Chapter

MOVING FACES AND MOVING BODIES: BEHAVIOURAL AND NEURAL CORRELATES OF PERSON RECOGNITION

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ABSTRACT

There is extensive research on the recognition of individual identity, typically using static images (e.g. photographs). However, in the last 20 years, research has considered how successful recognition can be achieved in more naturalistic situations, using information from dynamic faces and bodies. In this chapter, we review behavioural work research that explores the role of motion in the recognition of identity from faces and bodies. In addition to the behavioural work we will also review the brain based evidence that has attempted to establish the neural correlates of person recognition. The theoretical implications of this work, and whether motion should be thought of an additional cue to identity or is integral to the underlying representation of a familiar person, are discussed in detail. Finally, we suggest dynamic information available from the face and body may help us integrate identity information about person using different environmental cues.

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INTRODUCTION

There is extensive research on the recognition of individual identity, from both an experimental behavioural (for example, Lander, Christie, & Bruce, 1999) and a neural perspective (for example, Pitcher, Duchaine, & Walsh, 2014). Typically, research has used static images (e.g. photographs), and has focused on the role of the face in person recognition with considerably less work investigating identity recognition from bodies or faces and bodies. Whilst this static-based research has been highly informative, it is important to note that faces and bodies are *inherently dynamic*. These dynamic characteristics convey much useful information. Indeed, we are able to able to quickly and accurately interpret social information conveyed by even subtle movements (Ambadar, Schooler, & Cohn, 2005; Bould & Morris, 2008; see Krumhuber, Kappas, & Manstead, 2013 for a review on the dynamic aspects of expressions). For example, the way a face and body moves conveys important information when determining emotional expression; such that we smile when we are happy and cower when afraid. The precise dynamic characteristics of the observed movement can determine our interpretation of the expression shown; whether we think the smile is genuine or false (Krumhuber & Kappas, 2005); and when judging the level of emotional intensity shown (Atkinson, Dittrich, Gemmell, & Young, 2004). Similarly, the role of motion in speech perception and communication is obvious. The communicative function of speech perception is signalled by lip movements (McGurk & MacDonald, 1976; Rosenblum, Johnson, & Saldaña, 1996) whilst the body conveys information important for communication through posture and gesture (see Goldin-Meadow & Alibali, 2013)

The role of motion in the recognition of identity has received a less prominent role in the literature with classic models of face processing either making no explicit reference to dynamic parameters (see Bruce & Young, 1986) or proposing that facial motion processing is largely independent of identity processing (Haxby, Hoffman, & Gobbini, 2000). However, over the last twenty years or so, a growing body of research has considered the role of motion in the recognition of identity. In this chapter, we review the behavioural and neural correlates of person recognition. We start by considering behavioural work on the role of motion in the recognition of identity from faces and bodies.

BEHAVIOURAL CORRELATES OF DYNAMIC FACE AND BODY RECOGNITION

Faces move in both rigid (e.g. head nodding and shaking) and non-rigid (e.g. expressions and speech) ways. In real life, the face usually makes a combination of changeable expression and speech movements coupled with larger head movements. Importantly, it has now been established that seeing a face move facilitates the recognition and encoding of facial identity (e.g., Hill & Johnston, 2001; Knappmeyer, Thornton, & Bulthoff, 2003), at least in some circumstances.

Several theoretical interpretations (not mutually exclusive) of this ‘motion advantage’ for face recognition are proposed in a seminal paper by O’Toole, Roark and Abdi (2002). First, each known face may have an associated ‘characteristic motion signature’, which acts as an additional cue to identity (termed the ‘supplemental information hypothesis’ by O’Toole et al., 2002). Characteristic motion signatures refer to idiosyncratic facial expressions, movements or facial gestures (e.g. particular ways of smiling, nodding or gesturing) that are indicative of an individual. Thus, the way a friend smiles or the way they characteristically nod their head during a conversation, may aid your ability to recognise their identity. Of course, this kind of cue is particularly important when recognising *familiar* faces.

Second, it may be that there is some generalised benefit for viewing a face moving naturally. O’Toole et al. (2002) refer to this idea as the ‘representation enhancement hypothesis’, positing that facial motion contributes to recognition by facilitating the perception of the 3D structure from the face. Perceptual research with *unfamiliar* faces and face encoding has explored the representational enhancement hypothesis. Thirdly, the social cues carried in movement (emotional expressions, speech) may attract attention to the identity specific areas of the face, facilitating identity processing (social signals hypothesis).

Evidence for characteristic motion signatures (supplemental information hypothesis; O’Toole et al., 2002) has been clearly demonstrated when recognising familiar faces. One of the first experiments to investigate the role of motion in the recognition of identity was conducted by Knight and Johnston (1997). They presented famous face images upside down (inverted) and/or as photographic negatives. Results suggested that movement significantly improved recognition only in upright, negative-image faces but played no role when the faces were presented as positive images, whether upright or inverted. Later work has established a robust and consistent recognition advantage for motion when recognising familiar faces (see Lander et al., 1999). Typically, in an experiment of this kind, participants view moving and static famous faces and are asked to try and recognise their identity by name or other unambiguous semantic information (such as, ‘Prime Minister of UK’ for Theresa May). Famous faces not known to the participant are removed from their statistical analysis (after all you are unable to recognise a face if you don’t know who they are) and thus accuracy is calculated as a percentage of known faces. The images used are usually degraded in some way so as to reduce recognition levels to below ceiling levels (negation, Knight & Johnston, 1997; thresholding, Lander et al., 1999; blurring, Lander, Bruce, & Hill, 2001). This degradation does not preclude the possibility that motion is a useful cue to identity when recognising undegraded faces, but rather any recognition advantage may simply be more difficult to demonstrate.

Interestingly, recent research has also shown that developmental prosopagnosics, who are impaired at face recognition, are able to match, recognise and learn moving faces better than static ones (Steede, Tree, & Hole, 2007;

Longmore & Tree, 2013; Bennetts, Butcher, Lander, & Bate, 2015). Similarly, motion is a useful cue to identity for those who are poor at face recognition (Albonico, Malaspina, & Daini, 2015). Thus, motion may be a particularly useful cue to identity when recognition is impaired by degradation of stimuli (Lander, Bruce, & Hill, 2001) or by perceiver impairment (e.g. Albonico et al., 2015; Bennetts et al., 2015; also see Xiao et al., 2014).

Of course, one obvious difference between a moving sequence and a single static image is the number of images viewed in each case. Thus, any advantage for motion may not reflect a truly 'dynamic effect' but rather the additional static frames contained in the moving sequence. Evidence against this viewpoint comes from Lander et al. (1999), who demonstrated that even when the moving and static sequences contained the same number of frames there was still an advantage for seeing the face move. Evidence that the motion advantage is not just due to number of frames also comes from the fact that the size of the motion advantage is linked to the dynamic characteristics of the observed motion. Indeed, changing the tempo, speed, rhythm or naturalness of the observed motion has a detrimental influence on the size of the recognition advantage (Lander & Bruce, 2000; Lander, Chuang, & Wickham, 2006). Furthermore, Lander and Chuang (2005) found that motion was only a useful cue to identity when the motion was rated as being distinctive (by different raters), with no significant recognition advantage for typical movers (see Experiment 2). Later work by Butcher and Lander (2017) explored this finding and showed that famous faces rated as moving a lot and moving in a distinctive manner benefited the most from being viewed in motion. Also, the magnitude of the motion advantage was significantly correlated with face familiarity, suggesting, in line with the supplemental information hypothesis (O'Toole et al., 2002), that facial motion becomes a more important cue to recognition identity the more familiar the face is (also see Roark, Barrett, O'Toole, & Abdi, 2006). Although characteristic facial motion patterns may be rapidly learned (see Lander & Davies, 2007), this supplementary identity specific information becomes more useful to identity processing with time and experience as we continue to become more familiar with the face.

Additional evidence in support of the usefulness of facial motion for recognition comes from studies that show participants can discriminate between individuals based on their facial motion alone (Hill & Johnston, 2001; Knappmeyer et al., 2003; Girges, Spencer, & O'Brien, 2015). Hill and Johnston (2001) animated an average face using the facial movements from different actors. Participants were able to discriminate between different identities based on the motion information alone. Further, Knappmeyer et al. (2003) trained participants to learn the identity of Face A or Face B from moving clips. Later, participants were presented with a spatially morphed image (identity between Face A and Face B) where it was not possible to determine identity from the structural characteristics alone. Results suggested that participants were biased to decide that the face morph was Face A or Face B based on the dynamic characteristics.

In more recent similar work, Girges et al. (2015) used a forced choice discrimination task to investigate whether identity could be categorised by facial motion cues alone. Here motion characteristics were captured from fifteen actors and mapped onto a standard avatar model. Participants were presented with a single animation reciting a poem. Next, they viewed two animations, one displaying the original actor reciting a different poem and other actor reciting any poem. Participants were asked to decide which animation showed the original actor (left or right). The results showed that participants were able to use motion as a cue to identity in the absence of any other cues (performance for upright faces was over 91% correct). It seems clear then that in the absence of other cues, seeing a familiar face move aids our recognition of identity.

In contrast to the literature on familiar face recognition, the role of motion when learning previously unfamiliar faces is less established and less consistent. Here, some research has demonstrated better recognition of unfamiliar faces using dynamic rather than static stimuli (for example, see Lander & Bruce, 2003; Pike, Kemp, Towell, & Phillips, 1997) but other research has found no benefit of motion for face learning (for example, see Bruce, et al., 1999; Bruce, Henderson, Newman, & Burton, 2001; Christie & Bruce, 1998). In a classic recognition memory task, Pike et al. (1997) asked participants to learn unfamiliar faces from static face pictures, multiple face pictures or moving clips (rigid head rotational movement). At test, participants were shown a single face image and were asked to decide if the face was familiar to them (learned; old) or not (new). Results found an advantage for learning faces in rigid motion. Similarly, Lander and Bruce (2010) found that viewing faces moving rigidly led to more accurate face learning than viewing a single static image. They concluded that the advantage for rigid motion was due to the multiple viewpoint images shown, rather than the dynamics of the rigid motion. Interestingly, Lander and Bruce (2010) also found an advantage for learning faces moving non-rigidly. They concluded that this may be due to participants paying increased attention to faces moving in a socially important manner.

One possible reason the evidence for the representation enhancement hypothesis is somewhat variable is that adults' ability to perceive and represent faces is at ceiling. Thus, it may be difficult to assess the perceptual effects of facial motion on the recognition of unfamiliar faces. Interestingly, in work using very young infants, Otsuka et al. (2009) found that unfamiliar faces were learned faster when shown moving compared with static (also see Skelton & Hay, 2009 work with older children). In addition, Maguinness and Newell (2014) compared the role of motion for younger and older adults when learning new faces. They found that later face matching performance improved in the older adult group, when faces were learned in motion relative to static. These results suggest that ageing may offer a unique insight into how dynamic cues support face processing, which may not be readily observed in younger adults' performance. Together, this work supports the representation enhancement hypothesis and suggests that seeing a face facilitates the creation of a face representation for infants (Otsuka et al., 2009) and older adults (Maguinness & Newell, 2014).

One further reason for the inconsistent results found with unfamiliar faces could be due to the experimental task being used (Pilz, Thornton, & Bülthoff, 2006). Indeed, Pilz et al. (2006, p.436) argue that the recognition memory paradigm usually used in unfamiliar face learning experiments may make it "difficult to extract stable measures of dynamic performance" as it biases observers to assume techniques dependent on memorization that favour static content. To overcome this potential bias, Thornton and Kourtzi (2002) used an immediate matching paradigm to compare the impact of priming with a short movie clip compared to a static image. They found that responses following a dynamic prime were faster than those following static primes.

Pilz et al. (2006) also used a novel approach to investigate the motion advantage of unfamiliar faces. Using a delayed visual search paradigm, they explored how learning over a longer period of time is affected by the availability of non-rigid motion. Participants were familiarised with two target faces; one static and one moving. Participants then completed a visual search task in which they were required to indicate whether either of the target faces was present. Pilz et al. (2006) found a reliable dynamic search advantage such that observers identified faces learnt from dynamic sequences faster than those learnt in static (Pilz, Bülthoff, & Vuong, 2009). Butcher, Lander and Jagger (2017) also used a delayed dynamic visual search task and found a dynamic search advantage (for same-race and other-race faces). Indeed, there were shorter search latencies and higher accuracy rates, for faces learned in motion. Also, differing clip lengths and face repetitions during familiarization yielded the same dynamic advantage, supporting the suggestion that motion provides a robust and valuable cue for face learning.

We can see then that although the role of motion in face learning is less clear than for familiar faces, a motion advantage for unfamiliar faces has been demonstrated across a number of experimental paradigms (recognition memory; immediate matching tasks and delayed visual search). It is hypothesised that when learning previously unfamiliar faces, motion facilitates the construction of more robust mental representations at encoding which later aid recognition; the 'representation enhancement hypothesis' (O'Toole et al., 2002).

In parallel with work on familiar and unfamiliar moving faces, other research started to compare the importance of the face and the body in the recognition of identity. For example, in classic work, Burton, Wilson, Cowan and Bruce (1989) collected CCTV surveillance footage of lecturers from the University of Glasgow Psychology department (familiar to the Psychology student participants) and unfamiliar individuals. They edited the footage such that the face was obscured, the body was obscured or the gait obscured (by using multiple frames from the dynamic sequence). Overall recognition of the familiar individuals was good, and obscuring the body or gait had a minimal effect on the identification of the familiar people. In contrast, there was a large decrease in recognition performance when the face was obscured, strongly suggesting that the face was the most important cue to identity (also see O'Toole et al., 2011 with static stimuli; Robbins & Coltheart, 2012).

Interestingly, other research has suggested that the body does provide useful identity information, particularly when the face is difficult to see or is shown at a distance. For example, Rice, Phillips and O'Toole (2013) asked participants to make identity matching decisions to people from faces or bodies. When the identity decisions were challenging (face similarity poor by face recognition algorithms), performance was similar in the face and body conditions. Other work by Rice, Phillips, Natu et al. (2013) found that in some circumstances, participants may even be unaware that they are using information from the body for identification, rather than from the face. It seems that identification is adaptive to circumstance, with reliance on the face in good viewing conditions whereas the body is important in other situations, like when there are poor quality face images or far viewing distances (see Hahn, O'Toole, & Phillips, 2016).

As well as the body being important for identity, body motion is also useful. Early work investigated the recognition of identity from walking movements using point-light displays (PLDs). Point-light displays place 'lights' on key areas of the body and remove all other cues in the visual image. When static the image appears as if a collection of spots or constellation of stars, yet when the image moves the body in motion becomes apparent. PLD have demonstrated that walking motion provides useful information about emotion (Dittrich, Troscianko, Lea, & Morgan, 1996), gender (Troje, 2002) and, importantly for our purposes, identity. Early work by Cutting and Kozlowski (1977) filmed six friends walking back and forth with lights attached to their major joints. Two months later, Cutting and Kozlowski (1977) asked the friends to watch the PLD displays created and try to identify the person shown. Their results showed that participants were able to identify an individual walker, a fairly modest (given that there were only 6 individuals to pick from) 38% of the time (also see Westhoff & Troje, 2005). More recent work by Loula, Prasad, Harber and Shiffrar (2005) asked participants to make forced choice decisions whether a PLD was displaying themselves, a friend or a stranger. Movements included jumping, walking, waving, boxing, dancing, laughing, hugging, playing ping pong and running. Results found that self-recognition was best (69% correct) but that friend recognition (47% correct) was also above chance (33.3% correct). In line with Cutting and Kozlowski (1977) there was a small advantage for viewing walking and gait movements. However, the most advantage was by viewing other more expressive movements such as dancing and boxing. Expressiveness or exaggeration may be particularly important as demonstrated by Hill and Pollick (2000). Hill and Pollick (2000) investigated the role of temporal exaggeration on identity recognition. Specifically, they asked participants to learn the identity of six individuals from their arm movements. They found that temporally exaggerated versions of the arm movements were recognised significantly better than the original versions or unexaggerated versions. It seems likely that when viewing bodies in motion we are able to use the characteristic motion signatures available to help identify the individual shown. Such characteristics may be more exaggerated in some kinds of movement (for example, dancing & boxing) than others (e.g. walking; Loula et al., 2005) and it may be possible to artificially exaggerate these characteristics using animation techniques (Hill & Pollick, 2000).

In the context of viewing more naturalistic clips of people in motion (rather than PLD), Pilz, Vuong, Bülthoff and Thornton (2011) considered how we integrate information across the face and body when making identity decisions. They placed three-dimensional head models from different people onto a single identical moving avatar body. Participants, who were asked to make sequential identity matching decisions, responded more quickly to a target face when the body was approaching than when it was static or walking backwards (receding). In a second experiment, they found that faces learned on an approaching avatar, were responded to more quickly than those learned on an avatar that was static. These findings suggest that natural approach motions by bodies may facilitate the processing of a face. However, in this study the body motion did not vary for different faces. Thus, the role of idiosyncratic body motion is unclear.

Further investigation of this issue was conducted by O'Toole et al. (2011), who asked participants to make identity matching decisions to pairs of videos depicting people in motion (walking or conversing) or static images (selected from the moving clips). Performance was best when participants were presented with the face and body compared with the face or body alone. Performance was best in the moving conditions, but only when the body was shown. O'Toole et al. (2011) concluded that some of the motion advantage may be attributed to viewing multiple images of the same person (multi static condition). Further they suggested that in static displays the face plays a key role in identification but both the face and body are important for identification when viewing dynamic clips.

To summarise, behavioural work has established a beneficial role of motion when recognising familiar people (from faces and bodies). Motion also seems useful when establishing new identity representations. It is likely that person identification in the real world relies on information from both faces and bodies, both moving and static. In the next section, we review the brain based evidence that has attempted to establish the neural correlates of person recognition.

NEURAL CORRELATES OF DYNAMIC PERSON RECOGNITION

Neuroimaging studies identify regions distributed across the brain that selectively respond to faces (Kanwisher, McDermott, & Chun, 1997; Gauthier et al., 2000; Phillips et al., 1997). In particular, the fusiform face area in the lateral fusiform gyrus is thought to be specialised for face processing (Kanwisher et al., 1997). This area is frequently damaged in patients with prosopagnosia (who have face recognition difficulties; see for example Barton, Press, Keenan, & O'Connor, 2002) and is thought to respond more to faces than other objects (Tong et al., 2000).

However, there is still controversy whether the FFA is face-selective or may apply to any object category where we have within-category expertise (see Gauthier & Tarr's 2002 work on expertise & with greebles). Furthermore, other neural areas have been found to be involved in face recognition (for example, see Gainotti & Marra, 2011).

This involvement of other brain areas has led to influential models that link these regions together to form the components of a distributed network specialized for face recognition (Haxby et al., 2000; Calder & Young, 2005). Haxby et al. (2000) propose two functionally and neurologically distinct pathways to face analysis, the lateral pathway that preferentially responds to changeable aspects of faces (including expressions; mediated by the superior temporal sulcus) and the ventral pathway that preferentially responds to invariant aspects of faces (identity; coded by the lateral fusiform gyrus). The Occipital Face Area (OFA) is thought to be involved in the early perception of facial features (see Pitcher, Walsh, & Duchaine, 2011).

As in the behavioural literature, the majority of studies that have investigated the functional roles of the face network have used static images of faces. However, recent work has identified the right posterior superior temporal sulcus (rpSTS) as the region that preferentially processes the dynamic, or changeable, aspects of faces (Allison, Puce, & McCarthy, 2000). Functional magnetic resonance imaging (fMRI) studies demonstrate that the pSTS preferentially responds to moving than static images of faces (Fox, Iaria, & Barton, 2009; Pitcher et al., 2011; Schulz et al., 2012). However, to date, studies that have investigated the functional role of the rpSTS have largely demonstrated that it is preferentially involved in facial expression and eye gaze processing (Hoffman & Haxby, 2000; Pitcher et al., 2014) rather than facial identity discrimination (but see Bobes et al., 2013; Gobbini & Haxby, 2006).

It is important to note that the majority of the studies that have found no role for the rpSTS in facial identity discrimination have used static rather than moving stimuli. It therefore remains possible that future work will demonstrate that the rpSTS does compute individual identity based on facial motion. It is also possible that the rpSTS contributes to facial identity discrimination in combination with other face-selective brain regions such as the fusiform face area (FFA) (Kanwisher et al., 1997). There is some evidence to support this hypothesis. A recent combined TMS / fMRI study demonstrated that TMS delivered over the rpSTS selectively impaired the neural response in the rpSTS for dynamic, but not static images of faces (Pitcher et al., 2014). TMS delivered over the rpSTS also reduced the neural response to both dynamic and static images of faces in the right FFA. This demonstration that the rpSTS and right FFA are casually connected suggests that both regions are important when processing dynamic facial aspects. Given that the FFA is thought to preferentially process facial identity (Rotshtein et al., 2005), this functional connection between the FFA and rpSTS may process motion information from a face that contributes to identity discrimination.

An alternative approach to understanding the role of motion in identity recognition is to consider the importance of motion from both faces and bodies. Such an approach makes sense because in the real world we rarely encounter moving faces in the absence of moving bodies. In addition, neuroimaging studies have identified a network of category-selective brain regions that preferentially respond to images of the human body. For example, the extra-striate body area (EBA; located in the lateral occipital cortex) is thought to contribute to the recognition of people from static images of bodies and body parts (Downing, Jiang, Shuman, & Kanwisher, 2001). The EBA may have a role in the processing of body motions when understanding actions and intent (Astafiev, Stanely, Shuman, & Corbetta, 2004; but see Downing, Peelen, Wiggett, & Tew, 2006).

In very recent work, Hahn and O'Toole (2017) examined how motion from faces and bodies facilitates person recognition in an fMRI study. Participants were scanned while viewing videos of familiar and unfamiliar actors walking towards the camera. Analysis of the data examined the neural patterns across both face-selective and body-selective brain regions at four different time points in the videos. Results demonstrated that when the actors were most distant, the bilateral pSTS regions contributed significantly to identity recognition. Then at later time points different combinations of face-selective and body-selective regions were significantly contributing to identity recognition. The authors conclude that a broad network of face and body-selective regions distributed across the ventral and lateral occipitotemporal cortex are used to recognise individuals as they move towards us.

CONCLUSIONS AND OUTSTANDING ISSUES

We have outlined both behavioural and neural work investigating the recognition of identity from faces and bodies. Research has suggested a key role for 'characteristic motion signatures' (from both faces and bodies) that provide useful cues to the recognition of familiar people. We seem able to use these characteristics as an additional cue to identity when recognition is tricky. In addition, motion provides a useful cue to help build robust person representations. Neural work has proposed a network of interconnected areas and pathways that support person perception and recognition. A number of key issues remain when we consider the recognition of identity from moving faces and moving bodies, as follows:

First, in the face studies conducted so far the motion displayed is typically of an unconstrained nature involving a mixture of rigid and non-rigid motion. How much identity information is conveyed by different kinds of facial motion is currently somewhat unclear. Recently, Dobs, Bulthoff and Schultz (2016) animated an avatar using emotional (expressions), emotional interaction and conversational facial movements. Identity matching was best with conversational movements, worse with emotional interaction and at chance level with emotional facial expressions (but see Lander & Chuang, 2005). Thus, it may be that conversational facial movements transmit more dynamic identity information than other types of facial movements. Further studies are encouraged to extend this work, comparing the usefulness of rigid, non-rigid and combined motion cues in other face recognition tasks. In addition, this work should compare the importance of facial and body movements, both separately and together. Body movements are in nature non-rigid but they vary hugely in terms of the extent and type of movements shown as well as in terms of other dynamic parameters, such as velocity and range. Research of this type would facilitate our understanding of what kind of motion is facilitating identity recognition.

Secondly, further work is needed to establish what is meant by ‘motion characteristics’. It is currently unclear whether motion characteristics and distinctiveness are synonymous or how these parameters are related. Whatever the relationship, the beneficial effects of motion for identity recognition are most pronounced when the face or body is moving distinctively (Lander & Chuang, 2005; Butcher & Lander, 2017). We must work on defining what is meant by motion distinctiveness and determine exactly how distinctiveness is tied to the dynamic parameters and characteristics of the observed motion. Like spatially based distinctiveness (see Valentine, 1991), the motion distinctiveness of an individual may be determined in relation to other known people and a ‘norm’ for the movements shown. In addition, motion distinctiveness may vary by the clip selected as well as by the individual shown. We should also consider whether common dynamic characteristics are present in both the facial and body movements of a particular individual. For example, if a person has particularly pronounced and exaggerated facial movements, are these dynamic characteristics mimicked in their body movements? Such commonalities may serve to bind together person identification from their face and body.

Accordingly, a third issue concerns the neural correlates of person identification and how motion from the face and the body is bound ‘together … into a coherent representation of a person that supports recognition’ (Yovel & O’Toole, 2016, page 383). The pSTS is suggested as a possible ‘neural hub’ for dynamic person identification. Indeed, dynamic information available from the face and body may help us integrate identity information about person using the different cues available from the face and body. Future imaging studies should use static and dynamic stimuli from faces and bodies to investigate person recognition. Research should also consider the role of voice recognition, as the temporal characteristics present in the movement of the lips are also heard in the sound of the voice (see Kamachi, Hill, Lander & Vatikiotis-Bateson, 2003). Thus, there may be multiple cues to identity available from the dynamic characteristics present in face, body and voice.

Finally, we should consider the practical implications of the moving face and moving body advantage. In ongoing work (Leverhulme Trust grant awarded to Lander, Frowd and Cootes), we animate face composites. Face composites are face images created of the suspect by a witness, typically following a serious crime.

Creating dynamic versions of the face composites (using their own motion or that of another person) seems to aid the recognition of identity (also see Chapter x of this book), suggesting an important role for motion in suspect identification and other security applications.

To summarise, a key role of facial motion in face recognition and learning is now established but more research is needed to consider the role of body movements and face and body movements in combination. New technologies and experimental methods have led to important findings and this research continues to uncover important information about moving faces and moving bodies. It is important that we gain converging evidence from both behavioural and neural methodologies to draw strong theoretical and applied conclusions.

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