THE EFFECTS OF MOTION AND ORIENTATION ON PERCEPTION OF FACIAL EXPRESSIONS AND FACE RECOGNITION

by

Zara Ambadar

B.S. University of Indonesia, 1989

M.S. Brunel University of West London, 1994

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This dissertation was presented

by

Zara Ambadar

It was defended on

August 8th, 2002

and approved by

Jeffrey Cohn, PhD

Julie Fiez, PhD

Jessie Van Swearingen, PhD

Jonathan Schooler, PhD
Dissertation Director

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Research on perception of facial expressions has neglected an important characteristic of facial expression, its dynamic property. In this dissertation, two experiments were conducted to assess the effect of motion on perception of facial expressions and to test three (3) possible mechanisms by which motion facilitates perception of facial expressions. (1) motion provides more static information than is available in a single image. This hypothesis was tested by comparing performances in single image presentations (Single-Static) with those in multiple image presentations (Multi-Static). (2) motion provides temporal information about expressions which aids perception. This was tested by comparing performances in multiple image presentations with those in moving sequence presentations (Dynamic). (3) motion improves perception of facial expressions by facilitating configural processing. This was tested by comparing the effect of motion in upright and inverted presentations of the stimuli. In Experiment 1, participants were shown posed faces with subtle facial expressions in one of three modes (Single-Static, Multi-Static, or Dynamic). Experiment 1 revealed a robust effect of motion relative to both Multi-Static and Single- Static condition. This finding, in addition to the absence of an interaction effect between motion and inversion suggest that the effect of motion was not due to additional static information and was not mediated by configural processing.

Experiment 2 replicated the basic procedure of Experiment 1 and in addition included a face recognition task and a memory measure of facial expression. The advantage for dynamic presentation was replicated. Converging evidence from Experiment 1 and 2 supported the second mechanism and suggests that the effect of motion on judgment of facial expressions is inherent in the dynamic property of the sequence. The nature of this dynamic property was discussed with regards to the possibility that motion might enhance the perception of change (change sensitivity hypothesis).

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In loving memory of my father Hussein Ambadar
With the greatest love for my mother, Hadijah Ambadar,
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I

INTRODUCTION

A critical aspect of face perception is its dynamic nature. With very few exceptions, in everyday living we rarely perceive a face in a static mode. The face is dynamic with every change in pose and expressions. Thus, studies on face perception attempting to mimic the natural processing of face perception should include this important characteristic. However, this very important property of a face has been largely ignored. Computer vision scientists have taken advantage of the dynamic nature of face perception in their attempt to automatically detect facial expression (Bartlett, Hager, Ekman, & Sejnowski, 1999; Cohn, Zlochower, Lien, & Kanade, 1999; Tian, Kanade, & Cohn, 2000, 2001). Human judgment studies, however, have not been nearly as extensive.

The lack of attention on this dynamic property is clearly evidenced from the extensive use of static displays in previous studies of face perception. What could be the role of motion in human face perception? This question will be addressed in the following sections.

A face contains a wealth of social information. From a face, people can extract information about identity, gender, age, speech action and also emotion. Research on face processing has concentrated on the perception of identity and affect. The discussion below focuses on these two important domains of face processing, with respect to potential role of emotion.

The Role of Motion on Perception of Facial Expression

As mentioned previously, research on facial expressions has almost exclusively studied facial expression with static displays. This is perhaps in part due to the belief that static representations are segments taken from an ongoing expression and therefore the expression itself is entirely represented within the chosen segments. However, there is a concern that the utilization of static facial expressions relies on instances that are highly prototypical and exaggerated forms of expression (see Wallbott & Scherer, 1986). Real life situations involve much more subtle interpretations of the visual signal than what is usually employed in the static domain (Carroll & Russell, 1997; Tian et al., 2001).

Impoverished Stimuli. There have been only a handful of studies to characterize the role of motion on perception of facial expressions. The first formal study on dynamic facial expressions was one by Bassili in 1978. Using the point-light technique, he showed that observers were able to identify the emotion accurately in the moving condition as compared to the static ones. Bruce and Valentine (1988) replicated Bassili's results in a similar setting. They investigated whether observers could make various judgments about the posers through point-light displays. The results indicated that for all types of judgment (gender, identity, type of motion, and judgment of emotion) moving displays of the point-light figures were always more accurate than still ones.

Although useful for demonstrating the role of motion in emotion detection, the point light procedure reduces the information available to the motion components exclusively. The problem with it is that point-light displays are highly impoverished stimuli in that they include much fewer moving elements than those observed with real face stimuli. Nevertheless, these studies demonstrate that with the absence of any information other than movement people can still judge facial expression with a certain level of accuracy. This suggests that facial information may contain reliable information in the temporal domain to produce accurate recognition.

Actual Face. In studies using actual, full display of face stimuli, the role of temporal information of facial expression on finer distinctions within the same category of emotion has been demonstrated. Specifically, dynamic characteristics of facial expression have been demonstrated to influence the perceived authenticity (posed or spontaneous) of the expressions (Ekman & Friesen, 1982; Hess & Kleck, 1990; Hess & Kleck, 1994). For example, it was found that some markers differentiate enjoyment smile from other types of smiles. These markers include the presence of *obicularis oculii* action in conjunction with the *zygomatic major* (ZM), symmetrical action of the ZM on both sides of the face, ZM actions that are smooth and not irregular, duration of ZM action that is consistent from 1 enjoyment smile to the next, and synchronous action of the ZM and the *obicularis oculii* such that they reach maximal contraction at about the same time (Frank, & Ekman, 1993).

The above studies, although important, do not answer the question of whether motion affects categorical judgment of expressed emotions. This is because these studies focused on the dynamic properties that distinguish posed from spontaneous expressions, rather than comparing individuals' ability to classify the emotions from dynamic versus static displays of emotion.

It is only recently that attempts to assess the effect of motion on the perception of facial expression have been conducted using full actual faces. However, as will be described, these studies have important limitations. Harwood, Hall, and Shinkfield (1999) presented moving and static videotaped and photographic displays of posed emotional expressions to 12 19-54-yr-olds with mental retardation and 12 without mental retardation. Participants chose the corresponding emotion portrayed by the displays from among 6 written and pictorial labels of the emotions. Their results indicated that individuals with mental retardation who were significantly poorer than normal subjects at identifying Anger, Fear, Disgust, and Surprise, performed significantly better on the moving as opposed to the static videotaped displays of Sad and Angry. A similar result for motion was also observed in the normal control participants matched for age and gender.

Harwood et al. (1999) appears to be the only published study to report a significant effect of motion on the judgment of emotion. However, their result was limited to the perception of Sad and Anger. The authors never offered any explanations for the limited effect of motion on the perception of Sad and Anger. Their data indicated that the lack of effect for Happy expression might have been due to a ceiling effect. However, this ceiling effect could not account for the lack of facilitative effect of motion on other expressions (Fear, Disgust and Surprise). It is possible that the effect of motion on these expressions was masked by the low performances of participants with mental retardation for these expressions. Given the fact that the participants with mental retardation were significantly less accurate than the normal control subjects for these expressions, the authors should have analyzed the effect of motion on perception of Fear, Surprise, and Disgust separately for the two groups of subjects. Alternatively, the lack of effect on some facial expressions may have been masked by a higher learning effect for those expressions. Harwood et al. (1999) presented the participants with both the static and dynamic presentations of the same items. Another attempt to test the effect of motion on perception of facial expression was conducted by Gepner, Deruelle, and Grynfeltt (2001). They presented children with autism (ages 52 - 84 months old) and normal (ages 21 - 61 months old) control children with “still”, “dynamic” and “stroboscopic” displays of the facial expressions of Joy, Surprise, Sad and Disgust. Their data failed to demonstrate the effect of motion on judgment of facial expression by children with autism and their normal matched controls. The authors attributed their results to a possible ceiling effect in the “still” conditions. Looking at their data, however, the ceiling effect interpretation seemed to be less likely given the fact that their participants were only 65% accurate in the “still” condition. It seems that other factors stemming from the design of the study are more likely to contribute to their results. First of all, their stimuli were developed from a single poser (a female actress). Even though Gepner et al. (1999) had selected the segments that they judged to be the most expressive and realistic, it is likely that their results were limited to the particular stimulus person that they used. Secondly, their “still” condition was developed by asking the actress to maintain the facial expressions as static as she could during 2 seconds of recording. Thus it may not have been purely “static”. Gepner et.al. (1999) acknowledged the possibility that the still condition contained micro movements that helped expression discrimination. Lastly, and more importantly, is the choices of facial expression included in their study may have minimized the possibility for confusions among facial expression and thus limited the effect of motion in disambiguating them. Studies in perception of facial expressions tend to demonstrate common confusions among some specific expressions (McKelvie, 1995). For example, Surprise is commonly confused with Fear, Anger with Disgust and Sad with Neutral. Gepner et.al.'s (1999) stimuli depicted only Joy, Surprise, Sad and Disgust. With those selections the expressions commonly confused with each other were not present both in the stimuli and in the response choices presented to the participants. If motion facilitates the recognition of facial expression by disambiguating the expressions, then the manifestation of this effect may have been greatly reduced in Gepner et.al.'s (1999) study.

Interestingly, Gepner et.al (1999) introduced a condition called "stroboscopic" to mimic the perception of motion reported by autistic adults (Gepner et al., 2001). The stroboscopic conditions consisted of 2 to 4 frames per second selected at regular intervals from the dynamic condition sequences. In principle, the stroboscopic conditions were also dynamic in nature with slow speed and abrupt changes of the expression displayed. Their data indicated a significant increase in performance by control subjects in stroboscopic conditions than in still presentations. For that reason, Gepner et.al. (1999) should have reported a beneficial effect of motion, that is, a specific effect of slow and abrupt changes presentation, on perception of facial expressions.

Another attempt to test the effect of motion on full-actual facial displays of emotion with normal adults also failed to find a significant effect. In an unpublished dissertation, Dube (1997) found a non-significant tendency toward better judgment of facial expression in the dynamic presentation than in static presentation. In his study, Dube (1997) asked 4 posers (2 males and 2 females) to express two sequences of facial expressions. Each sequence included the changing expression from Sad to Happy or from Happy to Sad. Each sequence was presented multiple times and participants had to label the expression and provide ratings on several dimensions (including intensity and confidence). The main relevant finding from these studies is that the dynamic presentation led to a general increase in the identification rates and saliency judgments as compared to static presentation. However, this overall observation across all subjects did not reach a significant level. One reason proposed by the experimenter is the ceiling effect for the static presentation.

Another problem with Dube's (1997) study is the use of very limited posers (4 or in some studies 3 posers). The limited number of posers allowed more room for posers' expressiveness and idiosyncrasy to have an effect. This aspect might have contributed to the poser effect in the studies, and limited the generalization and interpretation of the findings. More importantly, it might have contributed to the failure to demonstrate a facilitation effect of dynamic sequences on the perception of emotional facial expressions. In the future, studies should attempt to use more stimuli from varying posers to overcome this problem.

Another factor that appears to be common in the studies discussed above is the use of strong (intense) facial expressions as stimuli. In relation to that, those studies also raised a possibility of a ceiling effect. To this end, the intensity of the facial expressions may be important in maximizing the effect of motion. Perhaps motion would be more beneficial in more difficult tasks, as in the case of judging subtle facial expressions. The use of strong facial expressions as stimuli appears to be standard in most studies of facial expressions. In addition to the problem of ecological validity with using this form of stimuli (Carroll & Russell, 1997; Tian et al., 2001), it also may have contributed to the failure to demonstrate a robust effect of motion on facial affect judgment in the above studies.

In summary, previous studies indicate a suggestive but equivocal effect of motion on perception of facial expressions. One of the main problems appears to reside in the use of intense facial expressions. Specifically, the use of more subtle facial expressions may reveal a more robust effect of motion.

The Possible Mechanisms. As mentioned briefly above, studies by Ekman and Friesen (1982) and Hess and Kleck (1990, 1994) suggested one possible role of motion in facilitating judgment of facial expression, that is dynamic display of facial expressions provides unique information about the expressions that is not available in the static display, namely the temporal information of the expressions itself. Another possible role of motion on perception of facial expression is simply that moving sequences provide more information to disambiguate the expression. Indeed, one of the major problems in comparing static and dynamic display of facial expression is that only one image is sufficient to display an expression in a static mode. But it takes many more to create a sequence of facial expression in progress. Thus, by definition, moving sequence usually contain many more static pictures, and hence more information on the expressions in progress, than static display. This fact alone suggests the possibility that it is the additional information that helps in disambiguating the emotion signal. Toward this end, the dynamic property of the sequence itself may not be important. This possibility, although has been implicitly recognized (Ekman & Friesen, 1978; Ekman & Friesen, 1984; Hess & Kleck, 1990) has not been tested empirically.

Previous studies comparing static and dynamic presentation (e.g. Dube, 1997) could not test this hypothesis, because the dynamic condition was only compared to a single static condition, and hence confounding the amount of information with the dynamic property of the stimuli. Thus, the possibility that dynamic sequence simply provides more static information remains a hypothesis, which will be tested in the current study. This hypothesis can be tested by separating the effects of the two factors that are inherently combined in a dynamic sequence, the amount of information and the dynamic property of the sequence. The effects of those two factors can be tested separately by adding one more static condition. This condition should have an equal amount of information with that presented in the dynamic condition, but without the perception of motion. This condition will be called Multi-Static condition. (See Figure 3. Descriptions of Motion Conditions).

Another way in which motion can affect perception of facial expression is through its effect on the mode of processing employed by the observer. In face perception, a distinction is often made between configural-based processing and featural-based processing. These two distinctions of mode of processing originally came from studies of face recognition. Configural information is defined as interactions among individual features of the face, whereas a feature is a visual characteristic of a single facial component (eyes, brows, mouth, and nose). Caroll and Russell (1997) made a similar distinction between *pattern* and *action unit (AU).* While all of the configural information in the current definition falls into Caroll and Russell's (1997) category of *pattern*, the current definition of a feature is different from their description of an *action unit*. An angled brow in a sad expression will be one piece of featural information even though it can be scored as AU 1+4, which would be categorized as a pattern in Caroll & Russell's (1997) study. Another similar distinction is that between *holistic* and *componential* processing in face recognition (Carey & Diamond, 1994). Holistic, just like *pattern*, involves the processing of multiple components of the face. In the face recognition literature, holistic and configuration have been used to refer to slightly different kinds of information. Configural information usually refers to spatial relationships among features, for example, the distance between the eyes, the distance between the tip of the nose and the upper lip, etc. Holistic usually refers to the perception of the whole face as a non-decomposable unit. In the current study, the term configuration or *configural information* is conceptualized as *interactive influence of facial features*. No assumption will be made about the nature of information contained in the configuration, whether it is the spatial relationship or other kind of relationship among features or even the holistic impression of the face.

The possible role of motion in mode of processing mentioned above specifically hypothesized that motion might improve perception of facial expression by facilitating configural processing of the face stimuli. It could be that seeing the movements of the facial features (elements) in accordance sheds light on the organization of those facial elements and how they relate to one another, and hence promotes the perception of coherence, and thereby shapes the interpretation of expression through the pattern of movements of the whole elements synchronously.

The idea that motion can promote the perception of coherence among the facial features is not implausible. The human visual system is known to have a remarkable ability to recover spatial structure and the nature of action of an object from the motion of its elements (Braunstein, 1962; Cutting, Moore, & Morrison, 1988). Cutting, Moore, & Morrison (1988) used the point-light technique and put some points on the major joints of a poser. The poser was then instructed to perform several actions, such as walking, running, jumping, and dancing, while being videotaped. Before showing the images to observers, Cutting, Moore, and Morrison (1988) added extra, random, dots to the display of the poser's figure. These extra random dots masked the dots that were carefully positioned on the major joints. Thus, on a still image, the walker's dots became totally invisible, blended seamlessly into the background dots. If, however, motion is added to the display by playing the film, then the form of the point-light figure and the nature of the action it was performing became quickly and easily apparent. Cutting, Moore, and Morrison's (Cutting et al., 1988) study demonstrated that motion could provide information about structure. Perhaps the pattern of motion promotes the perception of coherence and wholeness among the body parts of the point-light figure that allows observer to interpret the dots as belonging to the point-light figure and separate it from the background dots, which did not move the same way. Based on the above demonstration, it is plausible that a moving sequence of facial expression could have a similar role in promoting the perception of configuration, and hence facilitating configural processing in the perception of facial expressions. Indirect evidence of this role comes from studies of face recognition. A more detailed description of this study and an interpretation of the findings to support the above idea will be discussed in the next section on The Role of Motion on Face Recognition.

The new idea introduced above, that motion improves judgment of facial expression by facilitating configural processing, entails a very important aspect. That is, it strongly relies on the premise that judgment of facial expression itself is largely configural-based. Supports for the premise should come from studies of mode processing in the perception of facial expressions. What has been known about the dominant mode of processing employed in the perception of facial expression? Unfortunately, the answer to this question has not been conclusive. As mentioned before, the traditional work on facial expression focused on the social aspects of judgment of facial expressions, and largely ignored the basic perceptual processes underlying the experience. However, one of the most reliable findings in the face recognition literature is the observation that people are sensitive to configural information in a face. Perception of facial identity is largely dependent on configural processing.

Ways to Test Mode of Processing on Face Perception. The inversion effect, the composite effect, and the filteration effect are three of the common findings in face recognition literature which provide evidence for the reliance on configural information. The inversion effect shows that recognition of faces is much more difficult when the faces are inverted than when they are in the (normal) upright orientation (Bartlett & Searcy, 1993; Freire, Lee, & Symons, 2000; Hancock, Bruce, & Burton, 2000; Leder & Bruce, 2000; Leder, Candrian, Huber, & Bruce, 2001). A number of strands of evidence indicate that it is the ability to perceive the configuration of the face that is disrupted by inversion (Bartlett & Searcy, 1993; Freire et al., 2000; Hancock et al., 2000; Leder & Bruce, 2000; Leder et al., 2001). For example, Freire, Lee, and Symons (2000) demonstrated inversion effect on same-different judgments between two faces but only on those faces which were altered configurally. No inversion effect was found on judgments of featurally altered faces.

Works on the composite effect combine the top half of one face with the bottom half of another. When the two halves are correctly aligned (to form a composite face), it is hard to recognize the individual identity of each half. If misaligned (to form a noncomposite face), identification is much easier. Thus, identification of the composite face as "all of a piece" interferes with identification of its parts (Carey & Diamond, 1994; White, 2000).

Filteration is a technique to manipulate the accessibility of featural and configural information during face recognition. The idea is based on Sergent's (1984) claim that featural information is preserved in the high spatial frequency, whereas only the configural information is contained in the low spatial frequency. A few studies have confirmed that face recognition can still be achieved in faces containing just the low facial frequencies (e.g. Nagayama, 1999), suggesting that recognition is still good even when only the configural information is available.

The same three techniques above have been used in a few attempts to study the mode of processing in judgment of facial expression (Bartlett & Searcy, 1993; Endo, Kirita, & Abe, 1995; Kirita & Endo, 1995; McKelvie, 1995; Muskat & Sjoberg, 1997; Searcy & Bartlett, 1996; White, 1999, 2000). These studies have demonstrated somewhat inconsistent results. However, direct comparison is difficult due to various methodological differences among them. The differences include the type of stimuli (line drawings, pictures of real faces); type of experimental manipulation (inversion, composite, filter); type of tasks (identification, same-different judgments, pre-semantic level search task, grotesqueness ratings), and the level of analysis (overall facial expressions, or type of emotion). The possibility remains that these various methodological differences can account for the differences in the results.

Although it has been somewhat inconsistent, the general picture seems to show that the dominant mode of processing employed in judging facial expressions partly depends on the type of emotion. Anger and Disgust are most consistently found to show the inversion effect, which means that judgment of Angry and Disgust faces tends to be based on configural processing. On the other hand, judgment of Happy and Surprise faces tend to be based on featural processing. For Sadness, there was a stronger tendency for judgment to depend on configural processing as opposed to featural-processing. Whereas for Fear and Neutral faces, the tendency is for judgments to be based on configural processing, although much more support is needed for this claim. (See Table 1)

Insert Table 1 about here

Another aspect worth noting about the studies mentioned above is that some of the stimuli and the types of task utilized in those experiments lack ecological validity. For example, line drawing is a very simplified (impoverished) kind of facial stimulus. Studies using line drawings tend to reveal a different result from studies using real faces (McKelvie, 1995, Experiment 1 and Experiment 2). Real faces are more ecologically valid than line drawings. However, the type of real face stimuli is also important. The above studies which used real face as their stimuli typically used selected pictures from a standard set of faces (Ekman & Friesen, 1976), which have been acknowledged to show exaggerated facial expressions (Wallbott & Scherer, 1986). As mentioned before, the above findings were based on a handful of studies with various methodological differences. Thus, more study is needed before the above interpretation can be proposed with more confidence, and future studies should attempt to use more ecologically valid stimuli and judgment tasks.

Furthermore, besides the various differences among the studies discussed above, the main similarity between them is their use of static displays of facial expression. This exclusive preference to static display is not surprising given the fact that traditional works on facial expression have used static presentations. Thus, the possible influence of motion on mode of processing is still unknown. The idea that motion can facilitate configural processing, however gains indirect support from studies on face recognition. A more detailed description of this issue will be discussed in the following discussion of face recognition.

Summary. In summary, the previous works on the perception of facial expression, with their exclusive preference for static presentation, have generally failed to consider one crucial factor, the role of motion (dynamicity) in judgment of facial expression. Of the few attempts to characterize the effect of motion, the problems come from the use of either impoverished stimuli (point-light display, line drawings), or a limited set of stimuli (Dube, 1997) and there was no clear explanation for the mechanism by which motion affects perception of facial expressions. The current study will build upon those previous studies and test three possible roles of motion. The first possible role is that motion simply provides additional information on the expression to help disambiguate the emotion signal. The second possibility is that motion improves perception of facial expression by providing temporal information, which was not available from a static display. Lastly, the role of motion may be mediated by its unique effect in facilitating configural processing.

The Possible Role of Motion in Face Recognition

In the above section, it was suggested that one the reasons why motion might influence the judgment of facial expression is that it may enhance configural processing. This idea suggests that motion would also facilitate other perceptual processes that rely on configural processing. As briefly discussed above, the perception of facial identity is reliably found to depend on configural-based processing. Thus, face recognition provides a great opportunity to explore the effect of motion on mode of processing. In other words, if motion facilitates configural processing, then motion should have a beneficial effect on processes that are configural-based, such as face recognition.

There have been several studies which documented the role of motion on face recognition (Bruce & Valentine, 1988; Christie & Bruce, 1998; Knight & Johnston, 1997; Lander, Christie, & Bruce, 1999; Lander & Bruce, 2000; Pike, Kemp, Towell, & Phillips, 1997). However, these studies mostly involve recognition of famous faces (Lander et al., 1999; Lander & Bruce, 2000) in which recognition of faces in static (single and multiple) and dynamic displays are compared. These studies have reliably documented the beneficial effect of motion in the recognition of famous faces.

The Possible Mechanisms. One important aspect of the studies discussed above, which is inherent in the type of face they used (famous faces), is that they have to avoid a ceiling effect by degrading the stimuli. Three techniques have been used to make the faces more difficult to recognize, inversion (Lander et al., 1999), negation (Knight & Johnston, 1997), and filteration (Lander & Bruce, 2000). The beneficial effect of motion for recognition of famous faces has been found across these different techniques of degradation. Two possible mechanisms have been proposed to explain the beneficial effect of motion:

1. Motion restores 3-D structure of the face through shape-from-motion effect.
2. Motion reveals idiosyncratic facial behaviors, which serve as another cue to identity.

One problem with the first interpretation is related to the type of motion that the stimuli in these studies were comprised of. It was described clearly that the face stimuli used in the studies primarily contain non-rigid transformation such as facial expression and talking, with very little rigid motion such as nodding and head turning (Lander & Bruce, 2000; Lander et al., 1999). Considering the type of motion in the stimuli, it is less likely that judges will be able to restore the 3-D structure of the face, simply because the 3-D information is not made explicit by non-rigid motion (Lander & Bruce, 2000).

It was discussed in the previous section that inversion and filteration affect the mode of processing that the judges could make use of in their judgments. Inversion disrupts configural processing of the face. Filteration (or blurring), however, limits the availability of the type of information by filtering out featural information and leaves only the configural information intact. The last notion suggests that recognition of blurred faces should be based on the processing of configural information alone. The fact that inversion and filteration influence mode of processing, and that motion facilitates identity judgment of inverted and blurred faces, suggest that the role of motion in facilitating these faces might well be mediated to mode of processing. The previously proposed mechanism has neglected the important aspect of the nature of the stimuli and the possible effect of motion on mode of processing. Taking into account that inversion disrupts configural processing, and that blurring forces the use of configural processing, the more specific explanation of the role of motion on the recognition of inverted and blurred faces would be that motion restores or facilitates configural processing. This possible mechanism has not been appreciated in the literature. A study designed to directly test this hypothesis is necessary to support this new idea.

To directly test the role of motion in restoring configural processing, a study should be designed in such a way to minimize the other two possible roles of motion: those are, restoring the 3-D structure of the face, and providing idiosyncrasy to aid recognition of identity. The first caveat is relatively easy to control, that is by limiting the type of motion contained in the stimuli. Specifically, by strictly using non-rigid motion (such as facial expressions) we can minimize the possibility that movement restores the 3-D structure of the face. However, selecting the non-rigid motion (such as facial expressions and talking) does not minimize the second possibility, the idiosyncrasy factor. In fact, individual's unique facial behavior is usually unveiled by the way they talk or the way they express their emotions. For example, some people smile with wrinkles in their nose. One way to overcome this problem is by testing the effect of motion on the recognition of unfamiliar faces. With unfamiliar faces, we can rule out the idiosyncrasy effect, simply because the unique facial behavior of an unfamiliar person is, by definition, unknown. The recognition of unfamiliar faces, therefore, is an excellent research area to further explore the effect of motion on mode of processing. Furthermore, with unfamiliar faces, researchers have more control in the availability and the development of the stimuli. If studies using famous faces relied heavily on clips taken from TV and films as the source of stimuli, studies on unfamiliar faces allow researches to exercise relatively any control in the development of stimuli as deemed necessary (e.g., minimize head movements).

Recognition of Unfamiliar Faces. There have been only a couple of studies on the effect of motion on the recognition of unfamiliar faces in the literature. These studies mostly tested the effect of rigid motion (head turn or nod) and found that motion aids recognition (Pike et al., 1997). Studies by Schiff, Banka, and deBordes Galdi (1986) and Christie and Bruce (1998) are exceptions in that they manipulate non-rigid motion (facial expression and/or talking) in the study phase. However, the two studies differ in the type of motion they used at the testing phase. Schiff, Banka and deBordes Galdi (1986) used rigid motion (180^0 sweep of the camera around the face), whereas Christie and Bruce (1998) used different non-rigid motion than the one used in the study phase. Both studies revealed a slightly different result but the same tendency toward the beneficial effect of motion on the test phase. No specific mechanism was proposed for this tendency. Thus further study is needed to corroborate the beneficial effect of motion on the recognition of previously unfamiliar faces. Preferably, studies should attempt to generate and test hypotheses regarding the mechanism by which the effect is unveiled.

Summary. In summary, studies on face recognition have reliably found that judgment of a person's identity from the face is largely dependent on configural processing. This finding has been drawn mostly from studies showing the inversion effect, that is, recognition of a face is more difficult when the face is inverted than when it is in its normal upright orientation. Recognizing an upside-down face is difficult because inversion disrupts configural processing. Inversion has also been used as a technique to avoid a ceiling effect in studies of the recognition of famous faces. These studies have demonstrated the facilitating effect of motion in recognizing inverted famous faces. Those findings suggest a possible role of motion in restoring configural processing which has been disrupted by inversion. This interpretation has not been appreciated in the past. The current study will build upon the results of the previous studies and directly test the possible role of motion in facilitating configural processes in face recognition. Unfamiliar face recognition will be examined because it provides a good opportunity to test the above hypothesis directly while controlling for the competing interpretation. The use of unfamiliar faces, reduces if not eliminates the idiosyncratic effects of individual faces and affords greater control in developing the stimuli (e.g., allowing the restriction of the type of motion to non-rigid motion -facial expressions- contained in the face stimuli.) Minimizing the amount of rigid motion (such as head movement) is important to control for the effect of motion in restoring the 3-D structure of the face. Furthermore, studying the effect of motion on unfamiliar faces allows the advancing of our knowledge in the currently underdeveloped field.

Comparing the Role of Motion in Perception of Facial Expression and Face Recognition

The above discussions provided background and underlying motivations to study the effect of motion on judgment of facial expression and identity. Very few studies have been conducted to study both domains at the same time. This is consistent with the basic claim in face recognition literature, that is, the processing of facial identity and facial expressions are functionally independent. Supports for this claim mostly come from the double dissociation between ability to recognize a face and facial expression from prosopagnosic patients. Several cases have been reported about brain injured patients showing marked impairment in recognizing facial expression while having a preserved ability to recognize familiar faces, whereas patients with intact perception of facial expression and impaired face recognition have also been reported (Young, Newcombe, de Haan, Small, & Hay, 1998). However, this idea has been challenged by recent studies that demonstrate at least an asymmetrical relationship between face recognition and perception of facial expression (Baudouin, Gilbert, Sansone, & Tiberghien, 2000; Baudouin, Sansone, & Tiberghien, 2000; Endo, Endo, Kirita, & Maruyama, 1992; Nagayama, 1999; Nagayama, Yoshida, Miyatani, & Toshima, 1999; Schweinberger, Burton, & Kelly, 1999). For example, Schweinberger et.al. (1999) found that familiarity affected judgment of facial expression but facial expression did not affect familiarity judgment.

The idea of independency or even asymmetric dependency between face recognition and perception of facial expression suggest some differences between the two processes. Unfortunately, exactly how the two processes differ has not been documented in the scientific literature. One reason for this lack of comparison is probably due to the concern that comparing face recognition with perception of facial expression is like comparing apples and oranges. Indeed, the two domains are usually studied at different cognitive levels. Perception of facial expressions usually involves a perceptual paradigm whereas judgment of facial identity typically involves a memory paradigm. However, a comparison study can be done by carefully designing the procedures in such a way to minimize possible confounding factors and maximize compatibility between performances in the two tasks.

Another reason for the lack of documentation on the differences between judgment of facial identity and facial expression, and perhaps the most logical one, is that the nature of perceptual processes of facial expression is largely unknown. Although it seems surprising, given the fact that there has been a wealth of studies on facial expressions, it is not as surprising as it seems when we take a look at the traditions where these studies came from. Studies on face recognition and facial expressions generally come from different traditions. Studies on face recognition mostly came from the Cognitive Psychology tradition, and they have a strong emphasis on the perceptual mechanism involved and the mental representations of faces. On the other hand, studies on facial expression were strongly influenced by the Social Psychology framework. These studies put emphasis on the communicative value of signals of facial expression. For example, these studies concern how facial expression can reveal deception; influence judgment of responsibility; indicate social dominance; and guide mother-child interaction. As a result of this different emphasis there is still little knowledge about the perceptual processes of facial expressions. To this end, researchers of facial expressions have an advantage of being able to borrow some of the reliable and tested methods and paradigm from the face recognition literature. Additionally, the vast literature on face recognition provides a good source of references that can serve as guidelines on an attempt to compare perception of facial expression and facial identity.

There are good reasons to compare judgment of facial identity and facial expression. Both processes require information about the internal parts of a face, which suggest that there might be some similarities between the two processes. One of the similarities can be seen, for example, in the studies of lateral hemisphere, in which right hemisphere dominance has been documented for both face recognition and perception of facial expression (e.g. Ambadar, 1994). Another similarity is in the importance of context in judging identity and affect (Russell, 1991; Russell & Fehr, 1988; Walbott & Ricci-Bitti, 1993). On the other hand, the two processes require different level of details in the information. Perception of facial expression can still be achieved from eyebrows and mouth lines in drawings, which lack identity information (White, 2000). Moreover, identity judgment requires recognition of specific identity from a vast number of identifiable faces, whereas the number of possible facial expression is relatively limited, only half a dozen or so primary expressions (Ekman, 1992).

Comparing face recognition and perception of facial expression is not only feasible but also important in advancing our knowledge in both domains. Especially when comparison be made on critical aspects shared by the two domains such as motion and mode of processing.

Overview of the Current Experiments

Faces, perhaps, are the most salient objects encountered everyday and are rich with information. Two of the most important types of information, which people can extract from a face, is identity and emotion. These two aspects of face processing have enjoyed an abundance of attention in the scientific community. However, one thing that seems to be common for the bulk of research in the two domains is the exclusive preference for the use of static display. The dynamic property of a face has been neglected in the literature of facial expressions and face recognition. It is the main focus of the present study to directly test the role that motion might play in the perception of facial expression and identity. Motion is a critical aspect shared by the two domains. By looking at the effect of motion on both perception of facial expressions and face recognition, the study did not only advance our knowledge on both domains separately. It also allowed us to test whether motion affects the perception of facial expression in a similar way that it affects face recognition. Furthermore, the present study was designed to shed light on the mechanism by which motion affected those judgments. Three possible mechanisms were proposed and were tested in the study.

1. *Motion provides more information than static display*. In the case of judgment of affect, this additional information might help in disambiguating the emotion signal. Whereas in the case of face recognition, these additional information may promote richer representation by providing multiple instances of the face which will then facilitate search when making identity judgments.
2. *Motion provides temporal information of the expression, which is not available in the static display*. This second possible mechanism is specific to the judgment of facial expression.
3. *Motion facilitates configural processing*. Seeing the facial features move together could clarify the interaction among those elements, promote the perception of coherence and thereby facilitate configural processing of the face.

The first two (2) mechanisms described above were tested by comparing human judgment performances, on both perception of facial expressions and face recognition, on three (3) different conditions which differ only in the type/format of the stimuli.

1. *Single-Static* condition, in which only a single static picture was presented for each trial.

2. *Multi-Static* condition, in which a series of static pictures was presented for each trial.
3. *Dynamic* condition, in which a moving sequence was presented for each trial. The difference between Multi-Static and Dynamic condition is the absence (in the Multi-Static condition) or presence (in the Dynamic condition) of the perception of motion.

If motion facilitates performance by providing more static information than a single static display (mechanism 1), performance in the Multi-Static and Dynamic conditions will be significantly higher than performance in the Single-Static condition. However, there will be no significant difference between the Multi-Static condition and the Dynamic condition. If, however, motion provides temporal information that is not available in the static display (mechanism 2), there will be a significant difference between performances on the Multi-Static and Dynamic condition.

The last mechanism, that is motion facilitates configural processing, was tested by manipulating the orientation of the facial stimuli in the presentation. The faces were presented in two (2) different orientations: upright and inverted. This manipulation is the same for all three conditions described above. If the role of motion on facial judgments is mediated by its role in facilitating configural information, then we should expect a significant interaction effect between motion and orientation.

The role of motion in judgment of facial expressions and identity was investigated in two experiments with different paradigms. Both experiments implemented the same basic manipulations, which include inversion manipulation and the presence or absence of motion in the display of the stimuli. The stimuli for both experiments were drawn from the same database and were pre-processed in a certain way to avoid some confounding factors, which will be described later. There are two main differences between Experiment 1 and Experiment 2. Experiment 1 focused on judgment of facial expression, whereas Experiment 2 involved both judgments of facial expression and identity. More importantly, Experiment 1 implemented a perceptual paradigm, whereas Experiment 2 used a memory paradigm. In the perceptual paradigm (Experiment 1), participants made immediate judgments following each presentation of the stimuli. In the memory paradigm (Experiment 2), participants followed through two phases, the Study Phase and the Test Phase. The procedure for the Study Phase is identical to that in Experiment 1, whereas the memory for facial expression and identity judgments were made in the Test Phase that followed the Study Phase immediately.

The implementation of two different paradigms as briefly described above was meant to serve several specific purposes. The perceptual paradigm represents the natural way people judge emotion in the face better than the memory paradigm. It is much more likely that people make online judgments about the emotion underlying others' facial expressions, rather then recalling them in future time. On the other hand, identity judgments always involve a memory component. Judging whether or not we recognize someone basically indicates whether or not we have seen the person previously. This basic difference in the nature of the two domains is critical and should be taken seriously in an attempt to compare performances. It is for this reason that the second experiment was designed with a memory paradigm, that is, to ensure that the two tasks (judgment of facial expression and identity) are at a comparable cognitive level. Furthermore, having different paradigms in Experiment 1 and Experiment 2 allows for the assessment of the limitation or the extension of the role of motion on judgment of facial expression. That is, whether the role of motion will endure the passage of time or will it just affect the immediate judgments without affecting the recollections of the previously seen facial expression.

Specifically, Experiment 1 was designed to address the questions below.

1. Does motion facilitate judgments of facial expressions?
2. Do judgments of facial expressions depend on configural processing?
3. Does motion influence the mode of processing involved in making judgments about facial expressions?

Similarly, Experiment 2 was designed to address the issues below.

4. Does motion facilitate face recognition of unfamiliar faces?
5. Does motion influence the mode of processing in making judgments about facial identity?
6. Does motion facilitate memory for facial expressions?
7. Does motion influence judgment of facial expression the same way as it affects judgment of facial identity?

Summary

Motion and change are inescapable features of the world around us. Our perceptual systems must have come well equipped to deal with this fact. Faces, as one of the most numerous and salient objects we see in everyday life, change and move with every passing smile, nod or spoken words. It is the main goal in the proposed study to understand more about the role that motion might play in two important domains of face processing, perception of facial expression and face recognition.

Previous work on perception of facial expression and identity has exclusively used static displays of face stimuli. There have only been a handful of studies that attempted to assess the role of motion on perception of facial expressions and identity. Studies on perception of facial expressions held serious limitations which come from the use of either impoverished stimuli (point-light display, line drawings), limited set of stimuli, and there was no clear explanation for the mechanism by which motion affects perception of facial expressions. Moreover, a few studies that demonstrated suggestive but equivocal effects of motion have used intense facial expressions which may have contributed to their unconvincing results. The subtlety of the facial expressions may be important in maximizing the effect of motion and demonstrating a more robust effect. Similarly, studies on face recognition, even though generally were more carefully designed, restricted in their focused of a special type of faces, famous faces. Thus, the role of motion on the recognition of previously unfamiliar faces remains an underdeveloped area.

The current study was build upon those previous studies which attempted to characterize the role of motion on face identification and judgment of facial expression. More importantly, the current study was designed to directly test three possible roles of motion. First, motion simply provides additional information of the expression to help disambiguate the emotion signal, or in the case of face recognition, the additional information provides multiple instances in the representation of the face which facilitate search in identification task. The second possible role is that motion might improve perception of facial expression by providing temporal information of the expression, which was not available on static display. Lastly, the role of motion may be mediated by its unique effect in facilitating configural processing. The second and third mechanisms might be shared by judgment of facial expression and identity.

The current study contributes to the scientific literature by advancing knowledge in the domain of perception of facial expression and identity, specifically with regards to the role of motion. It does so by carefully designing the experiments and selecting stimuli that are more ecologically valid than those which have been heavily used in the traditional works. One main characteristic of the stimuli used in the current study is the subtlety of the facial expressions. The use of more subtle facial expressions is important not only for their ecologically validity, but more importantly for their potentials in maximizing the effect of motion. By comparing the role of motion in face recognition and judgment of facial expression, the study also sheds light on the similarities or differences between the two processes. Similarities and differences between the processes of face recognition and judgment of facial expression are direct deduction from the claim that the two processes are functionally independent. This notion however has suffered from a lack of documentation in the past. Furthermore, the design of the study allows more direct assessments of the possible mechanisms that might mediate the role of motion. Finally, it is the first attempt to promote and test the idea that motion might play a role in restoring or facilitating configural processes on judgment of facial expressions and face recognition. .

Hancock, Bruce, and Burton (2000) noted that based on a review of a large number of studies, humans are usually very poor at recognizing previously unfamiliar faces. However, motion as an important characteristic of a face has been neglected in most of those studies. Hancock, Bruce and Burton (2000) acknowledged that the importance of motion in face identification remains an outstanding question. Based on only a handful of studies, there was a tendency that seeing a face moving improves recognition of the same face at later time. Until we have more knowledge about the role of motion on the recognition of faces, especially, previously unfamiliar faces, we should be careful in attributing difficulty of recognizing unfamiliar faces to human poor ability in this area. The above judgment might have to be rephrased in a way that recognize the limits of human ability in identifying **static display** of not just unfamiliar faces but, under certain conditions, famous faces too. A claim that would be less discouraging given the fact that the very nature of human environment, including social environment (faces), is dynamic.

II

PILOT STUDY

The main purpose of the Pilot study was to select items for Experiment 1 and Experiment 2. Previous studies on perception of facial expressions had exclusively used static prototypic facial expressions, which tend to be very intense. The Pilot study was to select items that are subtle but still recognizable by the majority of participants.

Participants

Participants were 79 (49 females and 30 males) undergraduate students at the University of Pittsburgh, who were taking an Introduction to Psychology class. Participants received class credit for their participation. The age range was 18 to 25 years old with a mean of 18.9 years old. The majority of the participants were Caucasian (72.2%), and 21.5% were African American. Most of them (87.2%) were right-handed, and 9% were left handed, and 2.6% were ambidextrous.

Stimuli

The facial stimuli were derived from the Cohn-Kanade Facial Expression Database (Kanade, Cohn, & Tian, 2000). In this database, 198 posers were instructed to display facial expressions of 6 basic emotions (Anger, Disgust, Fear, Happy, Sad & Surprise). Thus, all of the expressions are posed instead of spontaneous. All posers were undergraduate students of the University of Pittsburgh. The facial images underwent a series of selection processes before being included in the Pilot study. The selection processes were described in detail below.

Stimuli Race. Because there were unequal proportions in the ethnic background of the posers, and because race could affect face recognition, only images from

Caucasian posers were used. Based on this criterion, stimuli were selected from 82 Caucasian posers, most of whom displayed 3 or more basic emotion expressions.

Identifying Information and Occlusions. From the above process, the next selection involved excluding images with identifying information or occlusions (e.g. hat) on the face (for example hair on the forehead, or cheek). This criterion was used to maximize the likelihood that no other information except the facial features and facial expressions will be used in face recognition judgment in the second experiment. Twelve posers (6 males and 6 females) were further removed from the list based on this exclusion criterion. The resulting number of posers was 70, with 42 females and 28 males, and the total number of sequences of 404.

Sequence Quality. The 404 sequences that met the first and second inclusion criteria were shown to 1 certified FACS coder to further select the sequences based on the following criteria. First, the expression should not be ambiguous. Twenty-six (26) sequences were excluded based on this criterion. Second, each sequence had to start with a neutral expression, thus 10 sequences that do not have a neutral start were excluded. Third, no blinks should occur in the sequence. Six (6) sequences were excluded because the poser blinked during the sequence. The last criterion, which resulted in the exclusion of another 5 sequences, had to do with image quality. The total number of sequences that met these selection criteria was 357 sequences from 69 posers. Most of the posers contributed to 3 or more expressions.

Pre-Pilot Naïve Judgment. All 357 sequences from 69 posers were then shown to 3 naïve judges who made independent judgment about the facial expressions. Sequences were selected if all three judges agree on the expressions displayed. Based on judgment agreements from the three judges, 180 sequences by 42 posers were selected. These sequences made up the stimuli for the Pilot study.

Stimuli Preprocessing. The sequences that passed the selection processes described above were then preprocessed in 5 steps for the Pilot Study. First, subtle target frame were selected by 1 certified FACS (Facial Action Coding System) coder. At this step, the first instance for which the target Action Units (AU) met the "b" level according to FACS was selected. Level "b" was chosen as the target intensity level at this step because it is the lowest level for which acknowledged reliability among experienced FACS coders can be achieved. This selected target was defined as the subtlest observable point of the facial expression.

The second step was to create 3 levels of intensity for each of the stimuli based on the subtlest point selected in the first step. Level 1, is the subtlest expression sequence which include the neutral face up to level "b" of intensity. Level 2 was created by adding 1 frame to level 1sequence, that is, adding the very next frame after the level 1 intensity. Level 3, which was the least subtle expression, was created by adding 1 frame to Level 2 sequence. Level 2 and 3 did not necessarily reach the "c" level in FACS, but visibly more intense than Level 1. From this process, all 180 sequences have 3 levels of intensity each, resulting in a total of 540 sequences. The third step was conducted to eliminate background information from the stimuli. This step is important because external information (such as hairstyle, earrings, etc.) can serve as a cue for face recognition especially for unfamiliar faces. In the current experiments maximum effort was done to minimize background or external information, and maximize the likelihood that participants made judgments based on the internal information of the face. For this reason, Photoshop 5.0 software was used to place each face in a black oval frame, which almost entirely eliminated hair and other background information. A specific oval frame was created for each individual face (poser), and showed only the part of the face from forehead to chin. The size of the resulting images varies slightly between posers depending on the size of the poser's face in the recorded image. The range of size is from 3 x 4 inch to 4.3 x 5.4 inch (See Figure 1 for example of the stimuli).

Stimuli Grouping. All the resulting 540 sequences were then divided into 3 groups that made up 3 sets of stimuli (A, B, C). Each set consisted of 1/3rd of each level of intensity for a total of 180 sequences. Thus, each set included all intensity levels at the same proportion. Assignment of items into stimuli set was counter balanced so that each sequence was only represented in one intensity level in a given set. For example, in set A, item 1 is at level 1, in set B the same item is at level 2, and in set C the item is at level 3, etc. Thus, no same sequences in different level of intensity were included in the same set.

In any given set, order of presentation was randomized within each level of intensity. However, items with lower intensity levels preceded items with higher intensity levels. Thus, in each set, all items of level 1 were in the first 1/3rd portion followed by items in level 2 intensity which was then followed by items with level 3 intensity. All items were presented in moving sequence (Dynamic Mode).

Procedures

The Study was described as a study about perception of facial expression. Participants were given explanations and instructions either individually or in groups. After filling in a brief questionnaire about background information and listening to the instructions all participants worked on individual computers. The instructions included how to use “Sequence Player” to open and play each item. Sequence Player is a simple interface written by Tsuyoshi Moriyama (Moriyama, 2000) to play sequences only (See Figure 1). Participants were instructed to drag the item to the Sequence Player window, and play the sequence at least once. They were instructed to watch the sequence and wait until it stops playing to make judgments. This was to ensure that all participants made judgments about the same target, which was the last image in the sequence. Participants were allowed to play the sequence as many times as they need to.

For each of the 180 items participants were asked to make judgments about the facial expressions by selecting among Anger, Disgust, Fear, Happy, Sad, Surprise or Neutral. Each participant worked on the judgment task for about one (1) hour.

Insert Figure 1. about here

Results

Data from the Pilot studies showed the percentage of subjects who judged the items correctly. From this list, items were selected to be included in Experiment 1 by applying four selection criteria. First, items are selected if at least 60% and no more than 75% of the participants judged the expression accurately. From here on, this percentage is referred to as the “score” of each item, and was defined as the percentage of participants who correctly judged the item. Second, if the same sequence with a different intensity level met the first criterion, then only the lower intensity level was included. Third, the movement in the face should involve more than one facial feature. This was to allow configural processing of the face. Lastly, the same number of sequences was to be selected for each facial expression, thus, if extra sequences met the above criteria for any given emotion, then sequences were selected at random to maintain the same average of score among emotion. Table 2 and Figure 2. present Percent Correct of Items Selected for Experiment 1 by emotion category.

Insert Table 2 and Figure 2. about here.

There was no significant difference of average score among emotions [F (5,25)<1).

III

EXPERIMENT 1:

THE EFFECT OF MOTION ON PERCEPTION OF FACIAL EXPRESSIONS

Experiment 1 was designed to test the role of motion on perception of facial expression. Three possible mechanisms by which motion might play a role in perception of emotion and face recognition were tested. These possible mechanisms include:

1. Motion provides more information than static display. In the case of judgment of affect, this additional information might help in disambiguating the emotion signal.
2. Motion provides temporal information of the expression, which is not available in the static display.
3. Motion facilitates configural processing. Seeing the facial features move together could clarify the interaction among those elements, promote the perception of coherence and thereby facilitate configural processing of the face.

The first two (2) mechanisms described above were tested by comparing human perception of facial expressions on three (3) different conditions that differ only in the type/format of the presentation.

1. Single-Static condition, in which only a single picture will be presented in a static mode for each item.
2. Multi-Static condition, in which a series of static pictures will be presented for each item.

3. Dynamic Condition, in which a moving sequence will be presented for each item.

The difference between Multi-Static and Dynamic condition is the absence (in the Multi-Static condition) or presence (in the Dynamic condition) of the perception of motion.

If motion facilitates performance by providing more static information than a single static display (mechanism 1), then performance in the Multi-Static and Dynamic conditions should be significantly higher than performance in the Single-Static condition. However, there will be no significant difference between the Multi-Static condition and the Dynamic condition. If, however, motion provides temporal information which is not available in the static display (mechanism 2), then we should expect a significant difference between performances on the Multi-Static and Dynamic conditions.

The last mechanism, that is motion facilitated configural processing, was tested by manipulating the orientation of the facial stimuli in the presentation. The faces were presented in two (2) different orientations: Upright and Inverted. This manipulation is the same for all three Motion Conditions described above. If the role of motion on facial judgments is mediated by its role in facilitating configural processing, then we should observe a significant interaction effect between motion and orientation. More specific hypotheses are described in the previous general method section.

Participants

Participants were 68 undergraduate students at the University of Pittsburgh who received class credit for participating. Thirty-eight (38) of the participants were females, and 30 were males. Their age ranged from 18-38 years old with an average of 19.66 years old. The majority of the participants were Caucasians (79%), with 8.8% African-

American, and 11.8% other ethnic. Almost all participants (85.3%) reported being right handed, and only 14.7% reported being left handed.

Design

Experiment 1 used a 3 x 2 x 6 Mixed-Design. The Within-Subjects factors were Motion (3 levels) and Emotion (6 levels). The Between-Subjects factor was Orientation of the presented stimuli, which included Upright and Inverted orientation. The 3 levels of Motion conditions were Single-Static, Multi-Static and Dynamic. The motion condition concerned the mode/format of presentation in which the stimuli was displayed. In the Single-Static condition, participants were presented with one face-image only in a static-mode. This target image was identical to the last image of the sequence in the other two conditions. In the Multi-Static condition, stimuli were presented in a static mode, but each item consisted of more than one image (on average 3 to 4 images per item). In the Dynamic condition, the stimuli were presented as moving sequences, just like movie clips. The similarity between the Multi-Static and the Dynamic condition was that each item included more than one image. However, in the Dynamic condition the items were presented as a moving sequence, whereas in the Multi-Static condition, there was no perception of motion.

Insert Figure 3. about here

To prevent perception of motion in the Multi-Static condition, masks were presented in between face images.

Insert Figure 4. about here.

The factor of Emotion had 6 levels; Anger, Disgust, Fear, Happy, Sad, and Surprise.

Stimuli

Sequences were selected based on the result of Pilot Study. Below was a list of selection criteria by which the stimuli were selected.

1. Sequences were selected if they were correctly judged by 60% to 75% of the participants in the Pilot Study.
2. In the case that the same item (same person and same emotion) with different intensity levels met the first criterion, only the subtlest level of the sequence was selected. For example, if Poser 1 with Anger expression in Level 1 was recognized by 65% of the participants, and the same poser displaying the same emotion in level 2 was recognized by 70% of the participants, only the Level 1 sequence was selected.
3. Sequences were selected if the facial movement involved more than 1 facial feature. This criterion was to make possible configural processing of the face.

Based on the above criteria, 36 sequences were selected from 29 posers. The 36 items include 6 basic emotions, which were represented equally in the set (6 sequences per emotion). Masks were created for each of the 36 sequences using Photoshop 5.0. Each mask was created by filling in the face area within an oval frame with black and white *gaussian noise*. The main purpose of using masks is to prevent perception of motion in the Multi-Static condition. The same masks were also used in the beginning of all sequences (see Figure 4. Diagram of Stimuli Presentation in Three Motion Conditions). All 36 sequences were then duplicated in 3 different conditions: Single-Static, Multi-Static and Dynamic based on the specification described above. Each sequence starts with an oval-noise mask that was presented for 200 milliseconds. In the Single-Static condition, the mask was followed by the last image. In the Multi-Static and Dynamic condition, the first image of the sequence was presented for 500 milliseconds following the mask. In the Multi-Static condition, the first image was followed by the mask for 200 milliseconds before the second image was presented. This pattern continued in the Multi-Static condition until the last image. In the Dynamic condition, the first image (presented for 500 milliseconds) was followed by the rest of the images presented at 30 fps (frames per second), that is the rate of which they were originally recorded. All sequences in all conditions end at an identical picture, which was the last image of the sequence. During this time participants made their judgments. Therefore, participants made their judgments on the same target image on all conditions (see Figure 4). Examples of the Single-Static, Multi-Static and Dynamic presentation for the Upright and Inverted orientations can be seen in the movie files linked below:

1. Example 1. Single-Static, Multi-Static, and Dynamic
2. Example 2. Single-Static, Multi-Static, and Dynamic
3. Example 3. Inverted stimuli, Single-Static, Multi-Static and Dynamic

The total of 108 (36 sequences x 3 motion conditions) sequences was then divided into 3 sets of stimuli (Set A, B, and C), counter balanced between conditions. Thus, on each set of stimuli, there were equal numbers of Single-Static, Multi-Static and Dynamic sequences. Stimuli that were presented in a Single-Static mode in set A were presented in

Multi-Static mode in Set B, and in Dynamic mode in Set C, etc. With this counter balancing, each sequence was only presented once for each participant. Each emotion was also represented equally in each set. There were 6 sample of each emotion in each condition. The order of items within a set was randomized with one restriction; no same face was shown consecutively.

One caveat, which should be mentioned regarding the stimuli, was that each emotion was not represented equally in each condition within each set. For example, Anger was represented by 3 items in Single-Static mode and 3 items in Multi-Static mode in set A. There was no Anger item in Dynamic mode in set A. (See Table 3. Stimuli by Condition, Set & Emotion). Consequently, there were empty cells for some emotions, and this affected the analysis on Emotion category effects, which will be discussed in the result section.

Insert Table 3. about here

All 108 stimuli were then duplicated and inverted to make the Inverted Stimuli-Set. Thus, there were 3 sets of inverted stimuli; A, B, and C. These inverted stimuli were identical to the Upright stimuli in all respects except the Orientation.

Procedures

Upon arriving, participants were given a booklet containing a consent form, a brief background questionnaire, PANASX (Positive and Negative Affect Scales), and response sheets. The PANASX includes items with high loadings of Negative and

Positive affect factors (20 items). After completing the questionnaire and PANAS, all participants (in a group) listened to the experimenter's instruction. The experimenter explained the types of judgments participants should make, and demonstrated the way to download and play the sequences. The sequences were played in Sequence Player. Participants were allowed to re-play the sequence as many times as needed, but they had to play it at least once. They were instructed to make their judgment only after the sequence reached the end (the last image).

For each item, participants made 5 different judgments. First, "What emotion best describes the facial expression?" For this judgment, participants chose among 7 options, Anger, Disgust, Fear, Happy, Sad, Surprise, and Neutral. Second, "How strong was the emotion?", and third, "How confident are you with your judgments?" The intensity and confidence judgments were made on 5 points scales (from 1 to 5) where 1 = very weak (or not confident at all) and 5 = very strong (or very confident). Fourth, "Did you see change in the face?", and fifth, "Did you see motion in the face?" Descriptions of what was meant by "change" and "motion" were given and printed at the bottom of each response sheet for reference. "Change" was defined as "when you notice a difference between images in an item", and "motion" was defined as "when you actually see the face move as in a movie clip". Perception of "change" and "motion" were a forced choice judgment, and participants selected "yes" or "no".

Participants were shown one example of the items. They were also told that some of them would see the face upside down. Afterwards, any questions were answered and instructions were repeated when necessary. Each participant then worked on an individual computer. To minimize the possibility of cheating (looking at another participants answers) one computer and an empty chair was placed in between each pair of participants.

Participants were randomly assigned to Upright or Inverted condition, and to one of three stimuli set (A, B, C). Upon completion of the tasks, participants were debriefed and thanked for their participation.

Results

Analysis of Variance on General Linear Model for Repeated Measure Data was used in the analysis of all factors. All analyses were done with SPSS 11.0.1. Statistical analysis of Emotion effects and its interaction with Motion and Inversion were carried out on Macro Subjects. For statistical analysis of Emotion effect, stability of measurement was a problem due to the small number of observations per condition. For each condition on each emotion, there were only a maximum of 4 observations. For some emotions there was no sample information in a particular motion condition (empty cells). By combining data across groups of 3 subjects, the empty cells were eliminated and the emotion effect could be based on a larger number of observations (Loftus, Donders, Hoffman, & Schooler, 1989).

Percent Correct. A highly significant effect of motion was found on perception of facial expression. Participants were far more accurate in judging facial expression when the items are presented in Dynamic mode [F (2,132) = 32.996, p = .000]. The difference between the Single-Static and the Multi-Static presentations was not significant [F (1,66) = 2.584, p = .133]. There was also a highly significant effect of Orientation, which shows that inversion impairs perception of facial expressions [F (1,66) = 78.822, p = .000]. See Figure 5. for the main effects of motion and orientation.

Insert Figure 5. about here

There was also a main effect of gender, which showed that women judged facial expressions more accurately than did men [F (1,64) = 5.580, p =. 021]. There were no significant interaction effects between Motion and Gender [F (2,128) <1], Orientation and Gender (1,64) <1), or three way interaction among Motion, Orientation, and Gender [F (2,128) <1].

The Emotion effect was carried out on 22 macro subjects (11 in upright and 11 in inverted condition). Macro subjects were created by combining data from subjects who were tested at the same time and were assigned to different stimuli set (A, B, and C). A macro subject analysis was used to increase stability of measurement and to overcome the empty cell problems for some emotions. The result revealed a highly significant effect of Emotion [F (5,100) = 22.885, p = .000]. As Figure 6. showed, Happy expressions were more likely to be judged correctly than other emotions, and Anger expression was the least likely to be judged correctly.

Insert Figure 6. about here.

There was no interaction between Motion and Orientation [F (2,132) = 1.108, p >.05]. Two-way interactions between Emotion and Motion, and between Emotion and Orientation were highly significant [F (5,100) = 9.62, p = .000; F (10,200) = 4.674, p=.

000]. However, the 3 way interaction between Emotion, Motion, and Orientation was not significant. [F (10,200) = 1.225, p>.05]. Figure 7. shows that the effect of motion and orientation was similar on all emotions except for Happy and Sad. For Sad expressions, there was no effect of motion [F (2,40) = <1], whereas for Happy, the benefit of dynamic presentation was driven by the motion effect in the inverted orientation [F (2,40) = 7.709, p = .001]. For Upright orientation, the effect of motion was due to the difference between Dynamic, and Multi-Static condition, and between Single-Static and Multi-Static conditions. For Happy expressions, the difference between Single-Static and Dynamic conditions was not significant [F (1,20) = 2.099, p>.05]. In all emotions, except for Happy, the difference between Single-Static and Multi-Static conditions was not significant.

Insert Figure 7. a-f about here

Intensity Ratings. Analysis of intensity ratings was carried out on mean intensity ratings for correctly judged items. The effect of Motion was found to be highly significant [F (2,130) = 6,456, p= .002]. There was also a significant main effect of Orientation [F (1,65)=4.940, p= .03]. Figure 8 shows that the intensity ratings were higher in the Dynamic condition than in the Multi-Static condition. The difference between the Single-Static and the Multi-Static mode was not significant [F (1,66)=2.287, p= .1]. For Inverted orientation, items presented in Dynamic mode were also rated more intense than items presented in Single-Static mode, however, this difference disappeared on the Upright orientation. These results suggest that there might be an interaction effect between Motion and Orientation. However, the interaction effect between Motion and Orientation on intensity rating did not reach significance [F (2,130) = 1.554, p= .215]. Combining the Single-Static and the Multi-Static condition for a general Static condition revealed a similar result. The result for main effect of motion was [F (1,65) = 10.010, p = . 002] and for interaction between Motion and Orientation was [F (1,65) = 2.445, p = .123] not significant.

Insert Figure 8. about here

Confidence Ratings. Similar to the results for intensity ratings, there was a significant main effect of Motion on mean confidence ratings for correctly judged items [F (2,132) = 3.873, p = .023]. The main effect of Orientation was also significant [F (1,66) = 8.889, p = .004]. The main effect of Motion on confidence ratings seemed to be driven by the difference between the Dynamic and the Multi-Static condition [F (1,66) = 6.965, p = .01], and particularly in the inverted orientation. Participants felt more confident with their judgments after Dynamic presentation than after Multi-Static presentation, especially when the faces were upside down. A similar effect was also found between Dynamic and Single-Static presentations in the Inverted Orientation but not in the Upright orientation. The interaction between Motion and Orientation, however, was not significant [F (2,132) = 1.277, p = .282]. (See Figure 9.)

Insert Figure 9. about here

The difference between the Single-Static and the Multi-Static condition was not significant [F (1,66) = 2.579, p = .113]. Combining data from the Single-Static and Multi-Static condition revealed similar results [F (1,66) = 5.571, p = .02] for the effect of motion.

Perception of Motion and Perception of Change. The main purpose of the motion question was for manipulation check, that is, participants should see motion in the dynamic presentation but not in the two static presentations. Statistical analysis was done on percentage of items in which movement was reported in three presentations (Single-Static, Multi-Static, and Dynamic). In addition to perception of motion, participants were also asked to indicate whether or not they see "change" in the face, that is, whether or not they notice a difference in the face between images in an item. Analysis of perception of change was conducted as an indirect test for the change blindness interpretation of the Motion effect. Statistical analysis was done on percentage of items in which participants saw as showing changes in the face.

The data showed that 87% of items presented in the Dynamic condition were seen as showing movements, whereas in the Single-Static and Multi-Static conditions the perception of motion were negligible (3% or 1 item in the Single-Static and 13% or 4 items in the Multi-Static conditions). The effect of Motion was highly significant [F (1,66) = 363.537, p = .000] and was true for both the upright and inverted orientation [F (1,66)<1]. (See Figure 10.)

Analysis on perception of "change" revealed a slightly different result. The main effect of motion was highly significant [F (2,132) = 45.447, p =. 000]. And both the main effect of Orientation and interaction between Motion and Orientation were not significant

[$F(1,66)<1$; for main effect of Orientation and $F(2,132)<1$ for the interaction effect). Figure 10. shows that participants perceived changes in the face for 50% of the items presented in Multi-Static condition, and 36 % of the items presented in Dynamic condition, whereas only 6% of the items in Single-Static condition were seen as showing changes in the face. The difference between the Dynamic and the Multi-Static condition was significant [$F(1,66) = 7.059$, $p = .01$]. (See Figure 11).

Insert Figure 10. and, Figure 11. about here

PANAS. Correlational analyses were conducted independently between PA score and accuracy in the three Motion conditions, and between NA score and accuracy in the three Motion conditions. These analyses were conducted to test the relationships between participants' affective condition at the time and the presentation format. The results showed no correlations between PA and NA score with accuracy on any of the motion condition. See Table 4. Correlation Between PA, NA Score and Accuracy in Single-Static, Multi-Static and Dynamic Condition.

Insert Table 4. about here.

Discussion

Experiment 1 was designed to test the hypothesis that motion can improve perception of facial expressions. The results confirmed the above hypothesis. Participants were much more accurate in judging the facial expression when they viewed a moving face relative to when the face was static. Another main purpose of Experiment1 was to test the possible mechanism by which motion exerts its effect. The three possible mechanisms tested were:

1. Motion provides more information than static display.
2. Motion provides temporal information of the expression, which is not available in the static display.
3. Motion facilitates configural processing.

The results indicated that there was no significant difference between the Single-Static and the Multi-Static condition. This result suggests that additional information alone is not enough to improve perception of facial expression significantly, therefore, the beneficial effect of motion observed in this study could not be due to the fact that motion provides extra static information. The third possible mechanism was tested by analyzing the interaction effect between Motion and Orientation. Inverted orientation makes configural processing more difficult than Upright orientation. Therefore, if the effect of Motion is modified by inversion, this would suggest an effect of configural processing. The result of Experiment 1 indicated no significant interaction between Motion and Orientation on perception of Facial Expression. This result argues against the idea that motion improves perception of facial expression by restoring/facilitating configural processing. Thus, Experiment 1 suggests that the beneficial effect of motion is due to something inherent in the dynamic property itself. One possibility is that specific temporal information of the expression made available and observable in the dynamic condition assists participants in identifying the emotion portrayed in the face. Another possible interpretation of the result is that motion enhanced the perception of change. In other words, the movement of facial features allows perceivers to observe what was changed in the facial expression, whereas, in static pictures perceivers had to envisage the course of the facial expression and hence could be less accurate. The idea that it is difficult to observe change in static pictures has been studied quite extensively in the literature of change blindness. The result in experiment 1 could suggest that motion might counter-act the change blindness tendency in perceiving changes in static pictures and enhance sensitivity to change.

An indirect test of the "change sensitivity" interpretation comes from examining participants' responses to the "perception of change" question. For each item in Experiment 1, participants were asked to report whether or not they see "change" in the face. "Change" was defined as noticeable difference(s) in the face between images in an item. If motion improves the perception of facial expression by facilitating the perception of change in the face, then there should be a significant effect of Motion on perception of change. The results in Experiment 1 suggest that this might be the case. There was a significant effect of Motion on perception of change. Participants reported perception of change on Dynamic items more than they do on Single-Static items. However, there was a non-significant trend that the perception of change was higher in the Multi-Static condition than in the Dynamic condition.

Analyses on Intensity ratings also suggest that Motion increased the perception of intensity of facial expression. Thus, the beneficial effect of motion was also mediated by the increased perception of intensity of the facial expression. The data on Confidence Ratings showed that participants were also more confident in their judgment when they saw the face move than when they saw static pictures.

The results also showed a significant effect of Orientation on the perception of facial expressions. This suggests that perception of facial expression depends on configural processing. The data also showed that some facial expressions depend more on configural processing than do others. Specifically, Surprise tended to be less dependent on configural processing than other expressions, as the accuracy in judging Surprise expression is similar in both the Upright and Inverted conditions. It was also observed that some expressions were more accurately perceived than others. Participants were more accurate in judging Happy expression than other expressions. This is consistent with the “Happy advantage” which was commonly observed in most studies of perception of facial expression (Ambadar, 1994; Feyereisen, Malet, & Martin, 1986; Kirita & Endo, 1995). The Gender effect which was observed in Experiment 1 is also consistent with other studies that find superiority for women as compared to men in judging facial expression (see McClure, 2000; Kirouac & Dore', 1983) for a meta-analytic review).

IV

EXPERIMENT 2

THE EFFECTS OF MOTION ON PERCEPTION OF FACIAL EXPRESSIONS AND FACE RECOGNITION

Experiment 2 served four (4) purposes. First it was an effort to replicate the results in the first experiment. Second, it sought to further test the idea that motion might facilitate configural processing by testing the effect of motion on a task which was found reliably to depend on configural processing, that is face recognition. More specifically, if motion facilitates configural processing, then we should observe the same beneficial effect of motion on face recognition as was found on perception of facial expression. Third, the second experiment also tested the effect of motion on memory for facial expression, a field that had been largely underdeveloped. Testing the effect of motion on memory for facial expressions allowed Experiment 2 to address its fourth purpose, which was a direct comparison between perceptions of facial expression and face recognition. The tasks of recognizing a face and remembering a facial expression were made more comparable, because in this experiment perception of facial expressions and face recognition were tested in the same memory paradigm at the same time. In this experiment remembering facial expression might be slightly more difficult than recognizing a face, because it required specific recollection of the previously displayed expression by a specific person (face), whereas with face recognition accurate judgment could be based on familiarity alone. However, recognizing a face in this experiment should be more difficult than the standard face recognition task. This was because recognizing previously unfamiliar people tends to be based on external information such as hairstyle (Bruce & Young, 1999; Hancock et al., 2000), and this kind of external information was not available in this study.

Experiment 2 was conducted in two sessions, the first session was a Study-Phase, and the second one was the Test-Phase. The study session was conducted in exactly the same way as the perception of facial expression study in Experiment 1. The procedures strictly followed those of Experiment 1. The only difference was that there was fewer items in Experiment 2 than in Experiment 1.

Participants

Participants were 80 undergraduate students at the University of Pittsburgh who received class credit for participating. Forty-three (43) of the participants were females, and 37 were males. Their age ranged from 18-48 years old with an average of 19.51 years old. The majority of the participants were Caucasians (77.8%), with 13.9% African American, and 8.3% other ethnic origin. Almost all participants (90.3%) reported being right handed, and only 6.9 % reported being left handed. Approximately half of the participants (39) were randomly assigned to be in the Upright condition, and 41 participants to the Inverted condition.

Design

Experiment 2 had a 3 x 2 x 6 Mixed-Design. The Within-Subjects factors were Motion (3 levels) and Emotion (6 levels). The Between-Subjects factor was Orientation of the presented stimuli (Upright, Inverted). The 3 levels of motion condition were Single-Static, Multi-Static, and Dynamic. The motion condition concerned the mode/format of presentation of the stimuli. In the Single-Static condition, participants were presented with one face-image only in a static-mode. This target image was identical to the image at the end of the sequence in Dynamic and Multi-Static conditions. In the Multi-Static condition, stimuli were presented in a static mode, but each item consisted of more than one image (on average 3 to 4 images per item). In the Dynamic condition, the stimuli were presented as moving sequences, just like movie clips. The similarity between the Multi-Static and the Dynamic condition was that each item included more than one image. However, in the Dynamic condition the items were presented as a moving sequence, whereas in the Multi-Static condition, there was no perception of motion (See Figure 3, and Figure 4).

The factor of Emotion had 6 levels (Anger, Disgust, Fear, Happy, Sad, and Surprise).

Stimuli

Study Phase. Sequences for the study phase were selected from the first experiment. Only one expression per poser was included in the stimuli resulting in 24 posers for 24 items. The 24 items included 6 emotions, which were represented equally in the set (4 sequences per emotion).

The total of 72 (24 sequences x 3 motion conditions) sequences was then divided into 3 sets of stimuli (Set A, B, and C) counter balanced between conditions. Thus, on each set of stimuli, there were equal numbers of Single-Static, Multi-Static and Dynamic sequences. Stimuli that were presented in a Single-Static mode in set A were presented in Multi-Static mode in Set B, and in Dynamic mode in Set C. With this counter balance technique, each sequence was only presented once for each participant. Each emotion was also represented equally in each set. There were 4 samples of each emotion in each condition. The order of items in a set was randomized with one restriction, no 3 same expression were shown consecutively.

The same caveat in experiment one was also present in the second experiment, which was, each emotion was not represented equally in each condition in each set. For example, Anger was represented by 2 items in Single-Static mode and 2 items in Dynamic mode in set A, but there was no Anger item in Single-Static mode in set A. (See Table 5. Table of Stimuli by Condition, Set, and Emotion). Consequently, there were empty cells for some emotions, and this affects the analysis on differences between emotions, which will be discussed in the results section.

Insert Table 5. about here

All participants regardless of the assigned orientation group saw the stimuli in upright condition in the study phase. The manipulation of Orientation (Upright vs. Inverted) was presented in the Test Phase only.

Test phase. Stimuli in the test phase included all posers in the study phase plus a new set of 24 posers as lures. Half of the old posers displayed the same facial expression as in the study phase (therefore, identical sequence), and the other half displayed a different expression from the one shown in the study phase. Thus, the stimuli in the Test Phase made up of two different sets, the Same-ID set and the Different-ID set. Half of the stimuli consisted of the Same-ID Set and the other half consisted of the Different-ID Set. The Same-ID set consisted of 24 sequences of the same person as the ones presented in the study phase. The Different-ID set consisted of 24 new persons. The Same-ID and Different-ID set contained the same number of items for each emotion (4 items for each emotion). In the Same-ID set, half of the faces (12) displayed the same expressions as shown in the study phase. This half made up the *same-id-same-affect* items. The other half (12) of the Same-ID set displayed a different expression from the ones shown in the study phase. This half made up the *same-id-different-affect* items (See Figure 12. Categorization of the Stimuli in Experiment 2- Test Phase).

Insert Figure 12. about here

In the Test-Phase, each of the 24 face stimuli was duplicated, and the duplicate copy was inverted. Just as in Experiment 1, the stimuli were divided into three sets, Set A, and Set B, and Set C. Each set consisted of 48 sequences (24 old posers or Same-ID, and 24 new posers or Different-ID).

For old items (Same-ID items), the format of presentation in the Test Phase is the same as in the Study Phase. For example, items presented in Single-Static format in Study Phase were also presented in Single-Static format in the Test Phase. With this arrangement, format of presentation between Study and Test Phase was held constant. For new items, the format of presentation was represented equally within a set. Thus, each motion condition was represented by 1/3 of the new items. Overall, the 3 motion conditions (Single-Static, Multi-Static, and Dynamic) were equally represented in the Test items (16 items each).

The order of presentation of the stimuli was randomized within each set. Participants in all three sets saw the same order of presentation of items. The assignment of each set was counter-balanced so that each set was presented to approximately 1/3 of the participants.

Procedures

Study phase. Procedures for the study phase strictly followed the procedure in Experiment 1. Please see procedures in Experiment 1 for more detailed description. Participants, in groups, were given instructions and an explanation about the task and how to respond. Then each participant worked on an individual computer. The study was described as "a study of perception of facial expression" which is the same as the description given in Experiment 1. Participants were not made aware about the upcoming recognition test in the Test-Phase.

Participants were randomly assigned into Upright and Inverted orientation and into group A, B or C indicating the stimuli set that they worked on. All items in the Study Phase were presented right side up. The orientation manipulation was given in the Test Phase only.

Test Phase. The test phase followed the Study Phase immediately. Participants were instructed to let the experimenter know when they were finished with phase 1. Then the experimenter explained the recognition task to participants individually. At this point, participants in the Inverted group were also told that they would see the face upside down and were instructed to do the recognition task the same way as if the faces were in the Upright position.

Results

Analysis of Variance on General Linear Model for Repeated Measure Data was used in the analysis of all factors. All analyses were conducted with SPSS 11.0. To overcome the empty cell problems in some emotions, statistical analysis of Emotion effect, and its interaction with Motion and Orientation were carried out on Macro Subjects. Macro subjects were created by combining data from subjects who were tested at the same time and were assigned to different stimuli set (A, B, and C). A macro subject analysis was used to increase stability of measurement and to overcome the empty cell problems for some emotions.

Just as explained in Experiment 1, for statistical analysis of the emotion effect, stability of measurement was a problem due to the small number of observations per condition. For each condition on each emotion, there were only a maximum of 2 observations. For some emotions, there was no sample information for a particular motion condition (empty cells). By combining data across groups of 3 subjects, the empty cells were eliminated and the emotion effect could be based on a larger number of observations (Loftus, Donders, Hoffman and Schooler, 1989).

Study Phase.

Percent Correct. A highly significant effect of motion was found on perception of facial expression. Participants were far more accurate in judging facial expression when the items were presented in Dynamic mode [$F(2,152) = 32.052$, $p = .000$] than when presented in either the Single-Static or Multi-Static conditions. There was a significant improvement of the facial expression judgment in the Multi-Static condition as compared to the Single-Static condition [$F(1,78) = 5.220$, $p = .03$]. No other effect was significant, including main effect of Gender [F (1,76) <1), and interaction between Motion and Gender [F(2,152) <1) (see Figure 13).

Insert Figure 13. about here.

Analysis of differences between the identification of the six emotions which was carried out on 24 macro subjects revealed a highly significant effect of Emotion [F (5,110)=8.357, p= .000]. Figure 14. shows that Happy expressions were more likely to be judged correctly than other emotions and that Surprise expressions were the least likely to be judged correctly.

Insert Figure 14. about here.

A two-way interaction between Emotion and Motion was also highly significant [F (5,220) = 7.227, p = .000]. Figure 15. shows that the effect of motion was similar for all emotions except for Fear. Participants were much more accurate in recognizing Anger, Disgust, Happy, Sad and Surprise in the Dynamic condition than in the other two static conditions. For recognizing the expression of Fear, however, participants were more accurate in the Multi-Static condition. There was no significant difference between Single-Static and Multi-Static condition for all emotions except for Fear, where the difference was marginally significant [F(1,22) = 3.868, p=. 062].

Insert Figure 15 a-f about here.

Intensity Ratings. Analysis of intensity ratings was carried out on mean intensity ratings for correctly judged items. The effect of Motion was found to be marginally significant [F(2,156) = 2.526, p= .08]. Figure 16 showed that participants gave higher intensity ratings for items presented in motion than items presented in static mode (Single or Multi). There was no significant difference between the Single-Static and the Multi-Static conditions [F(1,78) < 1]. But there was a significant difference between the Multi-Static and the Dynamic conditions [F(1,78) = 4.485, p =. 037]. Combining data from the two static presentations revealed a significant effect of motion [F(1,78)=5.751, p=. 015].

Insert Figure 16. about here.

Confidence Ratings. The results on confidence ratings show that participants were more confident when making correct judgment for items presented in the Dynamic mode as compared to items in Static modes (Single or Multi) [F (2,156) = 4.087, p = .02]. The difference between the Single-Static and the Multi-Static formats was not significant [F (1,78) <1). Combining data from the Single-Static and Multi-Static condition revealed a similar but more significant result [F (1,78) = 11.593, p = 001]. (see Figure 17.)

Insert Figure 17. about here

Perception of Motion and Perception of Change. Statistical analyses were conducted on the percentage of items in which movement was reported. The main effect of Motion was highly significant, suggesting that items in the Dynamic condition were reported as displaying facial movement, but items in the Single-Static or Multi-Static conditions were not [$F(2,156) = 532.501$, $p = .000$]. The data showed that 92.4% of the total items presented in dynamic condition were reported as showing movements, whereas in the Single-Static and Multi-Static conditions the perception of motion were negligible (3.66 % or 1 item in the Single-Static and 13 % or 3 items in the Multi-Static conditions). (See Figure 18)

Insert Figure 18. about here

Analysis on perception of "change" revealed a slightly different result. The main effect of Motion on perception of change was highly significant [$F(2,156) = 86.520$, $p= .000$]. However, this effect reflected the fact that participants reported change perception for items in the Multi-Static condition more often than in the other formats of presentations. Figure 19. shows that participants perceived changes in the face for 61% of the items presented in Multi-Static condition, and 42 % of the items presented in Dynamic condition, whereas only 1% of the items in Single-Static condition were seen as showing changes in the face. The difference between the Dynamic and the Multi-Static conditions was significant [$F(1,78) = 10.191$, $p = .02$]. (See Figure 19).

Insert Figure 19. about here

PANAS. Correlational analyses were conducted independently between PA score and accuracy (percent correct) in the three Motion conditions, and between NA score and accuracy in three Motion conditions. These analyses were conducted to test the relationships between participants' affective condition at the time and their performance on different presentation formats. The results showed no correlations between PA and NA score with judgment accuracy on any of the motion condition. See Table 6.

Insert Table 6. about here

Test Phase

During the Test Phase, participants made two (2) kinds of judgments. For each item they indicated whether they had seen the face in the previous part of the Experiment (Study Phase). Then, if they believed they recognized the face, participants had to judge whether the poser displayed the same expression as in the previous phase. For both of these questions participants answered "Yes" or "No". No more questions were asked for the unrecognized or new items. Participants' answers to the first questions defined the Face Recognition Data. The answers for the second questions, which were conditional upon the correct answer to the first question, made up the Memory for Facial Expression data. Orientation manipulation was also administered in this phase. Half of the participants were tested with items in the normal Upright orientation, and the other half were tested with Inverted faces.

Statistical analysis of the effect of Motion, Orientation, and their interaction effects on Face Recognition and Memory for facial expression were conducted independently on sensitivity (d-prime) and bias (B). In addition, analyses were also conducted for memory for facial expression conditioned upon accuracy of the expression judgment in the first phase. In other words, in the third analysis, memory for facial expression as a function of whether or not the expression was correctly identified in the Study Phase.

Face Recognition-Analysis of D-Prime. Participants' performance on face recognition was not affected by mode of presentation [F (2,148)<1]. In assessing the absence of an effect of motion, it is important to note that there may be a ceiling effect in the Upright condition, where the D-prime for all conditions were close to or even higher than .90. See Figure 20. However, no ceiling effect was observed in the Inverted condition.

Insert Figure 20. about here

The main effect of Orientation, on the other hand, was highly significant [F (1,74) = 253.978, p = .000]. The interaction effect between Motion and Orientation was not significant [F (2,148) <1].

Face Recognition-Analysis of Bias. Similar to the analysis on D-Prime, the result for analysis of Bias showed no effect of Motion [F (2,148) <1], and interaction between Motion and Orientation [F (2,148) <1]. However, the main effect of Orientation was highly significant [F (1,74) = 16.250, p=. 000]. See Figure 21. Effect of Motion and Orientation on Face Recognition-Analysis of Bias. The effect of Orientation on judgment bias suggested that participants exhibited a more reliable criterion shift in recognizing inverted faces than upright faces.

Insert Figure 21. about here.

Memory for Facial Expression-Analysis of D-Prime. Participants' memory for facial expression was not affected by Motion condition [F (2,148) <1]. However, the effect of Orientation was highly significant [F (1,74) = 73.318, p = .000] suggesting that participants in the Upright condition were much more accurate and sensitive in their Memory for Facial Expressions than participants in the Inverted condition. See Figure 22. Effect of Motion and Orientation on Face Recognition-Analysis of D-Prime.

Insert Figure 22. about here

There was no significant effect of interaction between Motion and Orientation [F (2,148)<1].

Memory for Facial Expressions-Analysis of Bias. A similar result was found for the Bias analysis of Memory for Facial Expressions. The main effects of Motion on Memory for facial expressions was not significant [F (2,156) = 1.036, p> .05]. However, there was a significant effect of Orientation [F (1,78) = 21.092, p = .000), suggesting that participants exhibited a more liberal criterion for the Inverted condition than for the Upright condition. There was no interaction effect between Motion and Orientation on judgment bias for Memory for Facial Expressions. (See Figure 23)

Insert Figure 23. about here

Participants' performance on memory for facial expressions was comparable to their performance on face recognition. Comparing accuracy of the memory for facial expressions and face recognition revealed no significant main effect of tasks, or motion [F (1,78) 1.620, $p > .05$ for the effect of task, and F (2,156) < 1 for the effect of motion].

The interaction effects between task and motion, task and orientation, motion and orientation and a three way interaction between task and motion and orientation were also not significant [F (2,156) <1; F (1,78) < 1; f (2,156) < 1; F (2,156) < 1 respectively]. The only significant difference was due to the Orientation effect, which suggests that for face recognition and memory for facial expression, performances were impaired by inversion. (See Figure 24).

Insert Figure 24. about here

Face Recognition Conditional upon Performance at Study Phase. The above analyses of face recognition and memory for facial expression were conducted without considering participant's performance in the Study Phase. A different way to analyze the effect of Motion and Orientation was by looking at participants' performance in the Test phase as a function of their performance in the Study Phase. The questions to answer here were, "How did participants' performance in the test phase relate to their performance in the Study Phase?"; "Will participants remember the expression better if they correctly judged it before?" Similarly, "Will participants recognize the face better if they judged the expressions correctly in the previous phase of the experiment?" And "How do the Motion and Orientation manipulations affect these performances?"

The data showed some intriguing results. The main effect of Accuracy at Study was not significant [F (1,156) <1]. Similarly, the main effect of Motion and the main effect of Orientation was not significant [F (2,156) = 2.116, p > .05, for Motion effect, and F (1,156) <1 for Orientation effect]. However, there was a significant interaction effect between Accuracy at Study and Motion [F (2, 156) = 33.948, p = .000]. As Figure 25. a to c show, the effect of Accuracy at Study on Face Recognition is similar for the Single-Static and Multi-Static conditions suggesting that when participants correctly judged the expressions at Study, they were less likely to recognize the face. The opposite effect, however, was observed for the Dynamic condition. Specifically, when participants judged the expression correctly (at Study), they were more likely to recognize the face at Test (See Figure 25 a to c). One possible explanation for these results would relate to the resources that participants allocated in encoding the face. It is possible that for difficult items (Single-Static and Multi-Static) participants dedicated a lot of resources to encoding the expression at Study and hence less resource were dedicated to encoding the face which could result in poorer face recognition at test. On the other hand, for relatively easy items in the Dynamic conditions, this competing resource problem may not have occurred.

Insert Figure 25 a to c. about here

Memory for Facial Expressions Conditional upon Performance at Study Phase. The same questions as above could be asked for Memory for Facial Expression data. How does accuracy at judging a facial expression at Study affect the memory for it at Test? The pattern of results on the Memory for Facial Expression data was very similar to that for Face Recognition above. The main effect of Accuracy at Study was significant [$F(1,152) = 11.622$, $p = .001$], and there was also a significant interaction effect between Accuracy at Study and Motion conditions [$F(2, 152) = 21.232$, $p = .000$]. Figure 26 a to c showed that the effect of Accuracy at Study on Memory for facial Expressions was similar for Single-Static and Multi-Static conditions. And that effect showed that when participants judged the expressions correctly at Study, they were <u>less</u> likely to recognize them at Test. The opposite pattern was observed for items in Dynamic conditions. For Dynamic items, items judged correctly at Study were <u>more</u> likely to be recognized at Test. This pattern of results seemed counter-intuitive, because if participants devoted more resources for the expressions at encoding, they should have been able to better remember them at later test, and vice versa. However, considering the way that Memory for Facial Expression was tested in the current experiment, each correct answer constitutes two elements, the memory for the face, and the memory for the expression of the face. Thus it is possible that the results mirrored those of face recognition, since it is a big part of the memory task.

Insert Figure 26.a to c about here

Discussion

As in Experiment 1, in Experiment 2 participants were much more accurate in judging the facial expression in the Dynamic presentation relative to either of the Static presentation conditions (Single or Multi). They were also much more accurate in the Upright orientation than in the Inverted orientation. The difference between the Multi-Static and the Single-Static condition suggested that having additional information may help disambiguate the facial expression and thereby improve accuracy in judging facial expression. However, this effect was not enough to account for the full beneficial effect of Motion. These data, together with the lack of interaction effect between Motion and Orientation suggest that the beneficial role of motion in improving perception of facial expression goes beyond simply providing additional views of the face, but is not mediated by configural processing of the face. Thus in sum, with respect to the Study Phase, Experiment 2 replicated the beneficial effect of Motion, the detrimental effect of Inversion, and the lack of interaction between Motion and Orientation on perception of facial expression. The one difference between the two experiments is that a difference between Single-Static and Multi-Static condition which was not significant in Experiment 1, but was significant in Experiment 2.

The results of Experiment 2 again suggest that there is something inherent in the dynamic property of emotional displays that facilitates the perception of facial expression. One possibility is that motion facilitates the perception of “change” in the face. However the results on “perception of change” data do not entirely support this idea. Consistent with the sensitivity to change hypothesis, there was a significant effect of Motion on the perception of change, which reflected in part a significant difference between the Single-Static and the Dynamic condition. However, counter to the sensitivity to change hypothesis the condition in which perception of change was most frequently reported was actually Multi-Static condition.

Participants also rated the facial expression as more intense in the Dynamic than in the Static condition (Single or Multi). This trend however did not reach a significant level. Participants were also more confident with their judgment for Dynamically presented items that the Static items.

Phase-2 in Experiment 2 tested the effect of Motion on Face Recognition and Memory for Facial Expression. Analysis on D-Prime suggested that Motion did not affect Face Recognition. It is possible that the ceiling effect observed for Face Recognition in the upright condition could have contributed to the absence of an effect of motion. However, importantly motion did not affect recognition in the inverted condition, for which there was no ceiling effect, even though it did influence emotion identification. Thus these findings suggest that the processes involved in emotion identification, at least with respect to the manner in which they interact with motion, are qualitatively different than those involved in face identification.

The effect of Orientation on Face Recognition was highly significant, which is consistent with the many studies that have shown that Face Recognition depends on configural processing (e.g. Bruce & Young, 1998; Hancock et al., 2000). A similar effect of Orientation was also observed in Memory for Facial Expressions, which suggest that this task is also more configurally based.

There was also a strong effect of Inversion (Orientation) on participants' tendency to make positive judgment for face recognition and memory for facial expressions. The data showed that participants tend to be more liberal and more likely to give positive identification in the Inverted than in the Upright Orientation.

When we took into consideration participants' performance in the Study-phase, a significant interaction effect between Accuracy at Study and Motion was observed on Face Recognition and Memory for Facial Expressions. The pattern of results for Face Recognition was similar to that for Memory for Facial Expressions. This result suggested that for difficult items (Single-Static and Multi-Static), when participants judged the expressions correctly in the Study-Phase, they were less likely to recognize the face and the facial expression at test. On the other hand, for relatively easy items (Dynamic conditions) correct judgment of the expressions at Study led to better face recognition and better memory for the expressions. The results on face recognition seemed to suggest that allocations of resources may have played a role. Specifically, for difficult items, participants may have allocated more resources on encoding the facial expressions at the expense of encoding the face, and this results in poorer face recognition performance. The same pattern observed in Memory for Facial Expression data seemed to suggest that face recognition may have been a big part of the memory for facial expressions performance at the current study.

V

GENERAL DISCUSSION

Perception of Facial Expression

The Effect of Motion-Main Findings. The results of the two experiments provide compelling evidence for the important, but previously under appreciated, role of motion in the detection of emotions in the face. In Experiment 1, participants were more accurate in judging the facial expression in the Dynamic than the Single-Static and Multi-Static conditions. This result was replicated in Experiment 2. Participants also rated the expressions as more intense in the Dynamic conditions than in the two Static conditions and were more confident in their judgments after seeing the moving sequences than the static ones.

Comparisons with Previous Studies. As noted in the Introduction, the few previous studies that have examined the effect of motion on perception of facial expressions have generally failed to find a significant effect (Dube, 1997; Gepner, 2001), and when effects have been observed they have been modest and limited to only a few emotions. Thus, at first glance, the substantial effect of motion observed in the current studies seems to be in contrast with previous results discussed before. However, differences in several methodological factors between the current and the previous studies may account for the difference in effect size. First and foremost, the current study was specifically designed to include only subtle facial expressions. Previous studies discussed above used fully displayed prototypic facial expressions, which tend to be more intense (Carroll & Russell, 1997). Harwood et al. (1999) selected sequences with average intensity as rated by an undisclosed number of judges. Gepner et al. (1999) selected the most expressive sequences, whereas Dube' (1997) included strong facial expressions of Happy and Sad. It is possible that the use of the subtle expressions in the current study may have been a key innovation that enabled motion to exert its full effect. If this is the case, we should expect the effect of motion to be diminished or even disappear for stronger facial expressions. A replication of the current study using more intense facial expression would be interesting and necessary to test the subtlety hypothesis. Such a replication would also be important for comparisons with the majority of studies in perception of facial expressions. This is because the majority of research on perception of facial expressions uses a standard set of facial expression which tends to be highly prototypical and of strong intensity. Testing the effect of motion on perception of prototypical expressions would render the current studies more comparable to previous studies. Importantly however, the present findings suggest that subtlety of facial expressions, like their dynamic display, may represent a critical feature of real life facial expression displays that has been largely overlooked in most investigations of facial expressions. Another factor that might account for the present studies' unique success in demonstrating the role of motion in facial expression identification involves the number of posers that were used and the variety of the facial expressions that were tested. All of the previous studies used a very limited number of posers and emotions. The number of posers ranged from 1 (Gepner et al., 2001) to 5 (Harwood et al., 1999). The limited number of posers allowed more room for posers' expressiveness and idiosyncrasy to have an effect. This aspect might have contributed to the poser effect in Dube's (1999) studies, and limited the generalization and interpretation of the findings. More importantly, it might have contributed to the failure to demonstrate a facilitation effect of dynamic sequences on the perception of emotional facial expressions. Similarly, the limited number of emotions in the stimuli and answer choices reduces the possible confusions between expressions that shared some common elements (for example eye widening in Fear and Surprise), and thereby reduces the potentials for motion to facilitate affect judgments.

The Mechanisms. In addition to be the first study to provide compelling evidence of the substantial beneficial effect of motion on the perception of all 6 basic emotions in normal adult population, the present study also was unique in exploring the potential mechanisms by which motion might facilitate perception of facial expressions. Three possible mechanisms were tested in both experiments.

1. Motion provides more static information than a single static display, which helps in disambiguating the emotion signal.
2. Motion provides temporal information of the expression, which is not available in the static display.
3. Motion facilitates configural processing.

Experiment 1 reveals no significant difference between the Single-Static and the Multi-Static condition. In Experiment 2, however, the difference between these two static conditions reached significance. This later results support the idea that having additional information about the expression may facilitate expression judgments to some degree. Yet, the difference between the Dynamic condition and the two Static conditions was far greater than the difference between Multi-Static and Single-Static conditions.

Furthermore, no interaction between Orientation and Motion was observed in either experiment, ruling out configural processing as critical mediator of the impact of motion. These converging results thus support the second mechanism for the beneficial effect of motion. That is, motion facilitates judgment of facial expression by providing dynamic information. The questions remain as to what is the specific dynamic property that accounts for the effect. Two possible explanations are discussed below.

One possible source of benefit of a dynamic display is that it may provide idiosyncratic temporal information that is specific to individual facial expressions. A few studies have observed that a particular expression (felt happy) is associated with specific dynamic markers. For example Frank and Ekman (1993) found that spontaneous enjoyment smiles are characterized by smooth and symmetrical action of the *zygomatic major* muscle along with synchronous action of the *orbicularis oculii*. They found this effect by comparing the dynamic characteristics of enjoyment smile and non-enjoyment smile. More recently, Schmidt and Cohn (2002) found a reliable difference in the temporal information of spontaneous smiles as compared to posed smiles. For example, the spontaneous smiles reach peak at slower speed than the posed smiles. These studies demonstrate that reliable dynamic characteristics associated with a specific kind of facial expression are available and that people can use such temporal information to make judgments about the expressions (Ekman & Friesen, 1982; Hess & Kleck, 1990; Hess & Kleck, 1994). Thus, in view of the previous results, the current data might suggest that some distinctive dynamic information may also exist that differentiates each basic facial expression, and that people may use such important information in determining the facial expression. This possibility opens up a new and important avenue for future research to investigate the dynamic property of the facial expression of each basic emotion.

Change Sensitivity Hypothesis. Another possible explanation of the beneficial effect of motion is that a moving sequence facilitates facial expression judgments by better enabling participants to perceive "changes" in the face. Accordingly, the subtle difference between the last image (the target) and the first image (the neutral face) as the expression progresses may have become more visible through motion. The idea that motion facilitates the perception of change is consistent with findings in the literature of change blindness. Change blindness is the inability to detect large changes to scenes from one view to the next. Studies in this field indicate that a very brief disruption in the visual presentation of two images can obscure people's ability to perceive large change between the pictures. The disruption can take several forms, for example through mud-splash (O'Regan, Rensink, & Clark, 1999), a flicker sequence (Rensink, 2000; Scholl, 2000), or a blank image (Rensink, 2000) presented in between the two pictures. People's ability to perceive the change, however, is preserved with consecutive displays of the pictures (Rensink, O'Regan, & Clark, 2000). (See change blindness demo in http://nivea.psycho.univ-paris5.fr/Mudsplash/Nature_Supp_Inf/Movies/Movie_List.html The consequence of the successive presentation of different pictures is the emergent perception of motion. To that effect, the vanishing of the change-blindness tendency (or the enhancement of change sensitivity) following consecutive presentation of the stimulus could be considered as the effect of perception of motion. The consecutive presentation of the two pictures in a standard change-blindness paradigm is identical to the dynamic presentations employed in the current studies. Moreover, the disrupted presentation in a standard change-blindness paradigm is comparable to the Multi-Static condition in the present studies. Thus, the current results may have shown that people demonstrate the change-blindness phenomenon in the perception of facial expressions following a disrupted display of the pictures (i.e. in the Multi-Static condition).

According to the change sensitivity hypothesis, therefore, the better performance in the Dynamic condition as compared to the Multi-Static condition may have been related to the perception of change enabled in the Dynamic condition and not in the Multi-Static conditions.

An indirect test of the change sensitivity interpretation of the effect of motion was included in the current experiments. Specifically participants were asked to indicate whether or not they perceive change in the face for each item they saw. And "change" was defined as noticeable differences in the face between images in a given item. According to change sensitivity hypothesis, participants should have no problem in perceiving changes in the Dynamic conditions, whereas they should demonstrate a difficulty or failure to notice those changes in the Multi-Static and Single-Static items. The results however, were not quite straight-forward. Experiment 1 partially supported the change sensitivity interpretation, since the perception of change was much higher for Dynamic items than for Single-Static ones.   However, contrary to the change sensitivity interpretation, participants reported the perception of change in the Multi-Static condition to a greater degree than in the Dynamic condition. Similar results were observed in Experiment 2.

The fact that perception of change was highest in the Multi-Static condition demands that interpretation of this result be made with caution. An explanation to this result could be offered by looking at the differences between report of “change” and report of “motion” in the Multi-Static and in the Dynamic conditions. In the Multi-Static condition, perception of change was reported much more frequently than the perception of motion. This difference is completely consistent with the expected data for the Multi-Static condition. Thus, participants might have noticed changes in some of the images in the Multi-Static items without perceiving motion. In the Dynamic condition, however, the data were not as expected. Strictly speaking, anytime an individual sees motion within a face they should report also having seen a change since movement requires some, at least brief, change in the configuration of the face. In other words all items reported to have shown motion should have been reported to have shown change, but not vice versa. Consequently, in the Dynamic condition, more items should have been reported as showing change than showing motion. However, this was not the case with the data in both Experiment 1 and Experiment 2. Participants reported more items showing motion than showing change. This means that for some items perception of motion were reported without the perception of change.

An argument could be made that participants might have had a different criterion for reporting motion and change, that is, they might have had a higher threshold (stricter criterion) for perception of change questions than for perception of motion. In other words participants might have been more reluctant to report a change if they could not figure out specifically “what” was changed during the brief sequence presented. Given the subtlety of facial expressions in the two experiments the specific facial change may not quite be apparent.

Another possible explanation is that some participants may not have understood that a moving sequence consists of a series of static images, and hence did not report the perception of change for moving sequences. This was possible because the definition that was given for the perception of change included notions about different images in the item. Those who were not aware that a moving sequence was simply a series of individual images presented consecutively might have thought of the Dynamic items as a whole single presentation and hence would not report the perception of change even though they do perceive the change in the face. One indication of this possibility is shown in the data of some participants who more than others consistently perceived motion without the perception of change.

In summary, there was partial support for the change sensitivity interpretation of the current results. However, it remains a hypothesis that needs to be tested more directly in future studies. Some alternative way to test the change sensitivity hypothesis will be discussed in a later section.

Effect of Orientation. Another main finding in the current experiment was a very strong effect of Orientation on the perception of facial expression. This result was consistent with a small number of previous studies of the way people perceive facial expression (Kirita & Endo, 1995; McKelvie, 1995; Muskat & Sjoberg, 1997; White, 1999). As noted before, there was no interaction effect between Orientation and Motion in the current experiments. However, an interaction effect of Orientation and Emotion was observed in Experiment 1, which suggests that perceptions of some expressions are more configurally based than others. Perception of Anger, Disgust, Fear and Happy are more configurally based, whereas perception of Surprise tends to be featurally based.

The interaction effects between Orientation and Emotion were also consistent with most of the studies mentioned above. Table 7. summarizes the effect of Inversion for each emotion observed in the current and previous studies. It should be noted, however, that Experiment 2 did not include the manipulation of Orientation in the Study-Phase. Therefore, the above interpretation of the interaction effect between Orientation and Emotion was based solely on 1 experiment with limited sample for each emotion. Hence, a replication of the effect is necessary before any strong conclusion can be drawn about this issue.

Happy Advantage and Gender Effect. Other results observed in the current experiments were also consistent with previous results on perception of facial expressions. The superiority of perception of Happy faces was consistent with the "happy advantage" commonly demonstrated in most studies of perception of facial expression. Happy faces are recognized faster and with higher accuracy than other facial expressions (Ambadar, 1994; Feyereisen et al., 1986; Harwood et al., 1999; Kirita & Endo, 1995; Kirouac & Dore', 1983). Also, a happy face can be judged with high accuracy even from more than 45 meters away (Hager & Ekman, 1979).

The present studies also found that women were more accurate than men in judging facial expressions. This gender effect is also commonly observed in the literature (McClure, 2000).

Memory for Facial Expressions.

The results on memory for facial expressions indicated that Motion did not seem to influence memory for facial expression. Participants were just as accurate in recognizing the expressions of a given face regardless of how it was originally presented.

It was quite tricky to compare the current observations with those in previous studies of memory for facial expressions. This is partly because there have been very few studies on this subject. There appear to be only six (6) published investigations on memory for facial expressions, and most of those studies involved participants with disorder, such as patients with anxiety disorders, generalized social phobia (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Perez-Lopez & Woody, 2001), or brain injuries (Prigatano & Pribram, 1982; Weddell, 1989). The argument behind those studies was that the ability to remember facial expressions might have been enhanced (in the case of anxiety and phobia) or impaired (in the case of brain injuries) by these pathological conditions. Two studies were more relevant to the current experiment on memory for facial expressions and will be discussed below.

The first one was by Galper and Hochberg (1971) who used a standard face recognition design similar to the one used in the current experiment. Their tests for recognition assessed both facial and expressional recognition over a series of trials. However, they did not assess the process by which people remember facial expressions. Their main purpose was to compare performance on face recognition and memory for facial expressions. This aspect of their result will be discussed along with the discussion about comparison between face recognition and memory for facial expression in a later section below. The only aspect of their findings which could be compared with the current result was the mean accuracy of the memory for facial expression. Galper and Hochberg (1971) found that participants were able to accurately remember the facial expression of previously seen faces 76% of the time.

Another relevant study with respect to memory for facial expression was one conducted by Cohen-Pager and Brosgole (Cohen-Pager & Brosgole, 1992). The design in this study was quite unique because it only involved 1 face to recognize followed by a recognition test 5 days later. Similar to Galper and Hochberg's (1971) study, Cohen-Pager and Brosgole (1992) also compared their participants' performance on face recognition and memory for facial expressions. This aspect of their results will also be discussed in the appropriate section below. Cohen-Pager and Brosgole (1992) found that 85% of the participants could remember the facial expression accurately. Obviously, the latter study should have been easier than the current experiment because it involved only 1 face stimulus, and the recognition task involved choosing between a pair of target and lure face of the same person with different facial expressions. Thus comparison on participants' performances on the Cohen-Pager and Brosgole's study and the current study is not quite fitting. Participants' performances in Experiment 2 of the current study, however were comparable to those on Galper and Hochberg's (1971).

Experiment 2 was the first study designed to shed light on the processing aspect of memory for facial expression. The results of in Experiment 2 showed no significant main effect of Motion on Memory for Facial Expression. However, a strong effect of orientation was observed, suggesting that inversion impairs memory for facial expressions.

Face Recognition

The lack of effect of motion in the second experiment suggests that dynamic information in the form of facial expressions neither help nor hurt the recognition of previously unfamiliar faces. Experiment 2 was one of the few studies that tested people's ability to recognize a face based on the internal characteristic of the face. Previous research had shown that people tend to depend on external information such as hair style and context for recognizing previously unfamiliar faces (Hancock et al., 2000). Experiment 2 showed that in about 20 minutes, people can learn the identity of 24 unfamiliar faces very well, when tested immediately. And given that the task did not allow them to perceive external information, Experiment 2 showed that participants could make use of the internal information of each new face quite efficiently to allow them to recognize the faces very well a short time later.

The effect of Orientation on Face Recognition was quite substantial, which is consistent with previous research on face recognition. Inverting the face during test significantly reduces recognition accuracy (Bartlett & Searcy, 1993; Carey & Diamond, 1994; Collishaw & Hole, 2000; Freire et al., 2000; Hancock et al., 2000; Leder & Bruce, 2000; Leder et al., 2001).

In addition to its effect on accuracy of face recognition, orientation also affected judgment bias. Participants tended to be more liberal in making positive recognition judgments in the inverted condition than in the upright orientation. This result was consistent with previous research which observed the effect of task difficulty on judgment bias (shift in criterion). These studies found that in a more difficult task, people tend to shift to a more liberal criterion and hold lower threshold in their judgment. For example, Pollack and Decker (cited in Hicks & Marsh, 1998) manipulated the signal-to-noise ratio for trials containing a set of items, one of which had been presented earlier. As the signal-to-noise ratio decreased (i.e., the task became more difficult), people exhibited a more liberal criterion shift. A similar result was obtained by Decker and Pollack (cited in Hicks & Marsh, 1998) with visual conditions made easier or more difficult by manipulating low-pass frequency cutoffs. The same was true in a study by Clarke (cited in Hicks & Marsh, 1998) and in another by Healy and Jones (cited in Hicks & Marsh, 1998). Thus, more difficult discrimination conditions induced a more liberal bias in responding. The important point of this earlier work is that if participants can identify different classes of test items either consciously or unconsciously, and those differences relate to difficult discriminations, then more difficult versions of the test produced more liberal shifts in criterion (Hicks & Marsh, 1998). The data on D-prime analysis proved that faces presented upside-down were more difficult to recognize. Thus it seemed likely that the effect of inversion on judgment bias observed in Experiment 2 was mediated by task difficulty.

Similarity and Differences between Perception of Facial Expressions and Face Recognition

The current experiments demonstrated a very strong effect of Motion on perception of facial expressions. This effect however was not observed on Face Recognition. On the other hand, a strong effect of Orientation was observed on both perceptions of facial expressions and face recognition, which suggests that both tasks were based on configural processing. Since the effect of motion did not seem to be mediated by its role on configural processing there was no reason to believe that the same beneficial effect of motion should have been observed in Face Recognition. The fact that motion substantially affected facial expression identification but not face recognition demonstrates that, although both tasks share some processes (e.g. a reliance on configural processing) they nevertheless also involve distinct processes that are differentially sensitive to dynamic properties.

Perhaps the kind of movement involved in the study may be important in that rigid movements (head movements) may be more beneficial than non-rigid movement (such as facial expressions) in the recognition of unfamiliar faces. Previous studies that demonstrated a trend towards a benefit of motion in recognition of unfamiliar faces involved more rigid motion (Pike et al., 1997; Schiff, Banka, & Galdi, 1986). In comparison, Christie and Bruce (1998) who manipulated non-rigid motion did not find a significant effect of motion on the recognition of unfamiliar faces. On the other hand, a small number of studies that demonstrated the benefit of moving sequences which include some facial expressions used highly familiar or famous faces (for example Lander, Christie and Bruce, 1999; Lander and Bruce, 2000). If non-rigid motion such as facial expressions provides idiosyncratic information that aids in identifying a face then it makes sense if the effect is not observed on unfamiliar faces in the current study because by definition the idiosyncratic facial movement of unfamiliar faces is unknown.

It must be noted that the lack of motion effect on face recognition in the upright condition could be due to a ceiling effect. However, this view presupposes that motion interacts with inversion in the case of face recognition, which as noted previously there is presently no direct evidence. Nevertheless, in view of the possible ceiling effect in the upright condition of the current study, the direct effect of motion on face recognition such as the ones observed for perception of facial expression still need to be tested. One way to do this would be to replicate the current study with an adjusted paradigm so as to avoid a ceiling effect by making the face recognition task more difficult in the upright condition. That is, either by adding the number of faces to be recognized or by using delayed recognition task in the Test Phase.

A more comparable task to face recognition was tested in the second experiment, that is, memory for facial expressions. The results for this memory loaded judgment of affect mirrored the results on Face Recognition. Specifically, performance on Memory for Facial Expressions was impaired by inversion but largely unaffected by motion. Thus, this task seems to depend on configural processing as well.

The same pattern of results between face recognition and memory for facial expression was also observed in the relation between performance at Study and Test. In both of these tasks, accuracy in judging facial expression at Study for more difficult tasks (Single-Static and Multi-Static) leads to poorer recognition of the face and the expression at Test. On the other hand, correct judgment of facial expressions for relatively easier tasks (Dynamic) leads to better face recognition and memory for the expressions. One possible explanation is that in more difficult conditions, encoding the facial expressions may have demanded resources which compete against the allocation of resources for encoding the face. As a consequence, in more difficult conditions, less resources were available to encoding the face, which in turn leads to poorer recognition of the face. The data on memory for facial expressions mirrored the results on face recognition. This is probably due to the fact that a big part of memory for facial expressions, at least in the way that it was tested in the current study, involves recognizing the face. An alternative way to assess memory for facial expressions would be to reduce the element of face recognition by presenting participants with pairs of the same person showing different expressions and asking them to select the expressions they have seen before.

Future Directions

The studies described in this dissertation constitute only the beginning of an investigation examining the processing of ecologically relevant display of facial expressions. Many questions remain unanswered. Is the effect of motion on perception of facial expression limited to subtle facial expressions? As previously discussed, the substantial effect of motion on perception of facial expression observed in the current study may have been mediated by the use of subtle facial expressions. Subtle facial expressions are more common in every day situations. However, there are occasions which elicit very strong facial expressions, such as Surprise when one just learned that s/he won a big prize in a lottery, or Sad for learning that one's beloved person just passed away, etc. It would be interesting to find how motion affects judgments of such strong facial expression. Given that the majority of previous studies on perception of facial expression relied on prototypic and intense facial expression, a replication of the current study using a more intense facial expression is important to assess the necessity of reviewing the previous researches in the light of the beneficial effect of Motion.

Another question that remains to be tested is with respect to the specific interpretation of the mechanism by which motion facilitates perception of facial expression. Specifically how does motion facilitate perception of facial expression? The current study provides evidence that an important factor responsible for the beneficial effect of motion is inherent in the dynamic property itself. However, what specifically this information is could not be determined from the current study. One possibility which gained partial support from the current experiment was that Motion might increase people's sensitivity to change. However, more direct test of this hypothesis remains to be done. One way to directly test the change sensitivity hypothesis might be to follow the standard paradigm in change blindness studies for facial expression stimuli. That is, to show participants with two pictures (images) only, the first (neutral) image and the last (target-expressional) image. The manipulation involves the presentations of a mud-splash, a flicker, or a brief presentation of a blank image. The standard effect of change blindness would be observed if participants were less accurate in judging the expressions in the mud-splash (flicker, or blank insertion) condition than in the condition without it.

Another alternative and perhaps a better way to test the change-blindness hypothesis would be to conduct an experiment where one of the main dependent measures is change. Thus, in some conditions participants would see the same face (i.e. it would actually not change between images), and in another condition they would see a changed face. The key questions would be whether or not people could discriminate the changed faces from the unchanged face trials, and whether this ability varies with respect to motion condition. In other words, would participants discriminate the changed and unchanged faces better in the Dynamic condition as compared to the Multi-Static condition? Then the same exact paradigm can be employed for the perception of facial expression judgments. If the beneficial effect of motion on affect judgment is mediated by its effect in enhancing sensitivity to change perception, then the prediction that follows would be that the advantage for the dynamic condition with facial expressions would be similarly mirrored with the change judgments.

Another aspect of the current study which is worth noting is that in Experiment 2, the mode of presentation of items was held constant between Study and Test Phase. Thus, identical items were used in Study and Test. The lack of effect of Motion on Memory for

Facial expression in Experiment 2 suggests that memory of identical images of facial expression were not affected by mode of presentation. However, it would be interesting to see if the same was true for a situation in which mode of presentation was varied between Study and Test. That is, whether items originally presented in Dynamic mode will be stored better in memory than items presented in Static modes such that it will facilitate recognition across different mode of presentation at test.

Furthermore, a replication of the present studies with a different set of stimuli would strengthen the external validity of the results. The current experiments utilized posed facial expression. It would be interesting to see whether similar result will be found with judgments of spontaneous facial expressions. An attempt to replicate the current experiments should take into consideration some of the unexpected problems with the current experiments. Accordingly, modification of the design should include a more independent measure of memory for facial expressions.

The current experiments demonstrated a substantial effect of motion on perception of facial expressions. This result bears a great importance in revisiting previous findings on this field in the light of the current findings. Keeping in mind the differences between the current studies and the standard perception of facial expressions research, which include the role of motion and the subtlety of the expressions, much of our knowledge about perception of facial expression such as the universality hypothesis might need to be reconsidered.

Table 1. The Effect of Inversion on Perception of Facial Expressions from Previous Studies.

	INVERSION EFFECT	
	YES	**NO**
Anger	(McKelvie, 1995) Exp 1& 2	
	(Muskat & Sjoberg, 1997)	
	(White, 1999)	
Disgust	(McKelvie, 1995) Exp 1&2	
	(Muskat & Sjoberg, 1997)	
Fear	(McKelvie, 1995) Exp 1& 2	(Muskat & Sjoberg, 1997)
		(Bartlett & Searcy, 1993)
Happiness	(White, 1999)	(McKelvie, 1995), Exp1 & 2
	(Kirita & Endo, 1995) (exp1 & 2, 3)	(Muskat & Sjoberg, 1997))
		(Bartlett & Searcy, 1993)
		(Endo et al., 1995)
		(Searcy & Bartlett, 1996)Exp 1
Sadness	(McKelvie, 1995)	(Kirita & Endo, 1995) (exp 1&2)
	(Muskat & Sjoberg, 1997)	
	(White, 1999)	
	(Kirita & Endo, 1995) (exp3)	
Surprise	(McKelvie, 1995) (Exp 1)	(McKelvie, 1995) (Exp 2)
		(Muskat & Sjoberg, 1997)
		(Bartlett & Searcy, 1993)
Neutral	(White, 1999)	McKelvie (1995, exp 2)
	McKelvie (1995; exp 1)	

Table 2. Pilot: Items Met Selection Criteria for Experiment I

No	ANGER			DISGUST			FEAR			No
	Poser	Level	Score	Poser	Level	Score	Poser	Level	Score	
1	010-1	Level-1	70.4	045-2	Level-3	69.2	124-3	Level-3	69.2	1
2	014-1	Level-1	69.2	059-2	Level-3	70.4	127-3	Level-2	70.4	2
3	032-1	Level-3	69.2	067-2	Level-3	70.4	100-3	Level-3	69.2	3
4	089-1	Level-1	70.4	071-2	Level-1	69.2	060-3	Level-2	73.1	4
5	094-1	Level-1	69.2	081-2	Level-1	69.2	075-3	Level-2	73.1	5
6	129-1	Level-3	69.2	096-2	Level-2	70.4	138-3	Level-2	65.4	6
	Mean		69.6	Mean		69.8	Mean		70.07	
	HAPPY			SAD			SURPRISE			
	Poser	Level	Score	Poser	Level	Score	Poser	Level	Score	
1	068-4	Level-3	69.2	071-5	Level-3	70.4	074-6	Level-1	69.2	1
2	071-4	Level-1	69.2	095-5	Level-1	69.2	087-6	Level-1	69.2	2
3	081-4	Level-2	69.2	115-5	Level-3	69.2	095-6	Level-2	70.4	3
4	082-4	Level-1	69.2	131-5	Level-1	70.4	114-6	Level-3	69.2	4
5	109-4	Level-1	70.4	035-5	Level-2	73.1	115-6	Level-1	69.2	5
6	115-4	Level-3	70.4	077-5	Level-2	73.1	032-6	Level-2	69.2	6
	Mean		69.6	Mean		70.9	Mean		69.4	

Table 3. Experiment 1- Table of Stimuli by Condition, Set and Emotion

SET	COND	ANGER	DISGUST	FEAR	HAPPY	SAD	SURPRISE	Total
	SS	3	3	1	2	2	1	12
A	MS	3	2	1	2	0	4	12
	DY	0	1	4	2	4	1	12
	Total	6	6	6	6	6	6	36
	SS	0	1	4	2	4	1	12
B	MS	3	3	1	2	2	1	12
	DY	3	2	1	2	0	4	12
	Total	6	6	6	6	6	6	36
	SS	3	2	1	2	0	4	12
C	MS	0	1	4	2	4	1	12
	DY	3	3	1	2	2	1	12
	Total	6	6	6	6	6	6	36

Note: SS= Single-Static, MS= Multi-Static, DY= Dynamic

Table 4. Experiment 1: Correlation Between PA, NA Score and Accuracy in Single-Static, Multi-Static and Dynamic Condition.

		PA Score	NA Score
Upright	Single-Static	-0.098	-0.144
	Multi-Static	0.137	-0.132
	Dynamic	0.125	-0.025
Inverted	Single-Static	-0.018	0.111
	Multi-Static	0.058	-0.096
	Dynamic	-0.084	-0.17

Note: PA= Positive Affect , NA = Negative Affect

Table 5. Experiment 2- Table of Stimuli by Condition, Set and Emotion

SET	COND	ANGER	DISGUST	FEAR	HAPPY	SAD	SURPRISE	Total
	SS	0	2	2	1	3	0	8
A	MS	2	1	1	1	1	2	8
	DY	2	1	1	2	0	2	8
	Total	4	4	4	4	4	4	24
	SS	2	1	1	2	0	2	8
B	MS	0	2	2	1	3	0	8
	DY	2	1	1	1	1	2	8
	Total	4	4	4	4	4	4	24
	SS	2	1	1	1	1	2	8
C	MS	2	1	1	2	0	2	8
	DY	0	2	2	1	3	0	8
	Total	4	4	4	4	4	4	24

Note: SS= Single-Static, MS= Multi-Static, DY= Dynamic

Table 6. Experiment 2 - Correlation Between PA, NA Score and Accuracy in Single-Static, Multi-Static, and Dynamic Condition

	Motion Condition	PA Score	NA Score
Upright	Single-Static	-.194	.099
	Multi-Static	-.084	-.056
	Dynamic	-.147	-.253
Inverted	Single-Static	.188	-.275
	Multi-Static	.108	.005
	Dynamic	-.013	-.074

Note: PA= Positive Affect , NA = Negative Affect

Table 7. The Effects of Inversion on Perception of Facial Expressions from Previous Studies and the Current Findings

	INVERSION EFFECT	
	YES	**NO**
Anger	(McKelvie, 1995) Exp 1& 2	
	(Muskat & Sjoberg, 1997)	
	(White, 1999)	
	(Ambadar, 2002)	
Disgust	(McKelvie, 1995) Exp 1&2	
	(Muskat & Sjoberg, 1997)	
	(Ambadar, 2002)	
Fear	(McKelvie, 1995) Exp 1& 2	(Muskat & Sjoberg, 1997)
	(Ambadar, 2002)	(Bartlett & Searcy, 1993)
Happiness	(White, 1999)	(McKelvie, 1995), Exp1 & 2
	(Kirita & Endo, 1995) (exp1 & 2, 3)	(Muskat & Sjoberg, 1997))
	(Ambadar, 2002)	(Bartlett & Searcy, 1993)
		(Endo et al., 1995)
		(Searcy & Bartlett, 1996)Exp 1
Sad	(McKelvie, 1995)	(Kirita & Endo, 1995) (exp 1&2)
	(Muskat & Sjoberg, 1997)	
	(White, 1999)	
	(Kirita & Endo, 1995) (exp3)	
	(Ambadar, 2002)	
Surprise	(McKelvie, 1995) (Exp 1)	(McKelvie, 1995) (Exp 2)
		(Muskat & Sjoberg, 1997)
		(Bartlett & Searcy, 1993)
		(Ambadar, 2002)
Neutral	(White, 1999)	McKelvie (1995, exp 2)
	McKelvie (1995; exp 1)	

Note: Highlighted are findings from the present studies

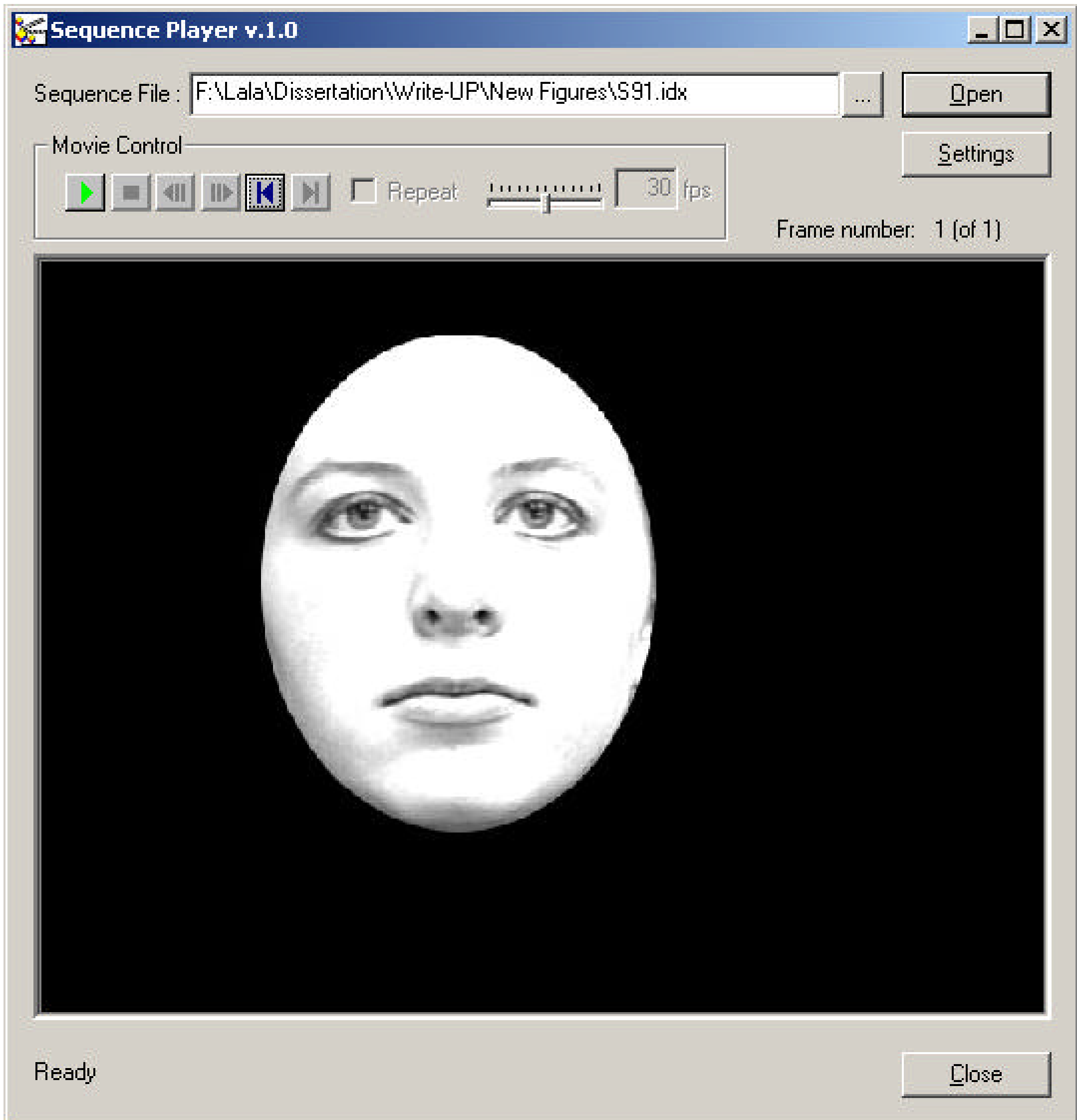

Figure 1. Example of the Sequence Player and the Stimuli.

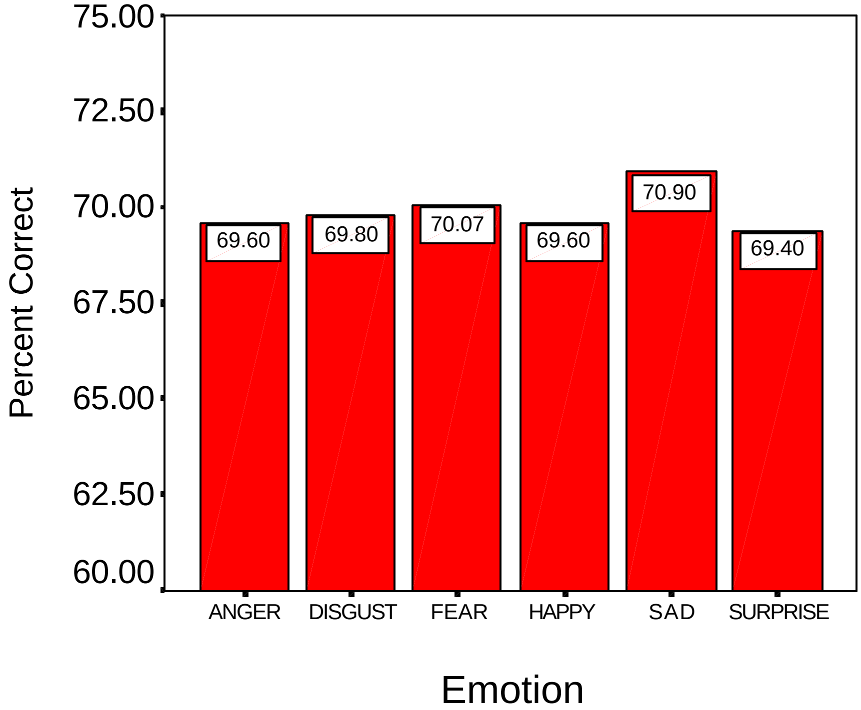

Figure 2. Pilot Study – Mean Percent Correct of items selected for Experiment 1

DISPLAY FORMATS	DESCRIPTIONS
SINGLE-STATIC	A single picture presented in a static mode (without the perception of motion)
MULTI- STATIC	A series of picture presented in a static mode (without the perception of motion)
DYNAMIC	A series of pictures with the perception of motion

Figure 3. Descriptions of Motion Condition (Display Formats).

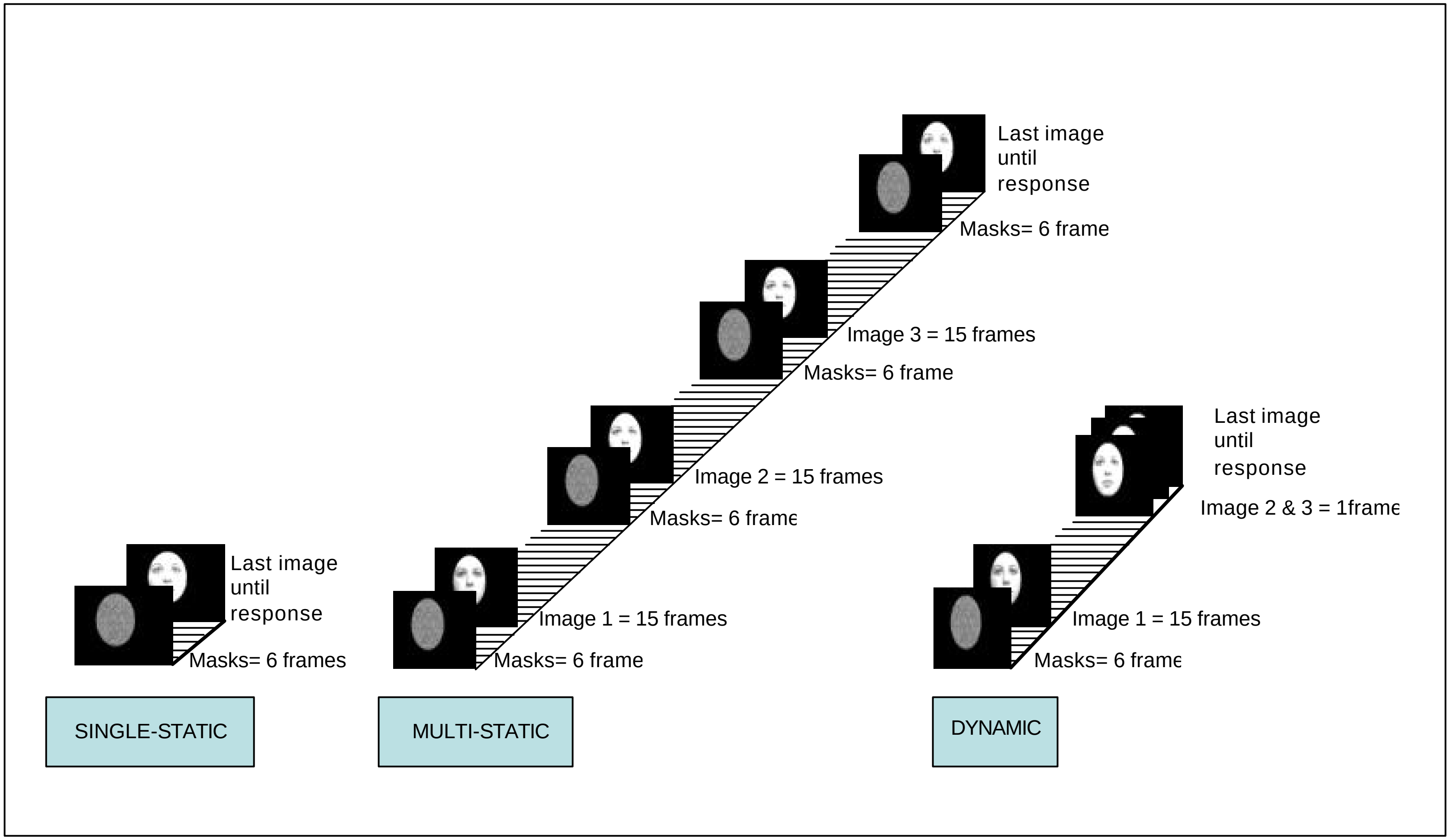

Figure 4. Diagram of Stimuli Presentations in Three Motion Conditions.

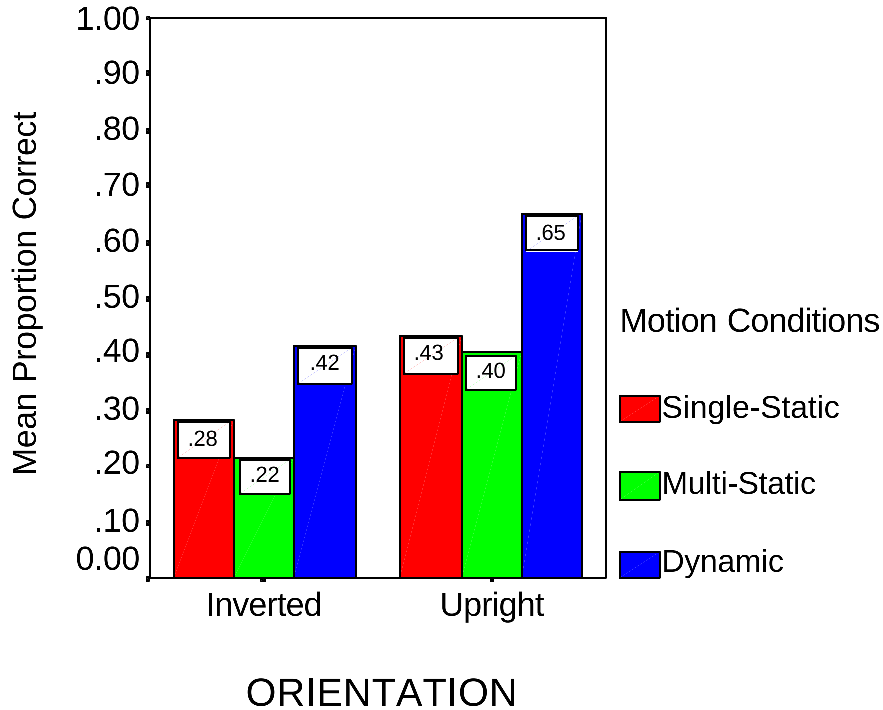

Figure 5. Experiment 1 - The Effects of Motion and Orientation on Perception of Facial Expressions

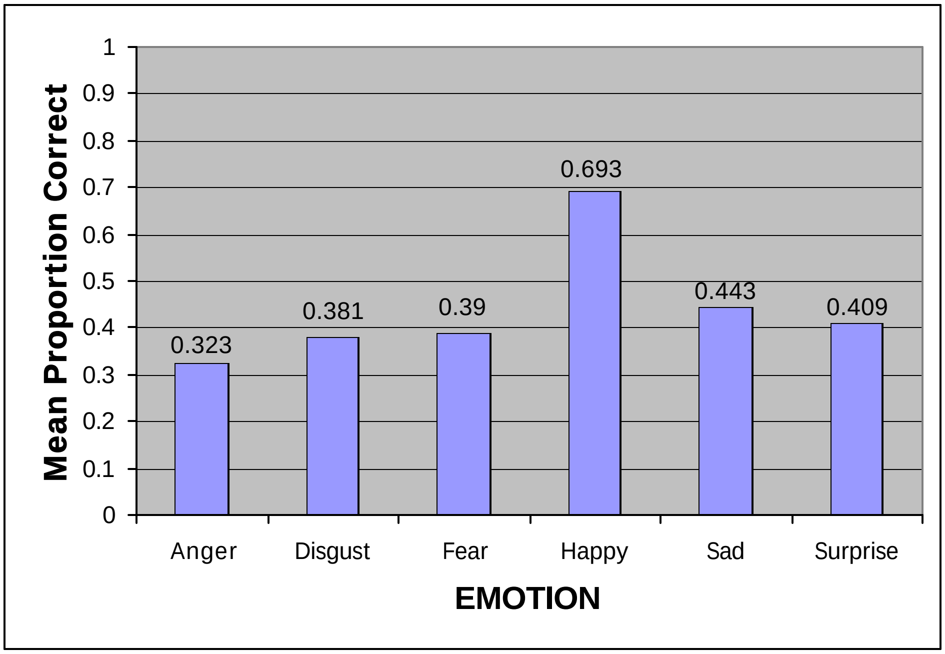

Figure 6. Experiment 1 - Mean Proportion Correct For Each Emotion

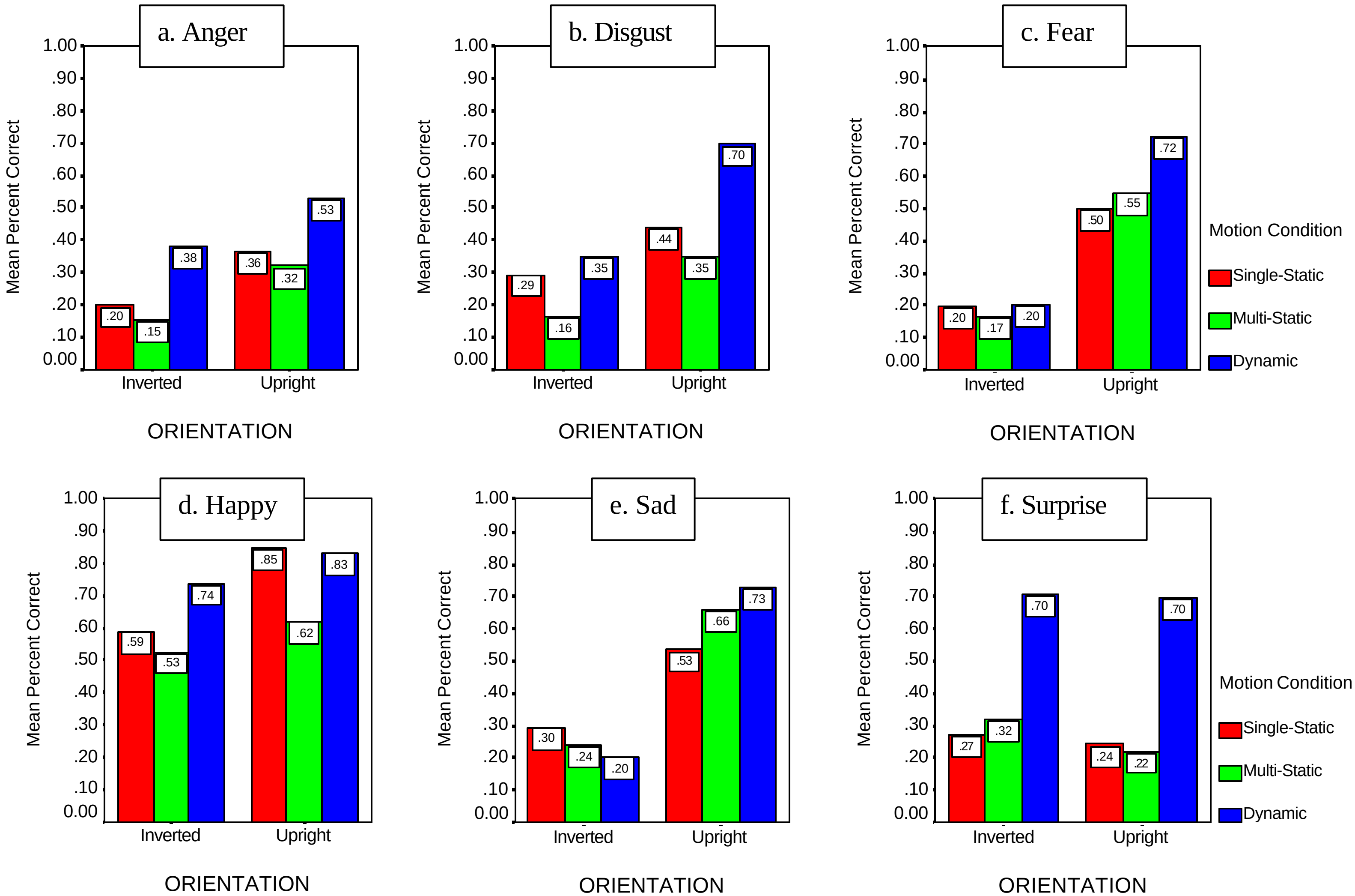

Figure 7. Experiment 1 - The Effects of Motion and Orientation on Perception of Facial Expressions of Each Emotion Category.

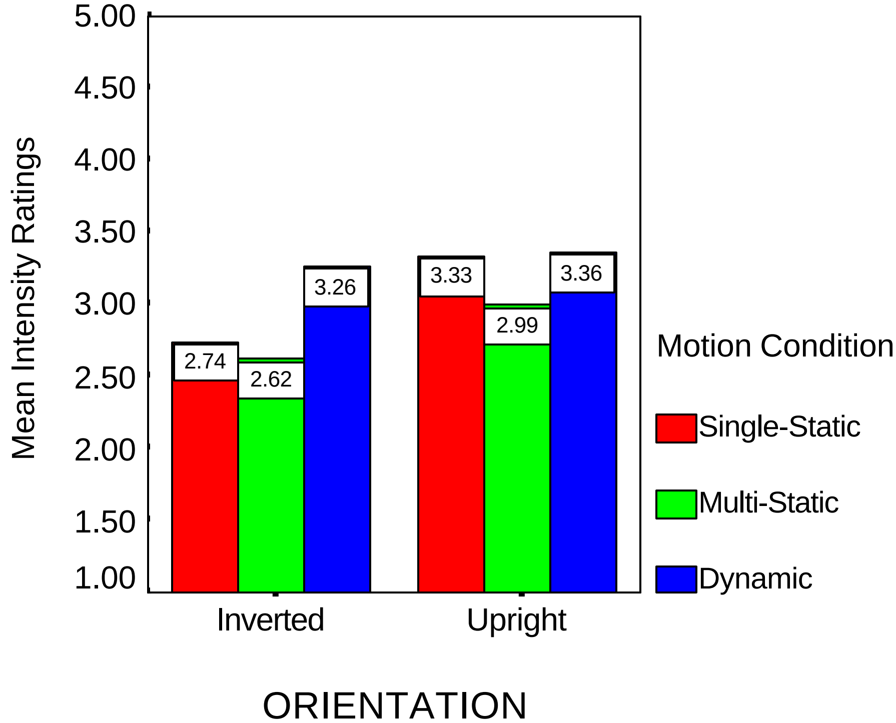

Figure 8. Experiment 1- Intensity Ratings for Correctly Judged Items

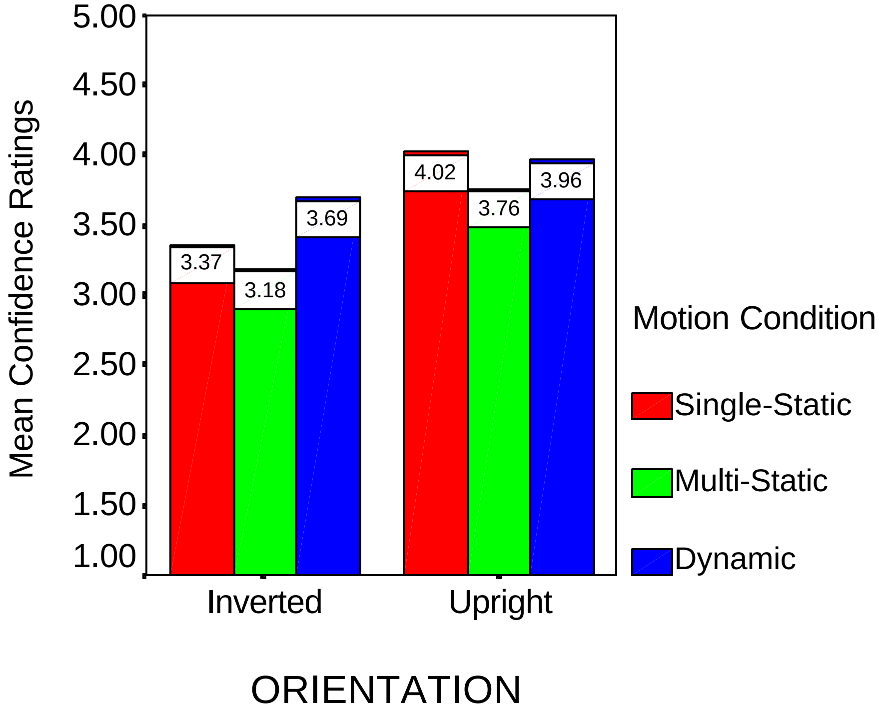

Figure 9. Experiment 1 - Confidence Ratings for Correctly Judged Items.

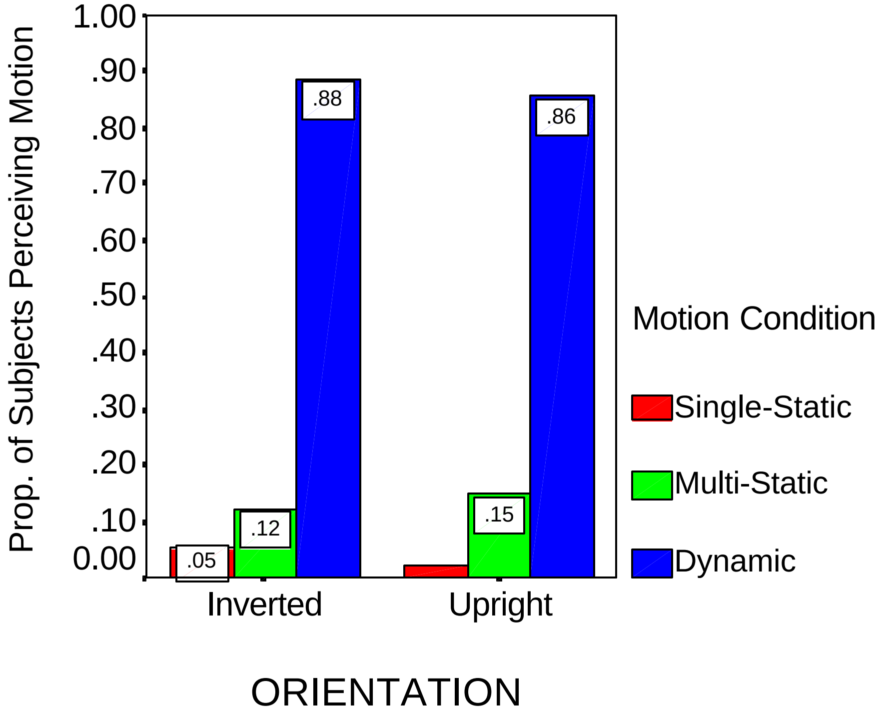

Figure 10. Experiment 1- Perception of Motion

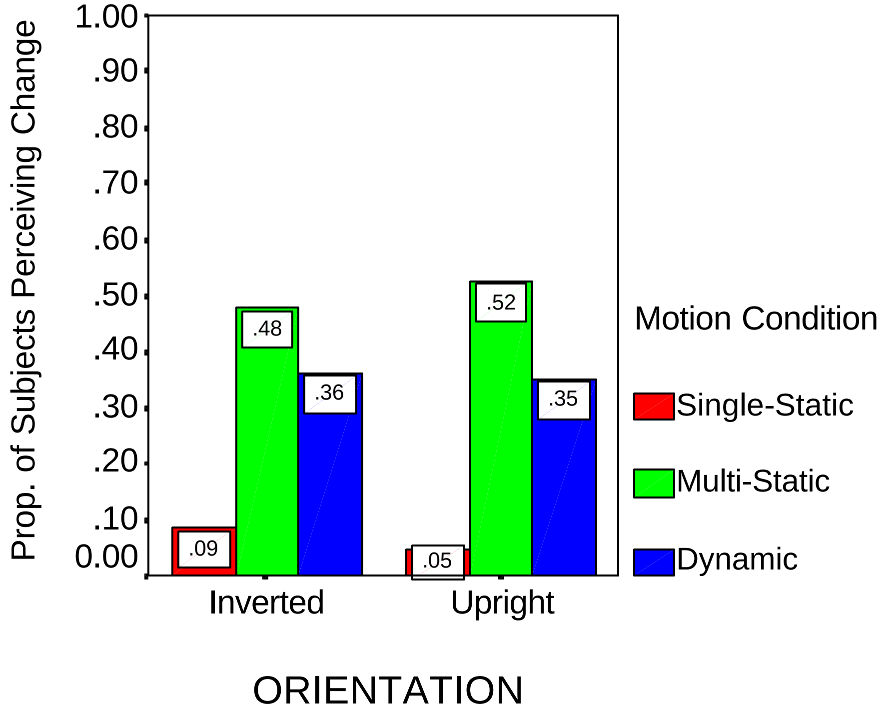

Figure 11. Experiment 1 - Perception of Change

			STUDY-PHASE					
			Anger	**Disgust**	**Fear**	**Happy**	**Sad**	**Surprise**
TEST PHASE	SAME-ID	**Anger**	Same-ID-Same-Affect Judgment=Yes,Yes	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No
		Disgust	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Same-Affect Judgment=Yes,Yes	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No
		Fear	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Same-Affect Judgment=Yes,Yes	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No
		Happy	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Same-Affect Judgment=Yes,Yes	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No
		Sad	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Same-Affect Judgment=Yes,Yes	Same-ID-Different-Affect Judgment=Yes, No
		Surprise	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Different-Affect Judgment=Yes, No	Same-ID-Same-Affect Judgment=Yes,Yes
	DIFFERENT - ID	**Anger**	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No
		Disgust	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No
		Fear	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No
		Happy	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No
		Sad	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No
		Surprise	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No	Different-ID Judgment = No

Figure 12. Experiment 2 – Categorization of the Stimuli - Test Phase

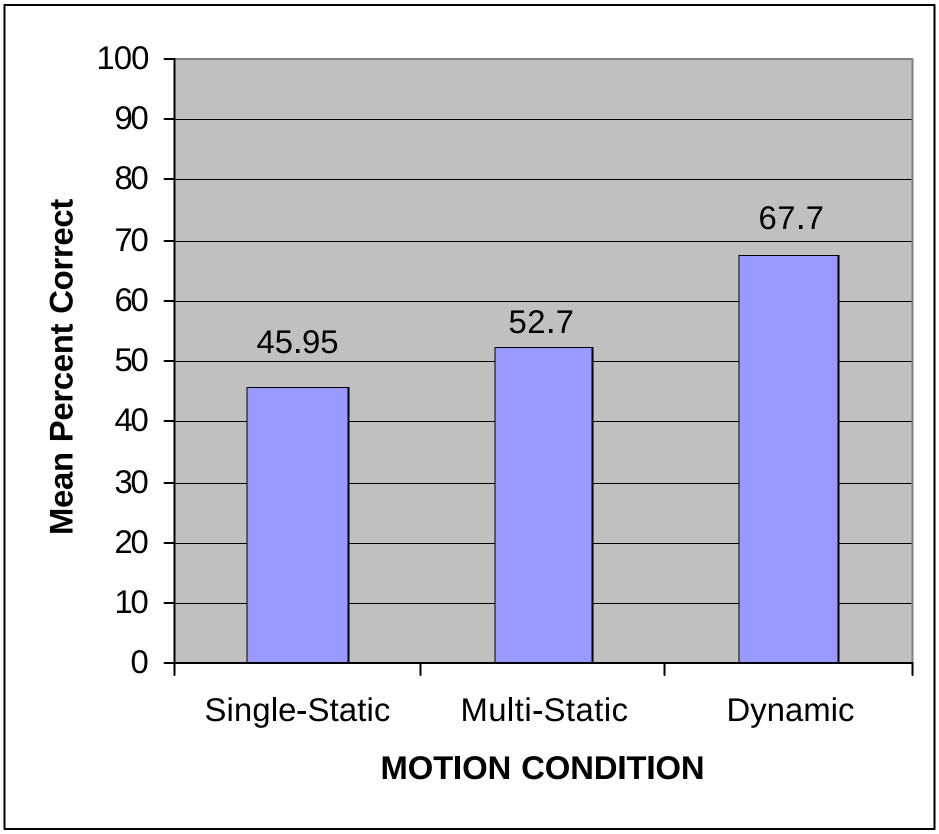

Figure 13. Experiment 2 – The Effect of Motion on Perception of Facial Expressions

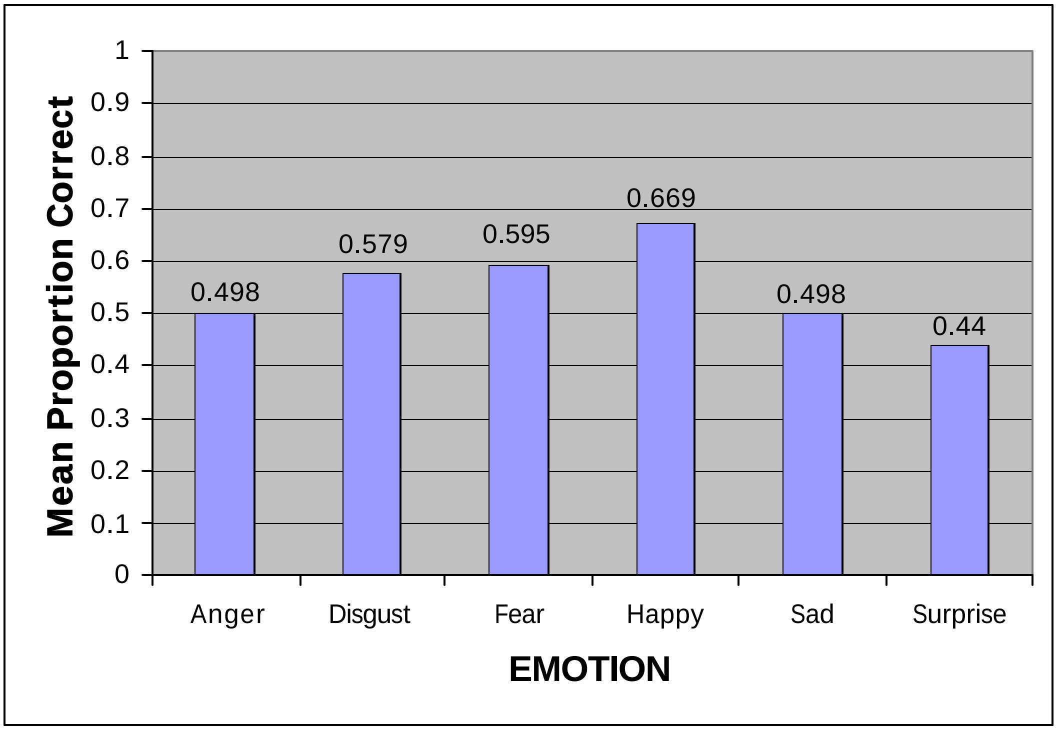

Figure 14. Experiment 2 – The Effect of Emotion Categories on Perception of Facial Expressions.

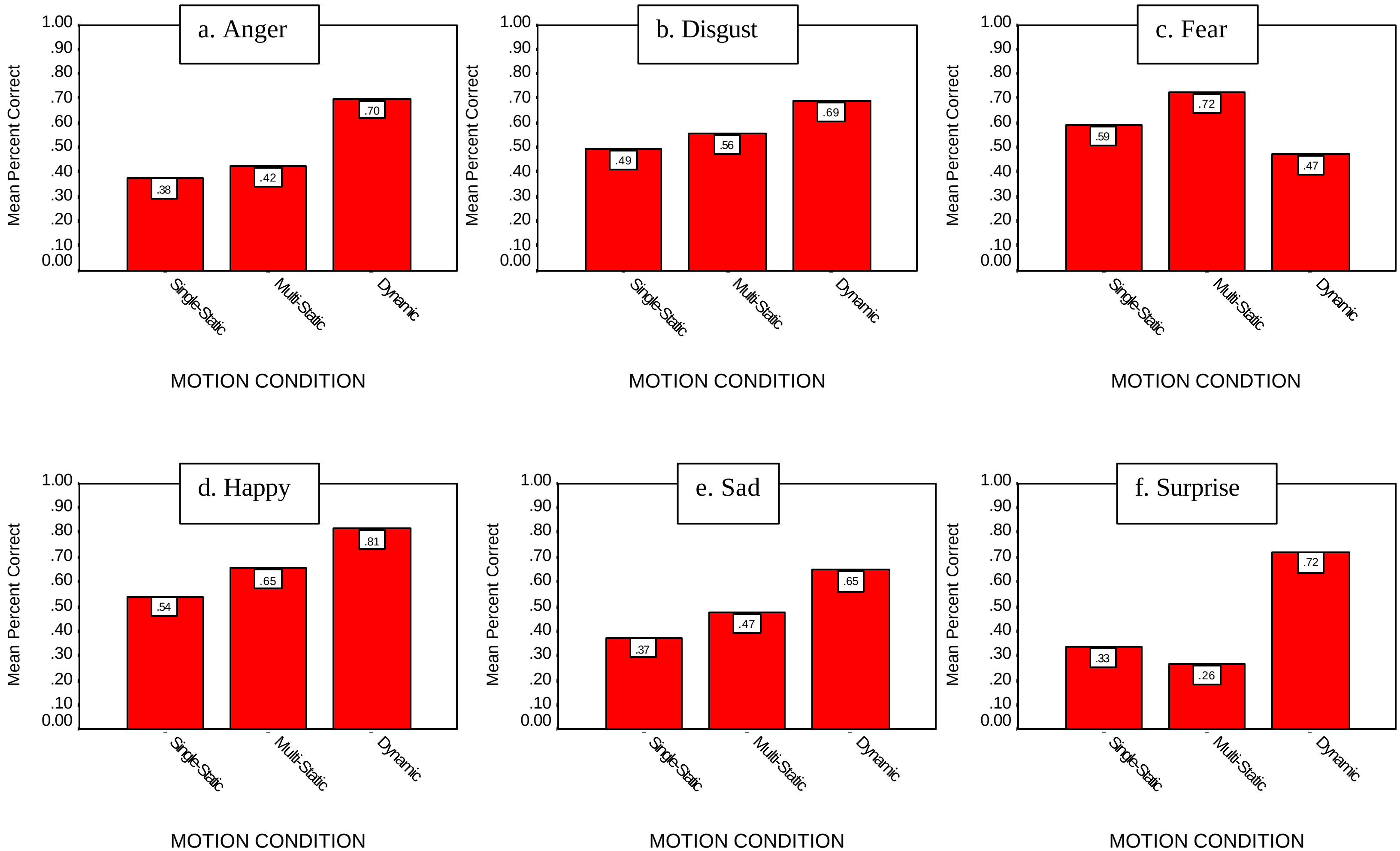

Figure 15. Experiment 2 - The Effect of Motion and Orientation on Perception of Facial Expressions of Each Emotion Category.

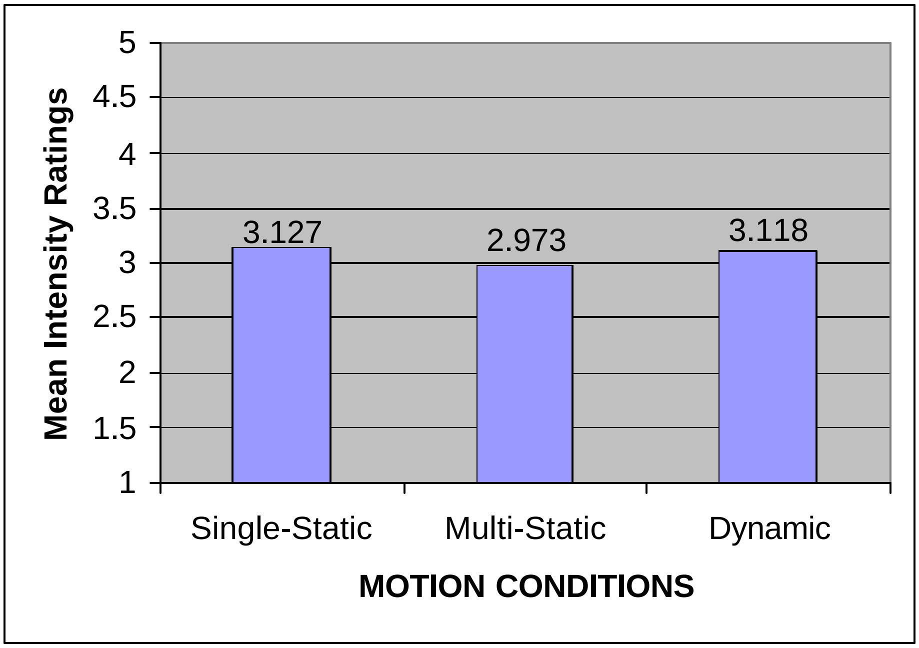

Figure 16. Experiment 2 - Intensity Ratings for Correctly Judged Items

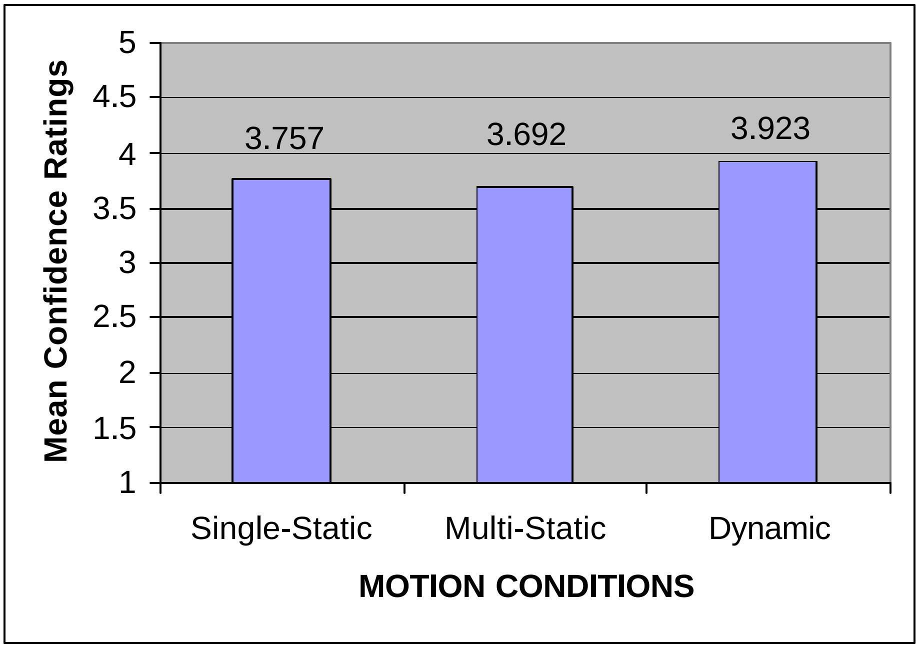

Figure 17. Experiment 2 - Confidence Ratings for Correctly Judged Items

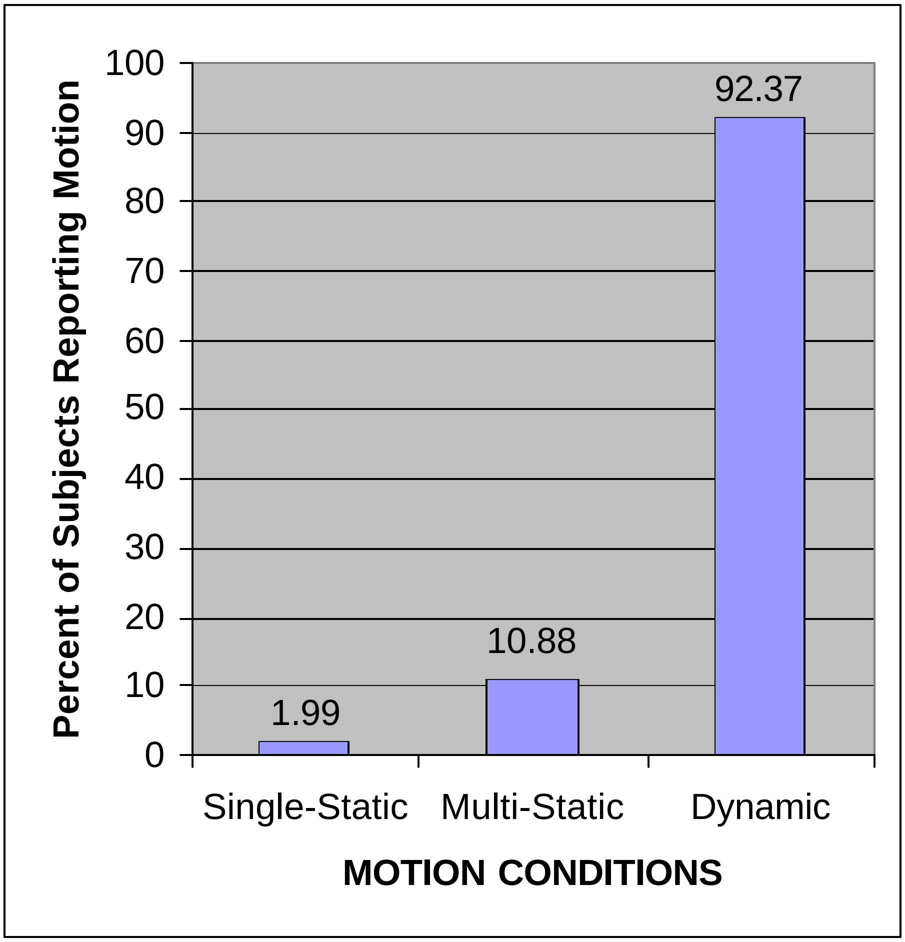

Figure 18. Experiment 2 - Perception of Motion

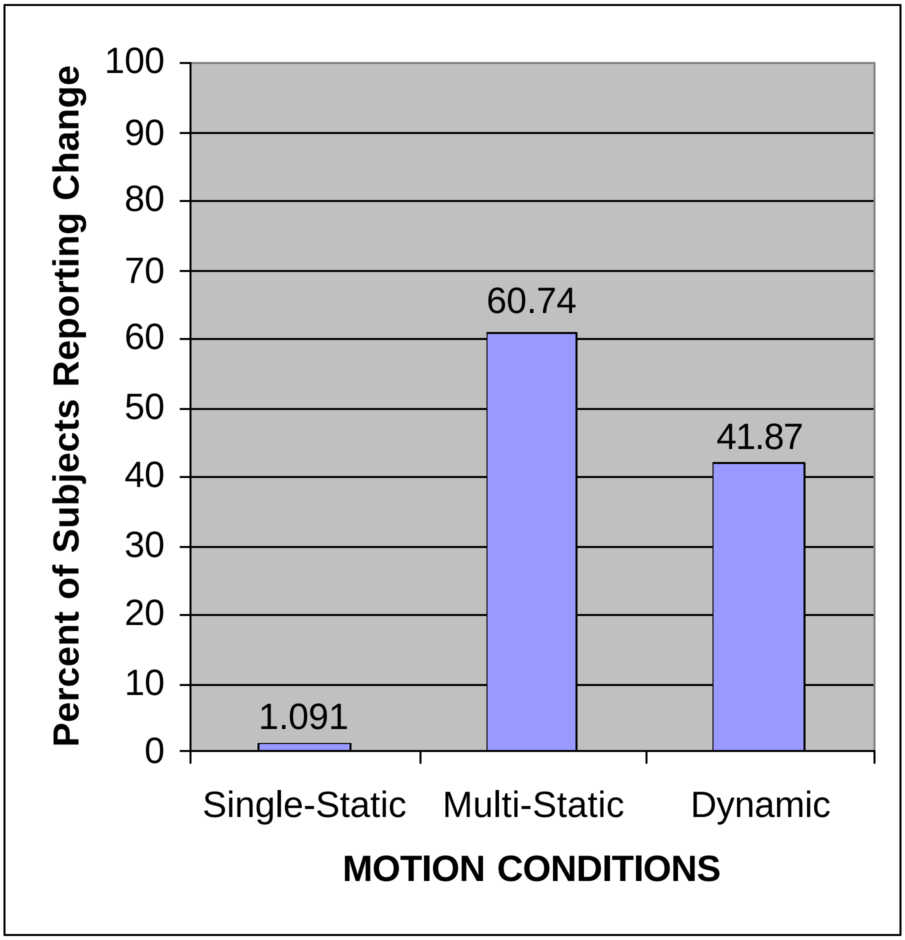

Figure 19. Experiment 2 - Perception of Change

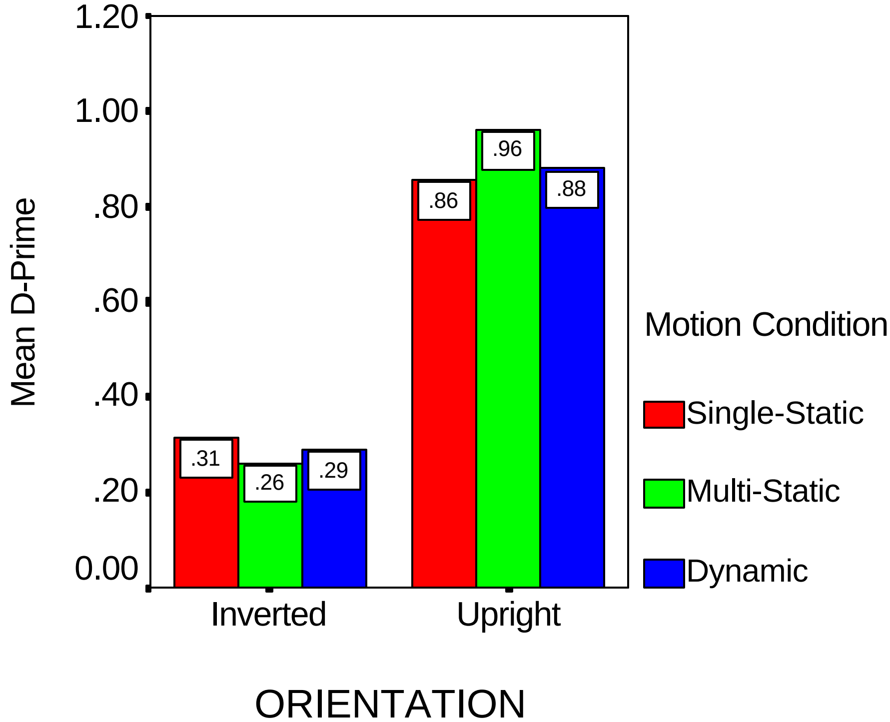

Figure 20. Experiment 2 - Face Recognition - Analysis of D-Prime

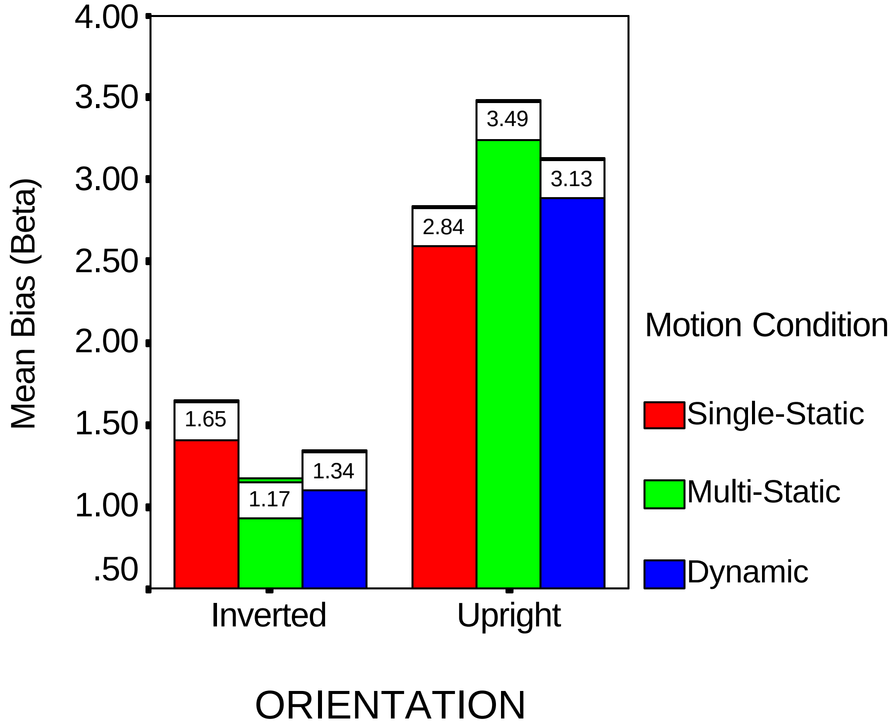

Figure 21. Experiment 2 - Face Recognition - Analysis of Bias (Beta)

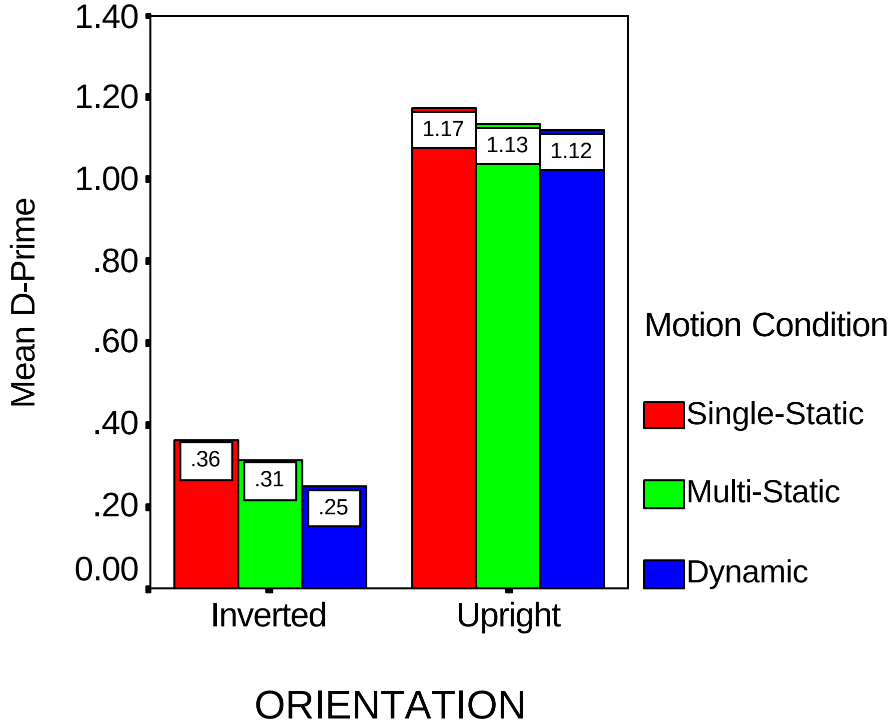

Figure 22. Experiment 2 - Memory for Facial Expressions - Analysis of D-Prime

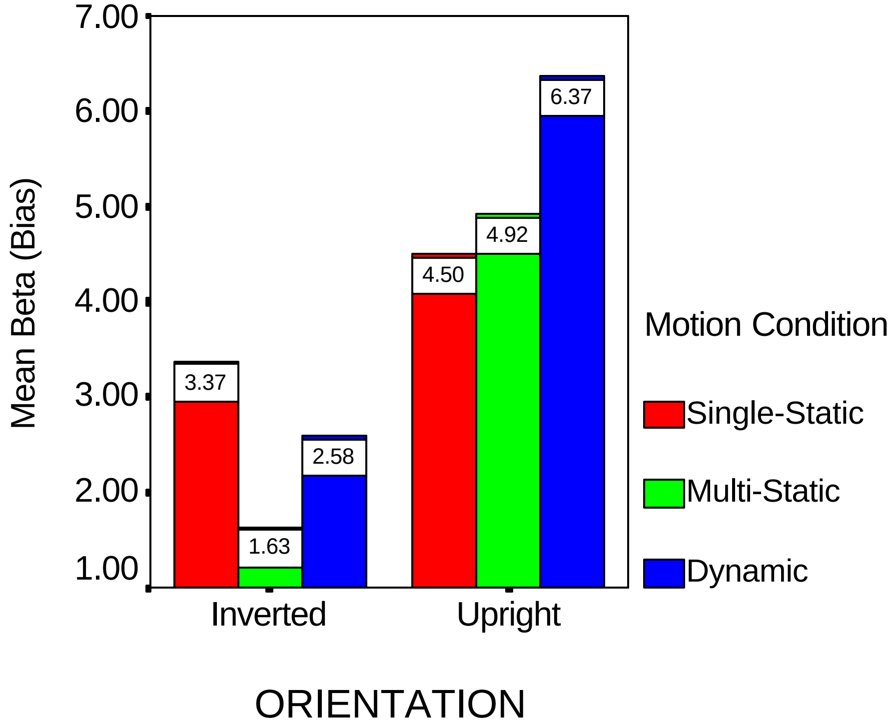

Figure 23. Experiment 2 - Memory for Facial Expressions - Analysis of Bias

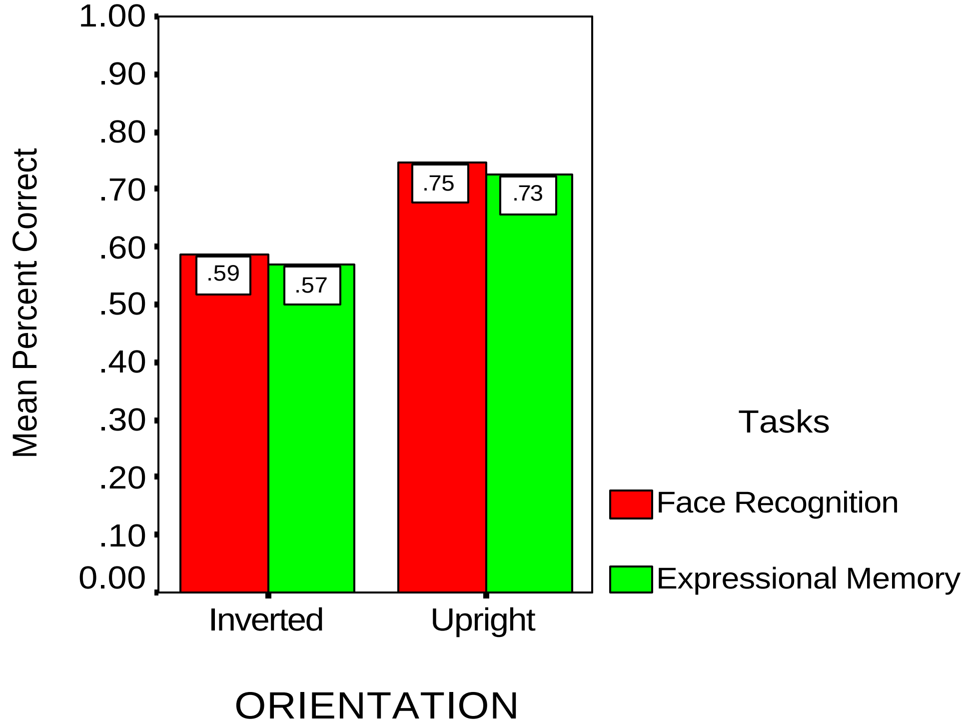

Figure 24. Experiment 2 - Comparisons Between Face Recognition and Memory for Facial Expressions

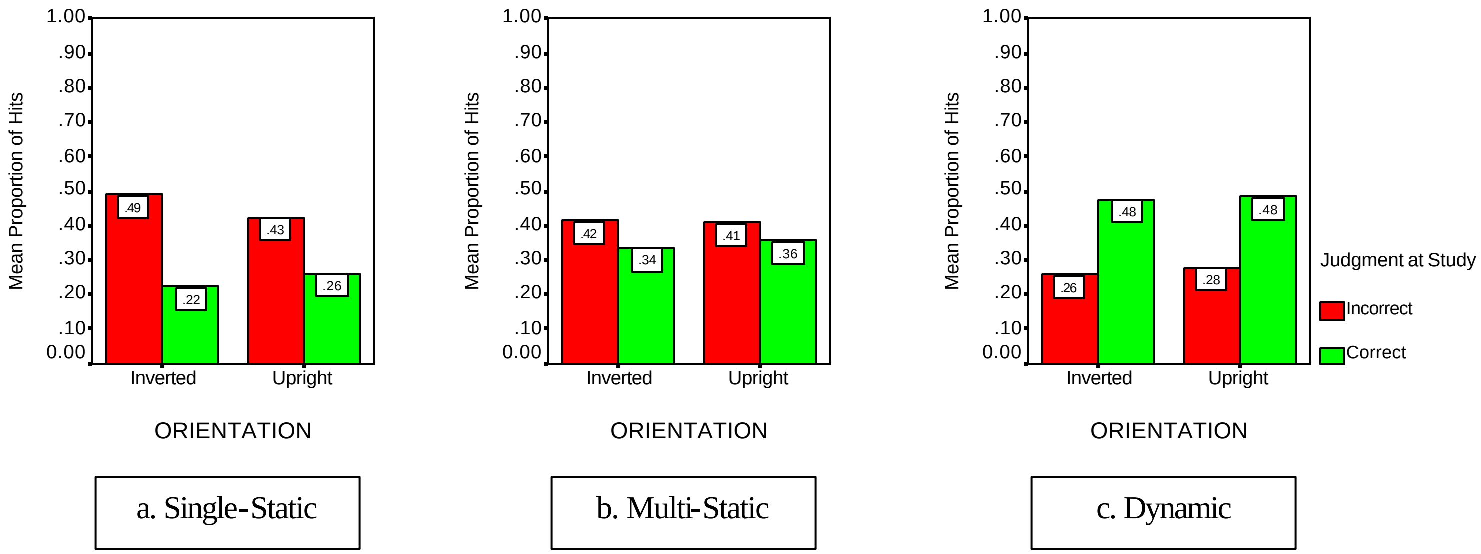

Figure 25. Experiment 2- The Effect of Accuracy at Study on Face Recognition at Test

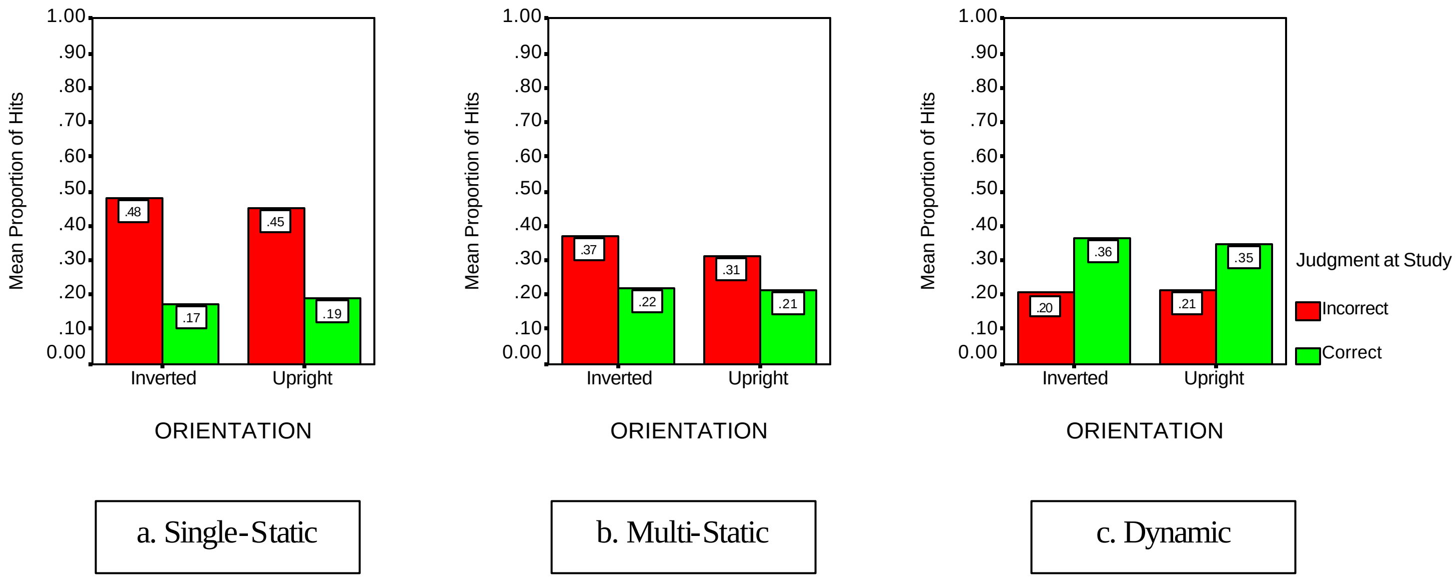

Figure 26. Experiment 2- The Effect of Accuracy at Study on Memory for Facial Expressions at Test

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