross & Pulusu, 2013). For example, the perception of anger is functionally and neurologically different from responding to smiles, since individuals encounter "real" anger less frequently in the social environment (e.g., Calder, Keane, Lawrence, & Manes, 2004). Moreover, smiles represent the most complex emotional expression, both in the intentions that they can convey and the factors by which they can be influenced (e.g., eye gaze, prior knowledge, social inhibition, etc.; Niedenthal, Mermillod, Maringer, & Hess, 2010). Consequently, OAS cues more readily affect anger likely because smiling responses take into account so many external social factors, especially when stimuli are dynamic, as was the case with the current paradigm (Krumhuber & Kappas, 2005). And from social and evolutionary perspectives, it is advantageous to be able to rapidly detect "genuine" anger, since this emotion can represent an immediate threat situation for the perceiver (e.g., Fischer & Roseman, 2007).

Recall that we found no differences by OAS for trustworthiness ratings when controlling for peak intensity in our stimuli, in contrast to recent research using chimeric faces (Okubo et al., 2013). This may indicate that shifts in higher-level judgments of dispositional "character" are actually driven by the expression's intensity. Also, judgments about the volitional nature of the expression (i.e., posed versus spontaneous) should be distinguished from judgments about the displayer's intent (i.e., trustworthy versus untrustworthy) because many posed expressions (e.g., "affiliative" smile) have no deceitful intent (Niedenthal et al., 2010). Thus, OASs may be particularly useful in researching how individuals initiate judgments of genuineness (e.g., "true" versus "fake" smiles) compared to judgments of character (e.g., "dependable" versus "deceitful" target).

In conclusion, this is the first demonstration that perceivers more quickly and accurately detect the onset of facial expressions starting in the LHF compared to the RHF (especially for anger at short OASs) and that OASs are used to infer expressions' spontaneity. Generally, these results are most important in showing that individuals are adept at using subtle signals, such as lateralized facial expressions, as interpersonal cues in navigating the social world.

Appendix A. Supplementary data

Supplementary material to this article can be found online at http://dx.doi.org/10.1016/j.jesp.2014.05.008.

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