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THE EFFECTS OF UNILATERAL FACIAL MANIPULATIONS
ON THE EXPERIENCE OF EMOTIONS IN RIGHT- AND
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presented by

TRAVIS GEORGE FOGEL

has been accepted towards fulfillment
of the requirements for

M.A. degree in PSYCHOLOGY

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**THE EFFECTS OF UNILATERAL FACIAL MANIPULATIONS
ON THE EXPERIENCE OF EMOTIONS IN RIGHT- AND
LEFT-HANDED UNDERGRADUATE MEN**

By

Travis George Fogel

A THESIS

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ABSTRACT

THE EFFECTS OF UNILATERAL FACIAL MANIPULATIONS ON THE EXPERIENCE OF EMOTIONS IN RIGHT- AND LEFT-HANDED UNDERGRADUATE MEN

By

Travis George Fogel

An extensive literature has documented handedness differences in lateral cerebral organization for language and visuo-spatial functions. The current study investigated handedness differences in cerebral organization of emotion, in particular, the valence hypothesis, according to which the right hemisphere is dominant for the experience and expression of positive emotions, the left hemisphere for positive emotions. It followed Schiff and Lamon's (1989) method of using unilateral facial contractions to induce positive and negative moods. Seventy-eight right- and left-handed men performed four alternating contractions (LRLR or RLRL) and completed the Depression Adjective Checklist after each. A repeated measures ANOVA failed to reveal main effects for handedness or side of facial contraction or any interactions between them. It did show that, regardless of side of contraction, participants' general sense of well-being decreased significantly over time. Lastly, mood changes were significantly correlated with the reported level of difficulty for contracting one side of the face.

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INTRODUCTION

Speech, language and visuo-spatial abilities are conventionally seen as cognitive functions. In recent years, there has also been increasing evidence for lateral specialization in the control of emotions (Silberman & Weingartner, 1986; Davidson, 1983). Given the evidence for handedness differences in cerebral organization for language and visuo-spatial functions, the question thus arises whether there also are handedness differences in the control of emotion. There has been little study of this. If there are such differences, then examining them may allow us to better see how emotion is processed by the brain. In other words, if we can show that right- and left-handers also differ in other skills (e.g., the experience of emotion), we then have the means to ask the functional utility of lateral specialization for those skills. The major aim of the current study is to examine this possibility by comparing right- and left-handers on a test designed to study laterality of function in a new way. The new method uses unilateral facial contractions to induce mood. By using unilateral facial contractions, one can selectively stimulate the contralateral hemisphere of the brain. Before turning to the current study, I shall begin with a review of research on handedness differences in lateralization of speech and language and visual-spatial functions, then present a review of two major neuropsychological hypotheses about laterality and emotion, followed by a review of prior studies of emotion and handedness.

Cerebral Organization for Speech and Language

in Right- and Left-Handers

Until the 1860s, the two hemispheres of the brain were widely regarded as mirror images of each other, both structurally and functionally. There was only occasional speculation, largely based on clinical observations of individuals with unilateral brain damage, that the hemispheres were not functionally identical. These observations, however, typically lacked essential detail, making it difficult to correlate lesion site to behavioral abnormality with any degree of accuracy (Benton, 1984). It was not until the work of the French physician Paul Broca in the 1860s that the concept of lateralization of function began to emerge and to replace the older view of hemisphere equivalency. Based on clinical studies of patients with unilateral lesions of the neocortex, Broca (1865; as cited in Harris, 1991) concluded that the left hemisphere plays the leading role in language functions.

Since Broca's reports, lateral specialization of function has received a vast amount of attention in new studies of clinical as well as normal populations. The research supports Broca's general proposition that the left hemisphere almost invariably plays the leading role for language functions. It also shows that this is true for right-handers. For left-handers, the picture is more complex. This literature will be discussed later.

The current evidence for language laterality comes from studies of clinical as well as normal populations. For example, in the former category are studies of patients who have undergone cortical excisions for the purpose of controlling epileptic symptoms. In one well-known study, of 179 right-handed patients who were operated on the left

hemisphere, 124, or 69.8%, showed some form of aphasia following the operation. Of 254 right-handed patients who were operated on the right-hemisphere, 1, or 0.4%, became aphasic (Penfield & Roberts, 1959). Other localization methods have yielded very similar results. For example, Warrington and Pratt (1973) found that among right-handed depressed patients who had been given ECT, 98% exhibited dysphasia following left-hemisphere ECT, compared with only 2% following right-hemisphere ECT. Rasmussen and Milner (1977) reported similar percentages with the Intracarotid Amobarbital Procedure.¹ In 140 right-handers with late-onset epilepsy² (without any history of early brain damage), 96% showed speech-disruption following left hemisphere injection; 4% following right-hemisphere injection. None had bilateral or mixed-speech dominance.³

In summary, the literature consistently shows the left hemisphere to be dominant for language in nearly all right-handers. The evidence for left-handers is less clear. Following Broca's 1865 report, it was widely supposed that left-handers were reverse dominant for speech and language, that is, that they "speak from the right hemisphere" (Harris, 1991, 1993). Early support for this view came from clinical observations showing that persons who became aphasic following right hemisphere damage were also

¹ This procedure is widely used prior to surgery to excise epileptogenic tissue. First one hemisphere, then the other is anesthetized via a barbiturate, sodium amobarbital, injected into the femoral artery, thereby anesthetizing the ipsilateral hemisphere. When the hemisphere for speech and language is anesthetized, the patient experiences complete aphasia. The symptoms last only for a few minutes.

² It is important to note that these individuals had late-onset epilepsy, because it suggests that their brains developed normally. Insofar as they did, we can make inferences about speech and language organization in right-handers. Had they had early-onset epilepsy, or a history of brain damage, it is quite likely that reorganization of cerebral functions (e.g., language and speech) also occurred (Davidson, 1983).

³ Harris (1992) suggests that the term 'bilateral' may be misleading as it is often misconstrued to mean that both hemispheres are contributing equally to speech functions, which is currently not known. Snyder, Novelly, and Harris (1990) suggest that the term 'mixed speech dominance' replace the term 'bilateral' as it is less likely to lead to the aforementioned inaccuracies. In the current paper, the term 'mixed dominance' will be used to avoid any misinterpretation.

left-handed. However, these early observations were questioned when others found clinical cases where left-handers became aphasic following left hemisphere damage, also known as 'crossed aphasia' (Bramwell, 1899). In contrast to the old view that right hemisphere speech dominance and left-handedness are highly correlated, the accumulated evidence indicates that the majority of left-handers are left-lateralized as well. The studies supporting this view include those already cited, all of which had left-handed as well as right-handed participants. For example, Penfield and Roberts (1959) found that of 67 left-handed patients operated on the left hemisphere, 19, or 28.3%, became aphasic; of 22 left-handed patients operated on the right hemisphere, 2, or 9.1%, became aphasic. Similarly, when Rasmussen and Milner (1977) examined left-handed patients with late-onset epilepsy and without any history of early brain damage, 70% of left-handers showed evidence of left-hemisphere speech, 15% showed evidence of right-hemisphere speech, and 15% showed evidence of mixed-speech dominance. Segalowitz and Bryden (1983) found similar percentages from studies of left-handed aphasic patients. They estimated that 61.4% are left-lateralized for speech, 18.8% are right-lateralized, and 19.8% have mixed-speech dominance. Warrington and Pratt (1973) reported similar percentages in their study of dysphasia and ECT. In left-handers, 70% showed dysphasia following left ECT, 23% following right ECT, and 6% following both left and right ECT (suggesting mixed-speech dominance). Taken together, the data indicate that the left hemisphere is the side dominant for speech in nearly all right-handers and in the majority of left-handers. They also indicate that mixed-speech and right-hemisphere speech dominance are almost

exclusively limited to left-handers and that left-handers, in general, are more neuropsychologically heterogeneous than right-handers.

Cerebral Organization for Visuo-Spatial Functions
in Right- and Left-Handers

Early research focused on the role of the left hemisphere for language and speech functions. Subsequent research has identified the right hemisphere as playing a leading role in visuo-spatial functions. Much of the initial research indicated that, in contrast to the evidence for speech and language, visuo-spatial functions were organized in the same way in left- and right-handers (see review in De Renzi, 1982). For example, early research showed that recognition of faces and drawings was impaired following right-hemisphere lesions in right-handers (Tzavaras, Hécaen & Le Bras, 1970) and left-handers alike (Tzavaras, Hécaen, & Le Bras, 1971). Similar results have been found for spatial disorientation and dressing apraxia (Hécaen & Angelergues, 1962), spatial agnosia (Hécaen & Sauguet, 1971), and constructional apraxia (Hécaen, De Agostini, & Monzon-Montes, 1981).

Newer evidence, however, suggests that left-handers have greater bilaterality in the form of secondary left-hemisphere commitment to visuo-spatial processing. Borod, Carper, Naeser, and Goodglass (1985) examined the relation between handedness in aphasic patients with left-sided lesions on the WAIS Performance Scale (Wechsler, 1958) and the Parietal Lobe Battery (Goodglass & Kaplan, 1972). Relative to right-handers, left-handers were significantly more impaired, especially on tests of visuo-spatial organization and construction. From these findings, the authors suggest that left-handers

have more left-hemisphere representation for non-verbal tasks, especially on tasks that involve manipulation and assembly.

Studies of normal adults give a similarly mixed picture. Some studies suggest that right- and left-handers show similar and equally strong organization for visuo-spatial functions. These include divided-visual field studies of recognition of tachistoscopically-projected dot patterns (McGlone & Davidson, 1973) and patterns of steady-state potentials to the temporal and spatial frequencies of stimuli (Mecacci & Spinelli, 1987). Other studies report the same directional effect in right- and left-handers, but with weaker asymmetries in left-handers. These include studies of dot location (Levy & Reid, 1978), tactual discrimination of line orientation (Varney & Benton, 1975), and learning of braille letters by naive, sighted participants (Harris, 1980).

Taken together, the results from clinical and adult normal populations indicate that for both right- and left-handers, the right hemisphere is dominant for visuo-spatial functions, but that left-handers show weaker asymmetries with greater commitment of the left hemisphere.

Left-Handedness Phenotype

From the research reviewed so far, it would seem easy to conclude that left-handers are typically less strongly lateralized than right-handers. The problem, as Hellige, Bloch, Cowin, et al. (1994) point out, is that some studies comprise a greater proportion of left-handers with left-hemisphere language, others with more left-handers with mixed-speech dominance, and still others with more left-handers with right-hemisphere language. This raises the possibility that the overall weaker lateralization shown by left-handers in all

of the neuropsychological measures cited earlier reflects the summing together of these different subgroups.

There have been many attempts to find a single method of classifying left-handers into meaningful subgroups. One method has relied on studying handedness phenotype because left-handers are more heterogeneous than right-handers in phenotype. In contrast to right-handers, who individually are strongly right-handed, left-handers are much more variable in their strength of handedness.

Preference Questionnaires and Performance Tests

To measure handedness, a variety of preference as well as performance measures have been used. On preference tests, participants are asked to indicate which hand they prefer to use for a variety of unimanual tasks; a Likert-type scale is typically employed to establish strength of preference. Some of these questionnaires are short (10 items or less), some are long (50 questions or more), some ask about preference for typical tasks, and some ask about preference for less typical tasks (Harris, 1992). These questionnaires have in common the skill level of the task being assessed; all emphasize tasks that require moderate to high skill rather than unskilled acts for the simple reason that tasks requiring a higher level of skill have been shown to be more lateralized (Harris & Carlson, 1993). Harris (1992) found that regardless of the inventory used (as long as there were a sufficient number of skilled tasks represented), normative studies of adults yielded a J-shaped distribution with 85-90% reporting an overall right-hand preference, with most of the rest reporting a left-hand preference. These tests have shown hand use for writing to have the highest strength of preference (Kang & Harris, 1992). Left-handers, however,

typically show weaker preference than right-handers for other tasks (e.g., Snyder & Harris, 1991). In other words, relative to right-handers, left-handers report using their dominant hand for a smaller proportion of acts on whatever hand preference inventory might be used.

Performance tests assess actual skill, including the rapid movement of pegs in a slotted board (Annett, 1970), rapid tapping of the fingers (Provins & Magliaro, 1989), and inserting a straight pin into holes along a metal grid (Satz & D'Elia, 1989). Like preference tests, left-handers show weaker lateralization than right-handers, that is smaller between-hand differences (e.g., Provins & Magliaro, 1989). Generally, preference and performance tests are significantly correlated (e.g., Peters & During, 1979).

On preference and performance tests, left-handedness, and to a much lesser extent right-handedness, is shown to be a continuous rather than dichotomous variable. For purposes of categorization, however, researchers divide the continuum into a variety of subgroups. In addition to the two main groups labeled right- and left-handers, researchers have used a variety of labels for 'weakly-handed' individuals, or those that lie between the two main groups. Weakly-handed individuals have been called "inconsistent left-handers," "mixed-handers," "ambidexters," and "ambilaterals" (Harris, 1992). Even more numerous than the names given to weakly-handed individuals have been the methods or criteria used to assign such persons to their respective categories. Some researchers have used stringent criteria. For example, Annett (1972), using a 12-item hand preference questionnaire, classified individuals who reported using the nondominant hand on *any* of the 12 items as mixed-handed. Individuals were classified as right- or left-handed only if

they used the same hand for all 12 tasks. Others have labeled all not perfectly consistent right-handers as mixed-handers (e.g., Witelson, 1985). Others have separated right-handers and left-handers with strong and weak preferences in order to obtain four different groups (e.g., Ponton, 1987). Still others have used an 8-item version of the Edinburgh Handedness Inventory (Oldfield, 1971) and a method similar to Annett (1972) but with less stringent criteria (e.g., Peters, 1990; Peters & Servos, 1989; Ponton, 1987). This method has enjoyed some measure of success in subclassifying left-handers and is the method proposed for use in the current study.

In this method, respondents who reported left-hand preference for seven of eight common unimanual tasks (to write a letter, hammer a nail, throw a ball at a target, unscrew the lid of a jar, use a knife to cut bread, use a toothbrush, hold a match while striking it, and hold a tennis racket), including writing, were classified as consistent left-handers (CLHs). Participants with inconsistent hand preferences (ILHs) were those who preferred the right hand for two or more of the eight items. When CLHs and ILHs were compared to right-handers on two types of performance tests (tests of fine motor skills and tests of strength), CLHs performed better with the left hand on both types of tests, much like right-handers would, except for the direction of the hand advantage (Peters, 1990; Peters & Servos, 1989). ILHs, on the other hand, performed better with the left hand on tests of fine motor skills, but performed better with the right hand on tests that involved strength and skill together (e.g., throwing a ball at a target). In addition, on fine motor skills tasks, ILH participants had smaller between-hand differences than either CLHs or the control right-handers.

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Hand Writing Posture

Levy (Levy & Reid, 1978) has proposed that hand writing posture is another basis for classification. Hand writing posture has typically been divided into two types: inverted and noninverted writing postures. Levy and Reid (1976) define the inverted writing posture as one involving a “hooked” position, whereby the hand lies above the line of writing, in contrast to the more common position where the hand lies below the line of writing (see Appendix E). Levy and Reid (1978) report that virtually all right-handers show the normal posture, whereas approximately 90% of left-handers show the inverted posture. They further report that classifying left-handers according to hand writing posture allowed them to predict cerebral lateralization for language, with inverted left-handers showing speech dominance in the left hemisphere, and noninverted left-handers with speech dominance in the right hemisphere. There have been numerous attempts to corroborate this initial report. The results so far are inconsistent and some neuropsychologists (e.g. Weber & Bradshaw, 1981) have questioned the neuropsychological significance of hand posture (see also Harris, 1992; Levy, 1982).

Neuropsychology of Emotion

The literature on the neuropsychology of emotion has focused on three main components of emotion: perception, experience, and expression. The *perception* of emotion has been measured by examining an individual’s ability to make judgments of emotionally laden visual or auditory stimuli as expressed either in human faces or in speech and non-speech sounds (e.g., Harris & Snyder, 1992; Levy, Heller, Banich, & Burton, 1983). To study lateral specialization for the perception of emotion, researchers

selectively present the visual or auditory stimuli in a way designed to give an initial processing advantage to one or the other cerebral hemisphere. A variety of methods have been used, including dichotic listening, divided visual field presentations, and free-viewing of chimeric faces. If one hemisphere is superior in performance to the other (e.g., in recognizing facial expressions or the emotional tone of a voice), that hemisphere can be said to play the leading role for this function.

The *expression* of emotion has been defined as the production of affective behavior. To study lateral specialization for emotional expression, researchers also have used a variety of methods. One method is to measure differences between the left and right halves of the face during either spontaneous or posed expressions (e.g., Mendolia & Kleck, 1991; Sackeim & Gur, 1978). Another way has been to draw on reports of emotional changes in patients with unilateral brain lesions. To the extent that unilateral lesions have different effects depending on the side of lesion, one can infer functional responsibility for behaviors arising or diminishing after hemispheric injury (e.g., Gainotti, 1969, 1972; Goldstein, 1939; Luys, 1890).

Finally, *experience* of emotion can be defined as an individual's subjective feelings or "felt emotion." It has been measured using dichotic listening tasks, clinical studies, as well as mood induction techniques (e.g., Schiff & Lamon, 1989; Deglin & Nikolaenko, 1975). Because *experience* lies on a continuum somewhere between perception and expression, it is often difficult to decide the extent to which emotional experience studies are truly studies of experience and not also studies of the perception and/or expression of emotion.

Clinical and experimental studies of the perception, experience, and expression of emotion have given rise to two main hypotheses about hemispheric specialization for emotion: 1) the right hemisphere hypothesis and 2) the valence hypothesis. These hypotheses are summarized in Figure 1a and 1b.

The right hemisphere hypothesis (Figure 1a) holds that the right hemisphere is specialized for the perception, expression, and experience of all emotions regardless of the valence of the emotion, that is, whether the emotion is positive or negative (e.g., Borod, Koff, & White, 1983; Borod & Caron, 1980; Rubin & Rubin, 1980). The valence hypothesis (Figure 1b) agrees with the right hemisphere hypothesis where perception is concerned but differs for expression and experience. Unlike the right hemisphere hypothesis, the valence hypothesis proposes that the right hemisphere is dominant for the experience and expression of negative emotions, the left hemisphere for positive emotions (Silberman & Weingartner, 1986; Davidson & Fox, 1982; Sackeim, Greenberg, Weiman et al., 1982).

Evidence for the Right Hemisphere Hypothesis

If, according to the right hemisphere hypothesis, the right hemisphere is specialized for all components of emotion, irrespective of valence, it follows that damage to the right hemisphere should lead to an impoverishment of all these components, while leaving cognitive functions (such as speech and language) relatively intact. On the other hand, damage to the left hemisphere should lead to an impoverishment of cognitive functions (such as speech and language) while leaving emotion relatively intact. This is an example of a double dissociation (the inferential technique used to demonstrate localization of

a. *The Right Hemisphere Hypothesis*

	Left Hemisphere		Right Hemisphere	
	<u>Positive</u>	<u>Negative</u>	<u>Positive</u>	<u>Negative</u>
Perception			+	+
Experience			+	+
Expression			+	+

b. *The Valence Hypothesis*

	Left Hemisphere		Right Hemisphere	
	<u>Positive</u>	<u>Negative</u>	<u>Positive</u>	<u>Negative</u>
Perception			+	+
Experience	+			+
Expression	+			+

Figure 1: Neuropsychological theories of emotional processing: The right hemisphere hypothesis and the valence hypothesis.

function): Lesions to one hemisphere disturb tasks not disrupted by similar lesions to the other hemisphere, and vice versa. This is one of the main methods used with clinical populations. For normal populations, the methods more typically use tachistoscopic, chimeric face, and dichotic listening tests. The following review begins with perception studies and then turns to studies of experience and expression.

Perception. For the perception of emotion, the right hemisphere hypothesis finds abundant support from clinical and experimental populations alike. For instance, Ley and Bryden (1979) asked children and college students to identify the emotions of tachistoscopically projected cartoon figure drawings displaying one of five emotional expressions (ranging from extremely positive to extremely negative). The result was significant left visual field (LVF) superiorities (indicating a right-hemisphere advantage). Using real photographs, as well as cartoons and line drawings, Strauss and Moscovitch (1981) found a similar LVF advantage for both smiles and frowns. Levy et al. (1983), using a free viewing chimeric face paradigm, found a similar LVF advantage. Specifically, participants rated a composite drawing with the smile in the LVF as more emotionally expressive than when the smile was in the RVF. Using the same method as Levy et al., Carlson and Harris (1985) not only found a LVF effect for judging the “happier” face, but the “sadder” face as well. A similar right hemisphere advantage has been found for dichotically presented words containing both positive and negative emotional content (Bryden, Free, Gangé, & Groff, 1991).

The evidence thus shows that for the perception of emotion the right hemisphere plays the leading role for both positive and negative emotions. There is only modest

evidence to the contrary. This comes from two studies of right-handed college students, both by the same first author using the same method (Reuter-Lorenz, Givis, & Moscovitch, 1983; Reuter-Lorenz & Davidson, 1981). In both studies, an emotional face was presented to one visual field and a neutral face to the other. The participants then were asked to indicate whether the emotional face appeared on the left or the right of the screen by pressing the response key on the corresponding side. Reaction time (RT) from face-presentation to button press was recorded. The result was faster RTs for the right hemifield (left hemisphere) for happy faces and faster RTs in the left hemifield (right hemisphere) for sad faces. Unfortunately, the account of the method is unclear. For instance, the authors say that RT was “manually recorded,” but they do not say how. The sample size also was very small (10 per cell), and men and women were combined into a single cell. Given these limitations, it is hard to understand why both studies found a valence for the perception of emotion instead of the more usual right-hemisphere dominance effect.

Expression and Experience. Possibly the earliest evidence implicating the right hemisphere in the control of emotional *expression* comes from a report by Olof Dalin (Dalin, 1745; cited in Benton & Joynt, 1960). Dalin reported the case of a farmer’s son who, following an illness, became aphasic and paralyzed on the right side (implying a left-hemisphere lesion). When prompted, however, he was able to “sing certain hymns, which he learned before he became ill, as clearly and distinctly as any healthy person. . . Yet this man is dumb, cannot say a single word except ‘yes’ and has to communicate by making signs with his hands” (Benton & Joynt, 1960, pp. 114-115). If music is the “language of

emotions,” then it can be inferred that the right hemisphere is intimately involved in these processes.

Recent clinical studies support Dalin’s early report. They show that the loss of musical ability, or amusia, is far more common after right- than left-hemisphere damage. In a review of the literature, Zattore (1984) demonstrated that right hemisphere damage was associated with deficits in tasks that demanded the processing of patterns of pitches as well as differences in timbre and that right temporal lobe damage appeared to cause the most consistent deficits. Taken together, the findings that the aphasic can still sing and that amusia is more likely to be acquired after right- than after left-hemisphere injury suggest that the right hemisphere exerts primary control for music and, by implication, for the *expression* and *experience* of emotional/prosodic elements of language.

This interpretation is strengthened by studies of the effects of right hemisphere injury on the emotional content of speech. The earliest studies are probably those by John Hughlings-Jackson. Finding that emotional speech was not disrupted following left hemisphere lesions, Hughlings-Jackson (1879) suggested that emotional speech is represented in the right hemisphere. “The speechless patient may utter ‘yes’ or ‘no,’ or both, in different tones, merely according as he is thus excited. It is then not a proposition, but an interjection, a mere vehicle for variations of voice, expressive of feeling” (p. 175).

More recent studies also suggest that right-hemisphere damage impairs the *expression* of emotion. The impairments appear in the affective intonations in speech (Kolb & Taylor, 1981) and impaired expression of emotions through facial gesturing

(Buck & Duffy, 1980). Other evidence comes from studies of what Borod, Caron, and Koff (1981) call *facedness*, which they define as “the relative intensity of expression and the extent of movement on the left and right sides of the face” (p.381). Using *facedness* as an index for the expression of emotion, Sackeim, Gur, and Saucy (1978) and Sackeim and Gur (1978) found that left-sided composites of six different posed emotions (happiness, surprise, fear, sadness, anger, and disgust) were judged to express emotions more intensely than right-sided composites. Ekman, Hagar, and Friesen (1981), however, questioned whether this effect holds for true or spontaneous facial expressions or only for ‘posed’ emotions. A study by Dopson, Beckwith, Tucker, and Bullard-Bates (1984) suggests that it holds for both. Dopson et al. secretly photographed participants after they had been asked to remember happy or sad experiences. They then compared these photographs with the participants’ posed expressions of happiness or sadness. In both conditions, the faces showed stronger expression on the left side, although the difference was greater in the spontaneous than in the posed condition. Similar findings have been reported by Moscovitch and Olds (1982) and Borod et al. (1983).

In summary, clinical and experimental studies of *expression* offer strong support for the right-hemisphere hypothesis. For the *experience* of emotion, the evidence is less clear; perhaps because it is questionable whether the methods employed have truly tapped “experience” or whether they are more accurately defined as studies of perception of experience.

Evidence for the Valence Hypothesis

As already noted, the right hemisphere and valence hypotheses are identical with respect to the perception of emotion, so the evidence on perception already reviewed for the right hemisphere hypothesis applies equally for the valence hypothesis. Where the hypotheses differ is in regard to the expression and experience of emotion, where, by the valence hypothesis, the left hemisphere has primary control for positive emotion, the right hemisphere for negative emotion. Support for this hypothesis comes from both clinical and normal populations.

Expression and Experience. Some of the earliest evidence was reported by Jules Luys in the 1880s. While working as a physician at the Salpêtrière in Paris, Luys (1890) noticed certain personality differences between right-hemiplegics and left-hemiplegics. Right-hemiplegics (implying left-sided lesions) were more often dysphoric, showing despair, hopelessness, anger, heightened tendency to self-blame, self-deprecation, and fits of crying. Conversely, left-hemiplegics (implying right-sided lesions) more often appeared indifferent or even euphoric, as marked by minimization of symptoms, denial, emotional plasticity, joking, elation, social disinhibition, and mania.

In 1969, Gainotti reported similar effects in a study of 150 patients with unilateral cerebral lesions. The incidence of dysphoric, or “catastrophic” reactions was significantly higher in patients with left-sided lesions (62% left-sided vs. 10% right-sided), whereas indifferent reactions were significantly higher in patients with right-sided lesions (38% right-sided vs. 11% left-sided). Gainotti (1972) corroborated these results in a more detailed study of 160 patients with unilateral lesions (80 left and 80 right). This analysis

also disclosed that the depressive-catastrophic reactions associated with left brain-damage occurred primarily in patients with severe aphasia, generally after repeated failures in verbal communication. Similar findings were reported by Sackeim et al. (1982). These investigators examined reports of pathological laughing and crying (involuntary and uncontrollable changes in emotion following a cerebral lesion). Pathological laughing was three times more common after right-sided than left-sided lesions, whereas pathological crying was twice as common after left-sided than right-sided lesions.

The IAP procedure, mentioned earlier, provides further support for the valence hypothesis. For instance, Terzian (1964) noticed that his patients often had intense emotional reactions as the anesthetic was wearing off:

Amytal on the left side provokes . . . a catastrophic reaction . . . The patient . . . despairs and expresses a sense of guilt, of nothingness, of indignity, of worries about his own future or that of his relatives . . . [amytal on the right side] produces on the contrary a complete opposite emotional reaction, an euphoric reaction . . . The patient appears without apprehension, smiles and laughs and both with mimicry and words expresses considerable liveliness and sense of well-being (p. 1232).

These findings were confirmed by Rossi and Rosadini (1967). Of patients showing depression, 62% showed it after left injection, only 16% after right injection. Conversely, of patients who showed euphoria, the figures were 75% after right injection, 38% after left injection. Finally, only 9% of patients showed a depressed *and* euphoric reactions after right-side injection.

Interpretation of the emotional reaction following anesthetization is difficult because the reaction occurs when the anesthetic is wearing off, not when the patient is at the most anesthetized point in the procedure. This raises the question whether the emotional reaction is due directly to the action of the non-anesthetized side or to the “waking up” of the other side. A further complication is that Milner (cited in Rossi & Rosadini, 1967) was unable to duplicate Rossi and Rosadini’s findings. In a study of 104 patients, she found no evidence linking depressive reactions to left-sided injections and euphoric reactions to right-sided injections. Davidson (1983) argues that methodological differences between the studies may account for the discrepancies: 1) Milner used a higher dose of sodium amytal, 2) injections were into the common carotid instead of the internal carotid, and 3) her sample included many individuals with early brain damage.

Gainotti’s findings suggest a question similar to one in the amobarbital injection studies; namely, does the person’s reaction directly reflect the action of the damaged hemisphere or does it reflect a release of inhibition of the undamaged hemisphere? In other words, is the catastrophic reaction associated with a left hemisphere lesion directly due to the left-hemisphere damage or is it that the left hemisphere lesion destroyed an area responsible for inhibiting the right hemisphere, thus allowing “catastrophic affect” to flow from the right hemisphere? This is a question that one might have supposed that the IAP procedure could address insofar as it eliminates the possibility of the opposite hemisphere from exerting an influence because it is now anesthetized. However, recall that the IAP data are equivocal because the reactions occur when the anesthetic begins wearing off so that the question remains as to whether the reaction is due to the unanesthetized side or

the “waking up” of the anesthetized side. Therefore, it might be concluded that lesion studies support the valence hypothesis but are inconclusive about the direction because there is no definitive way to determine whether emotional displays represent the patient’s reactions to deficits or to the disinhibition of the non-injured hemisphere. However, by applying Hughlings-Jackson’s inhibition theory (1874) to Gainotti’s findings, the catastrophic reaction after left hemisphere damage can be seen as the result of the left hemisphere’s release of inhibition over the right hemisphere. Furthermore, the euphoric reaction after right hemisphere damage would be the result of the right hemisphere’s release of inhibition over the left hemisphere. By this view, it could be argued that the left hemisphere leads for the expression and experience of *positive* emotion, the right hemisphere for *negative* emotion.

In addition to the evidence from clinical populations, support for the valence hypothesis comes from mood induction experiments in normal persons. The methods used to induce mood include having participants watch television programs with varying emotional content (e.g., Davidson, Schwartz, Saron, Bennett, & Goldman, 1979), asking participants to self-generate emotional states (e.g., Tucker & Dawson, 1984), and observing emotional displays by others (e.g., Davidson & Fox, 1982). Physiological measures such as EEG recordings are taken and hemispheric specialization for emotional experience is inferred. Schiff and Lamon (1989), however, question the validity of such studies. They raise the possibility that the participants’ mood states, instead of reflecting the emotional tone of the manipulations, reflect a demand characteristic. They also raise the question of whether the cognitive activities that these participants engaged in as part of

the mood induction might have reflected the lateralization for the processing of emotion as well as the regulation of emotional experience. In other words, these mood induction experiments might represent the perception of emotion rather than the experience of emotion.

Other approaches have presented emotional stimuli selectively to each hemisphere and measured emotional reactions. For instance, researchers have presented photographs of emotional faces selectively to one hemisphere (e.g., Davidson, Schaffer, & Saronson, 1985; Natale, Gur, & Gur, 1983) and have shown films with emotional content to one hemisphere (Dimond, Farrington, & Johnson, 1976; Dimond & Farrington, 1971). The results were mixed. For instance, Dimond et al. (1976) found that when participants were asked to evaluate the films for unpleasantness, the right-hemisphere condition yielded more unpleasant judgments than the left, but found no effects for pleasantness. Davidson et al. (1985), on the other hand, found significant differences only for the left hemisphere, namely, that sad pictures were judged as less sad, or more happy, when projected to the left rather than the right hemisphere; there were no significant effects for the happy or neutral pictures. In general, the results of these experiments support a valence effect for the experience of emotion. These experiments, however, raise the same questions as do the studies mentioned earlier; namely, how well do the stimuli induce mood, how much of the change in mood is due to response demands, and do these experiments truly tap “experience,” or are they more reflective of perceptual processes? To circumvent these difficulties, a new method of mood induction has been proposed by Schiff and Lamon

(1989). Because it is also the method used in the current study, it will be described in detail.

Schiff and Lamon's (1989) New Mood Induction Technique

Schiff and Lamon's (1989) mood induction procedure involves the selective contraction of the facial muscles, first on one side, then the other. The assumption is that contracting one side of the face selectively stimulates the contralateral hemisphere. To explain why such contractions also might be expected to affect the participant's mood, or emotional state, we first must discuss the anatomy of the facial sensory and motor pathways.

The lower two-thirds of the two sides of the face innervate the brain contralaterally. Thus, contracting the lower two-thirds of the left side of the face stimulates the right hemisphere; contracting the lower two-thirds of the right side stimulates the left hemisphere. Two types of neurons innervate the face. The *motor* neuron brings information from the brain to the facial muscles. The *sensory* motor neurons bring information to the brain from the sense receptors (Brodal, 1981, chap. 7). There are also two motor neuron circuits. Upper motor neurons (UMNs) carry motor impulses from motor centers in the brain to the brain stem or spinal cord. Lower motor neurons (LMNs) carry the impulses from the brain stem or cord to the muscle itself. It is the LMNs that innervate the lower two-thirds of the face. If emotional activity stimulates motor neurons, producing a facial expression, could one enter the system by the reverse route? Specifically, with manipulation of one side of the face, would the sensory neurons

send information to the brain and by spread of activation induce an emotion? This is Schiff and Lamon's supposition.

Schiff and Lamon's (1989) first report consisted of three experiments. In the first experiment, 12 acquaintances (4 men and 8 women) of the experimenter were asked to "pull back and lift each corner of their mouths" (p. 925). The authors selected acquaintances who they believed would be comfortable disclosing feelings that they presumably would find unexplainable, that is, emotions arising from simple manipulation of the face. Participants held the contractions for 60 seconds and were asked to "pay attention to whatever emotional experiences they might have while maintaining these contractions, to let them occur without judgment, and to report on them when they were asked to relax" (p. 926). The experiment used a within-participants design with side of initial contraction counterbalanced across participants. The sequence of subsequent contractions was different for each participant and depended on the experimenter's judgment about the participant's emotional state. For instance, if the experimenter determined that a participant was beginning to show signs of emotion following contraction of one side of the face, then that side was contracted again. Ten of 12 participants reported having emotional experiences following the facial contractions. In most cases, the first report followed the first two or three contractions. Subsequent to left-side contractions (activating the right hemisphere), these ten participants reported feeling "sad and depressed" and had sad facial expressions. In addition, three participants began to weep. None of the ten could report reasons for their mood change, and all expressed surprise that they were feeling sad; the feelings were described as "coming

upon them without warning and without reason” (p. 926). When a right contraction was performed after the left had produced the dysphoric reaction, the participants reported that the sadness lifted and, again, could not explain why. Descriptions following right-side contractions included reports of positive affect (e.g., “up” and “good”) and a mixture of positive affect and aggression (e.g., “cocky” and “smug”). The two participants who did not report emotional experiences following contractions reported feeling silly and self-conscious while holding the contraction.

Schiff and Lamon (1989) recognized that the semiclinical procedures that were used could not rule out whether the effect was due to the manipulation or to cues provided by the experimenter. Their sample size was also small and consisted of their own acquaintances. In addition, the dependent measure — self-report — was rated by the experimenters. For these reasons, Schiff and Lamon conducted a second experiment with 30 right-handed male and female undergraduates. The instructions were the same, except that the participants were to hold the contraction for only 45 seconds, were told to “breathe normally throughout the contraction,” and to “attend to feelings rather than to thoughts or facial sensory experiences” (p.929). Each participant performed four contractions, with order of initial contraction counterbalanced (LRLR or RLRL). After each contraction, participants were asked to report their emotional experiences. These reports were recorded on audiotape and later transcribed onto separate pages. There were 120 reports from the 30 participants. The order of the reports was then randomized across participants and conditions. Two independent judges (who themselves had undergone the manipulation) then attempted to classify the reports as following a right or

left facial contraction. The judges agreed on 106 of the 120 reports, calling 56 classifiable and 50 unclassifiable. Of the 56 reports that could be classified, an equal number were predicted to have occurred following right and left contractions. The judges correctly classified 75% of mood reports following a right face contraction and 71% of the mood reports following a left side contraction. A test for accuracy of prediction was significant. These results corroborate the findings of the first experiment. A third experiment was then performed to investigate the effects of the facial contractions using a measure other than self-report. The authors believed this third experiment to be the most rigorous; “this third experiment demonstrates conclusively that [if there were any remaining questions regarding the validity of the emotional reports in the first two experiments it] is not a problem” (p. 933).

The measure chosen for the third experiment was selected cards from the Thematic Apperception Test [TAT] (Bellak, 1986). The emotional tone of the stories told after the fourth manipulation was rated. Participants were 36 right-handed men and women. Standard TAT instructions were used. Following the fourth manipulation, the participant was presented with cards #13B and #14; these were the practice pictures and were chosen because they were not thought to be sensitive to emotional states (Bellak, 1986). The participant was then given the target card, card #11. The stories were audiotaped, transcribed, and rated by two independent observers for emotional tone (positive, negative, or neutral). Inter-rater agreement was 90%. As predicted, there were no differences in the tone of the emotional content for the practice cards. The target picture produced a significantly greater proportion of negative emotional content following the

left contraction than the right contraction. There was also a significantly greater proportion of both positive and neutral stories following the right contraction than the left contraction. For the stories told after the right contraction, however, analysis of variance failed to show any significant differences between the proportion of negative, neutral, and positive stories.

Taken together, the three experiments support the valence hypothesis for the experience of emotion but more clearly for the right than the left hemisphere. The right facial contraction produced fewer negative (or more positive) stories, but it could not be further differentiated. The first and second experiment, however, found a sharper distinction between the two facial contractions, with the right hemisphere showing more involvement for negative experience and the left hemisphere for positive experience. These experiments, however, were not so experimentally rigorous as the third.

In still another study, Schiff, Esses, and Lamon (1992) showed that their mood induction procedure could produce similar effects in social cognitive judgments about ethnic stereotypes as do positive and negative moods induced by conventional mood induction procedures. These findings not only provide further evidence for the valence hypothesis for the expression of emotion, they suggest that a mood's influence on cognition does not depend on a *cognitive* component of mood induction. Perhaps the emotional state results from a spread of activation from the sensory and/or motor areas to adjacent areas responsible for emotion, thereby affecting one's cognitions. If the spread-of-activation hypothesis is correct and if mood arousal does not depend exclusively on facial musculature, then one should be able to contract other muscles with similar motor

organization (innervation to the contralateral hemisphere) and produce similar mood changes. Schiff and Lamon (1994) found support for this hypothesis using unilateral contraction of hand muscles. The procedure was the same as in Schiff and Lamon's (1989) third experiment and yielded similar results. Left-handed contractions produced more negative stories; right-handed contractions produced more positive stories.

Since publication of Schiff and Lamon's (1989) initial report, only one replication, by Kop, Merckelbach, and Muris (1991), has been reported other than those by Schiff himself. This attempt failed. This led to spirited discourse between the two sets of authors (Schiff & Lamon, 1993; Kop, Merckelbach, & Muris, 1993). Schiff and Lamon (1993) effectively argued that the replication was not a true replication and that this may explain the null results. Schiff and Lamon pointed to numerous inconsistencies in the two methods, including non-alteration of the side of contraction after each manipulation (participants were assigned to LLLRRR or RRLLLL conditions) and use of a different dependent measure (subjective rating of six cartoon figures — one after each contraction — for pleasantness). Although Schiff and Lamon did not mention it in their list of criticisms, Kop et al. also only used female participants. The Kop et al. study, therefore, does not represent a true “replication” of the Schiff and Lamon (1989) technique. However, as Schiff and Lamon (1993) discuss, Kop et al.'s (1991) failed replication does show the limiting conditions under which the phenomenon occurs.

Cerebral Organization for Emotion in

Right- and Left-Handers

So far we have reviewed the evidence for two hypotheses pertaining to the organization of emotion. We now can examine the evidence comparing right- and left-handers on tasks such as those cited earlier when discussing the evidence for the right-hemisphere and valence hypotheses. These studies are divided into two groups:

- 1) studies that compare right- and left-handers on presumptive tests of emotion and
- 2) laterality studies, like those reviewed earlier, that compare right- and left-handers on tests of the perception and expression of emotion.

Studies of Handedness and Psychological Tests of Emotion

The literature on emotional/psychological differences between right- and left-handers includes tests of emotional stability, anxiety, and temperament. One of the earliest such comparisons was reported by Ingram and Reid in 1956 (cited in Orme, 1970). They found a high incidence of left-handedness and emotional disturbances in children with developmental aphasia but with normal intelligence (ages not given in Orme's report). Orme (1970) made a similar investigation in 300 non-aphasic British school girls, ages 14-17. Of these adolescents, 23 were left-handed, 277 were right-handed, as measured by the hand used for writing. Emotional stability was measured by a 13-item questionnaire created by Orme (1965). Using a chi-square test, Orme concluded that the left-handers were significantly more emotionally unstable than right-handers. Indeed, only one left-hander (4.3%) scored in the emotionally stable range compared to 89 of the 277 right-handers (32.1%). Hicks and Pellegrini (1978) properly question Orme's data analysis,

namely that he violated the rule pertaining to the minimum number of cases per cell in a contingency table. They also state that a more powerful statistic should have been used to measure the strength of effect given that the emotional stability scale score Orme computed was a parametric statistic.

Only a few studies have focused on possible links between handedness and anxiety. Hicks and Pellegrini (1978) compared 23 left-handed, 12 mixed-handed, and 35 right-handed college students on the Taylor Manifest Anxiety Scale (1953). Right-handers were significantly less anxious than either left- or mixed-handers, who were not different from each other. The relation between anxiety and handedness was also examined by Mueller, Grove, and Thompson (1993), who drew on archival data from four studies. In each study, handedness was based on self-report of hand-writing preference, and anxiety was measured by the Test Anxiety Inventory (TAI; Spielberger, 1980). The total N across the four samples consisted of 166 left-handers and 1,388 right-handers. No significant differences were found between the two groups in base levels of test anxiety. French and Richards (1990) and Weinrich, Wells, and McManus (1982) reported similar null findings.

Harburg, Roeper, Ozgoren, and Feldstein (1981) approached the question somewhat differently by focusing on temperament. Their participants were 1,153 persons ages 18 to 70 who were participants in the Tecumseh Community Health Study. This was a longitudinal study begun in 1959, and most of the data were medical. The protocol included a measure of handedness (showing two different hand-writing postures for both hands) and two measures of temperament (Buss & Plomin, 1974; Eysenck & Eysenck,

1968). The only differences were between the younger (18-39 year old) participants. In this subgroup, left-handers (N=86) compared to right-handers (N=565) showed significantly more emotionality (fear and anger), less sociability, less sensation seeking, and less extroversion.

In summary, the relation between handedness and these measures of emotionality is weak; sometimes it is there, sometimes not. However, when a difference occurs, it is always in the direction of left-handers being more emotional. This, in itself, offers some justification for examining the lateralization of emotion.

Handedness and Lateralization of Emotion

In most of the studies on lateralization of emotion reviewed earlier, the participants either were all right-handers or the handedness of the participants was not mentioned. The literature on handedness and lateralization of emotion thus is slim. Nevertheless, there are a sufficient number of studies to permit comparison of right- and left-handers on each of the three components of emotion: perception, expression, and experience.

Perception. Beginning with perception studies, most research suggests that both right- and left-handers show right-hemisphere dominance. Most of the evidence comes from chimeric face and dichotic listening studies. For example, Luh et al. (1994) compared 72 right-handers with 72 left-handers on four free-vision chimeric face tasks that required judgments of emotion. The chimeric faces were smiling on one side and neutral in expression on the other. They also differed in sex, one side male, the other female. The latter difference allowed the chimeras to be rated for what the investigators called "femininity." Each condition included photographs of real and cartoon faces. For

the emotion task, participants were asked to judge which face looked happier. For the femininity task, they were asked which face looked more feminine. For both tasks, right- and left-handers showed left-hemispatial biases. However, the task-specific reliable variance was decreased, and the variance common to all tasks was increased for left- compared to right-handers. More specifically, in left-handers the left visuo-spatial bias was higher for feminine faces than for emotion, whereas in right-handers, the emotional content of the face was more important. This suggests that those processes that underlie the perception of emotion are less lateralized in left-handers than in right-handers.

Bulman-Fleming and Bryden (1994) found similar results with a dichotic listening task. They presented 64 left-handers and 64 right-handers with a target word spoken in a happy, sad, or angry voice. They then asked them to report each time they heard a particular word or a particular emotion. All three emotions — happy, sad, and angry — showed a left ear advantage of similar magnitude. These results largely support Bryden et al.'s (1991) study with the exception that, in Bulman-Fleming and Bryden (1994), the left ear advantage was much larger for angry words than for happy, sad, or neutral words. The left-ear advantage was reduced in left-handers, but handedness effects failed to reach significance. As in the study by Luh et al. (1994), left-handers also showed higher variance.

The only exception to this picture would be the works by Reuter-Lorenz and Davidson (1981) and Reuter-Lorenz et al. (1983), cited earlier. Recall that they found a valence effect for the perception of emotion in right-handers. They also found evidence for a reversed valence for certain left-handers, namely those who wrote in the

non-inverted posture. The authors therefore suggested that: 1) non-inverted and inverted left-handers differ in their neural organization for the perception of emotion and 2) the two hemispheres are differentially specialized for positive and negative affect. Recall, however, the suggestion raised earlier that these findings might reflect some methodological artifact.

Keeping these two exceptions in mind, the weight of evidence shows that both right- and left-handers are right-hemisphere dominant for the perception of emotion, irrespective of valence. It also suggests, however, that left-handers show increased variance across different emotional tasks. The greater variance could reflect at least two, not necessarily mutually exclusive, differences between right- and left-handers: 1) left-handers' weaker differentiation in cortical organization for the perception of emotion or 2) left-handers' greater variability in cerebral organization.

Expression. Like the research on the perception of emotion, most of the evidence on expression of emotion suggests that right- and left-handers alike show right-hemisphere dominance. Recall that the usual method of demonstrating this effect is through the study of facedness. For instance, Borod and Caron (1980) had 31 right-handers and 20 left-handers perform nine different emotional expressions including greeting, disapproval, clowning, flirting, grief, toughness, and horror. Right- and left-handers were both significantly left-faced for all emotions except for "toughness" where left-handers were significantly right-faced. Borod et al. (1981) found similar results, and, once again, toughness was reversed in left-handers. It may be significant that toughness was the one expression requiring unilateral facial movement. To study unilateral facial movements in

greater detail, Chaurasia and Goswami (1975) examined deliberate manipulation of the face in 300 right- and 30 left-handers. The result was an inverse relation between handedness and facedness. Of the right-handers, 59% showed a left-sided smile and found it easier to perform a variety of facial manipulations with the left side of the face, whereas 73% of left-handers showed the reverse effect. Campbell (1979), on the other hand, observed 24 left-handers while they expressed a posed smile and found them to be significantly left-faced.⁴ In support of Campbell's (1979) results and in contrast to Chaurasia and Goswami's (1975), Heller and Levy (1981) found that for right- and left-handers alike, left-side facial composites of a posed smile were judged to be happier than right-side composites.

The discrepancies in these studies are hard to explain in terms of neuropsychological theory. However, the pattern of results across experiments supports the view that both right- and left-handers are left-faced, but significantly so only for right-handers.

Experience. In contrast to the literature on handedness, perception, and expression of emotion, the laterality literature on handedness and experience of emotion is sparse. One reason may be related to the difficulty in defining "experience." A study by McFarland and Kennison (1989) illustrates this point.

McFarland and Kennison (1989) presented music recordings to 80 right-handers and 80 left-handers. Two selections had a negative valence and two had a positive valence. Independent judges reported that the negative selections evoked images of

⁴ However, a reversal in the asymmetry was observed when the participants' facial expressions were relaxed (based on a photograph taken after the participant performed the posed smile).

agitated grief, sadness, and despair, whereas the positive selections evoked images of jollity, celebration, happiness, and contentment. The musical selections were presented monaurally either to the right or left ear for 3 minutes and 40 seconds. After the music ended, the participants were asked to “rate the valence of the emotion” they had experienced during the music using a scale anchored by the words “happiness” and “sadness.” Right-handers reported more positive and less negative affect when listening to the music in the right ear, whereas left-handers showed the reverse effect, reporting more positive and less negative affect during music to the left ear. These results, therefore, suggest reverse valences for the experience of emotion between right- and left-handers. But did the participants actually feel sad or happy (in other words, did they experience sad or happy emotions), or did they simply perceive the *music* as sad or happy? If the latter, then this would be a study of perception; if the former, it was a study of experience. The authors, perhaps sensing these difficulties, use neither term and instead described the results as showing asymmetry in the “processing” of emotions, which could mean perception, expression, or experience of emotion, individually or in combination.

In an attempt to better understand the relation between handedness and the experience of emotion, Smith, Kline, and Meyers (1990) made parietal EEG recordings from right- and left-handed adults while they listened to a variety of emotional sounds. The sounds included a woman screaming, a woman laughing, a woman crying, and a baby cooing. The participants were instructed to process the sounds in three different ways. In the “affective” condition, they were asked to “concentrate on feelings and actively attempt to experience the emotions elicited by each stimulus” (p. 63). In the “cognitive

condition,” they were instructed to avoid making an affective response. In the neutral condition, they were asked to focus full attention on the stimuli and to maintain a neutral (i.e., nonaffective, noncognitive) set. Left-handers showed a greater overall level of activation (arousal), especially for the emotional conditions, relative to right-handers. Right-handers showed greater overall lateralization for the three conditions with greater left-hemisphere activation. Left-handers showed nearly identical activity in the two hemispheres across all three conditions. This last finding corroborates the reports of increased variability for left-handers in the perception and expression studies cited earlier, which raises the possibility that the cerebral organization of emotional experience in left-handers, at a group level, is more diffuse than in right-handers.

For right-handers, then, some tentative conclusions can be drawn about the neuropsychological organization of emotion, namely, that they show a valence effect for the expression of emotion — negative for the right hemisphere, positive for the left hemisphere. Left-handers appear to differ from right-handers, but it is hard to say how they differ with any certainty. Given the aforementioned findings and the ample evidence of the heterogeneity of left-handers, it is plausible to hypothesize that left-handers show increased diffusion of cerebral organization for emotion. It is far more difficult to accept McFarland and Kennison’s (1989) conclusion that the valence is reversed in left-handers. It is also likely that some of the increased bilaterality in left-handers occurs at a group level when phenotypic subgroups of left-handedness are grouped together. Perhaps it is only when these subgroups are examined separately that we can better determine whether left-handers, in general, show greater bilaterality for the lateralization for the experience of

emotion, or whether it is only certain subgroups of left-handers who show increased diffusion of cerebral organization for emotion.

Rationale and Predictions

The current study was designed to study handedness and experience of emotion by comparing right- and left-handers on a new test using unilateral facial contraction to induce emotional experiences. The specific aim was to 1) determine whether Schiff and Lamon's (1989) findings could be replicated, 2) further examine the valence hypothesis for the *experience* of emotion, and, if able to replicate Schiff and Lamon's findings, 3) determine whether right-handers differ from left-handers in cerebral organization for the *experience* of emotion.

Replication of Schiff and Lamon's (1989) Mood Induction Procedure

To date, the only attempted replication of Schiff and Lamon's (1989) mood induction technique, other than those by Schiff or Lamon themselves, was by Kop, Merckelbach, and Muris (1991), and this attempt failed. Recall however, the many inconsistencies in the two methods pointed out by Schiff and Lamon (1989). To avoid the difficulties in interpreting Kop et al.'s null findings, the current study strictly adhered to Schiff and Lamon's descriptions of their mood production procedure.

Where this study purposefully deviated, however, was in the selection of the dependent measures used to assess the effects of the mood induction. Recall that Schiff and Lamon used a variety of dependent measures, self-report for the first experiment, transcribed self-reports judged by blind reviewers for the second, and, for the third and most experimentally vigorous experiment, three TAT cards rated for positive, negative,

and neutral emotional tones by two independent observers. Although the TAT lets the researcher measure the subtle effects of experimental manipulations, it is an indirect measure of mood and it does not allow objective measurement of the strength of the mood state or comparison of participants' scores to those in a normative sample. So that strength of mood could be measured and compared to normative samples, the current study used the Depression Adjective Checklist (DACL) and the Profile of Mood States-Bipolar (POMS-BI). In addition, the DACL has multiple forms specifically designed for the research setting and, in particular, for research involving repeated measures.⁵ Its ability to be used quickly and repeatedly was of great import to the current study, as it was important to be able to track changes in participants' moods across manipulations. Remember that Schiff and Lamon gave only the TAT cards after the fourth and final manipulation. To the extent that the experiment employed a between-participants design, Schiff and Lamon, therefore, could not make any definitive statements about mood changes relative to side of facial contraction. Like the DACL, the POMS-BI was chosen because of its ability to measure strength of mood and because of its established norms. However, unlike the DACL, the POMS-BI takes several minutes to complete and does not have multiple forms. Therefore, it was included as a pre-test measure and given after the fourth and final manipulation, similar to Schiff and Lamon's method. The difference was that giving the POMS-BI as a pre-test measure allows for the control of pre-mood differences between participants. The POMS-BI was also selected because of its reported ability to measure six bipolar mood states. Recall that Schiff and Lamon (1989) could not

⁵ These forms have well-demonstrated test-retest reliability and construct validity (Lubin, 1994). For a complete discussion of the DACL and POMS-BI see Methods/Materials.

clearly describe the moods that occurred after a right facial contraction. Therefore, unlike the DACL, it was believed that the POMS-BI would provide additional dimensions of mood, ones other than the simple “positive vs. negative” dimension of the DACL.

Test of the Valence Hypothesis for the Experience of Emotion

Schiff and Lamon’s (1989) mood induction method was also selected because, of all the methods used to date, it most clearly involves the *experience* of emotion. As we have seen, other methods often involve the perception and/or expression of emotion as well. To the extent that these methods also tap the perception and/or expression of emotion, any inferences about lateralization for the *experience* of emotion remain equivocal. Recall that the valence hypothesis postulates a valence effect only for the *experience* of emotion. This makes it crucial for the mood induction method to involve only the experience of emotion; to the extent that it involves other emotional processes, it could be measuring something other than experience. As a result, it would be difficult to determine whether there is a valence or right-hemisphere effect for the experience of emotion. It is believed that the Schiff and Lamon (1989) mood induction method may be useful for the researcher who wants a clean index of the *experience* of emotion.

Test of Handedness Differences in the Control of the Experience of Emotion

Lastly, the current study was intended to be a contribution to research on handedness and the experience of emotion, a slim literature as we saw, especially where handedness and the experience of emotion are concerned. To the extent that right- and left-handers can be shown to differ in other psychological processes (e.g., the experience of emotion), then we have the means to ask the functional utility of lateralization for those

processes. That is, because left-handers are reported to differ from right-handers on selected psychological tasks and to be more common in certain clinical and other special populations, the study of left-handedness and emotion may hold a key to understanding a fundamental question in neuropsychology — the relationship of laterality to cognitive, perceptual, and emotional processes (Harris, 1992).

Based on the review of handedness and emotionality, three major predictions were proposed.

Prediction #1: Mood and Side of Facial Contraction

In accordance with the literature supporting a valence hypothesis for the experience of emotion, it was predicted that left facial contractions (right hemisphere) would produce a dysphoric mood, and that right facial contractions (left hemisphere) would produce a positive mood. For the DACL, it was predicted that those DACLs completed after left-face manipulations would be significantly higher (indicative of more symptomatology) than those completed after right-face manipulations. Using the POMS-BI, it was predicted that those completed after a left-face contraction would result in significantly higher levels of negative mood state and lower levels of positive mood state, whereas POMS-BIs completed after a right-face contraction would result in lower levels of negative mood state and higher levels of positive mood state.

Prediction #2: Mood and Handedness

Based on the literature on handedness and the lateralization of the *experience* of emotion, it was predicted that right-handed males would be more clearly lateralized than left-handers on the mood induction task. Therefore, right-handers' moods (relative to

left-handers') would be expected to change to a greater degree toward a negative mood state following left facial manipulations and to a greater degree toward a positive mood state following right facial manipulations. On the DACL, it was predicted that right-handers would exhibit significantly greater changes in mood states after both right- and left-face manipulations than left-handers. On the POMS-BI, it was predicted that right-handers would exhibit significantly greater mood state changes on the PMS and NMS after both right- or left-facial manipulations than left-handers.

Although there were no predictions made for consistency of handedness and the lateralization for the experience of emotion, additional analyses were performed to determine whether the classification of left-handers into consistent and inconsistent subgroups acted as a predictor variable for the effects of the facial manipulations on mood.

Prediction #3: Handedness and Pre-mood Measures

Lastly, based on the literature on handedness and emotionality, it was predicted that if a difference was found on pre-mood induction mood measures, it would be in the direction of left-handers showing higher rates of negative emotional states (e.g., anger and depression). On the DACL, it was hypothesized that if a difference was found in pre-mood measures, it would be in the direction of left-handers having significantly higher T-scores on DACL-A, indicative of greater levels of depressive symptomatology. On the POMS-BI, if a difference was found in pre-test measures, then it was hypothesized that it would be in the direction of left-handers showing higher levels of negative mood states and lower levels of positive mood states.

METHOD

Participants

Participants were 78 male undergraduate college students (40 right-handed, 38 left-handed) from the Psychology Department Human Participants Pool at Michigan State University. Participants were enrolled in one of several large introductory (freshman and sophomore level) psychology classes and received credit in this course for their participation. The age of the participants ranged from 18 to 29 with a mean age of 20.1 years ($SD = 1.9$). Participants were treated in strict accordance with the ethical standards of the APA.

Of the entire sample, 81.8% of the participants were Caucasian, 9.1% were African-American, 5.2% were Asian-American, and 1.3% were Hispanic. The remaining 2.6% indicated that they were of Middle Eastern descent. Participants ranged from freshman to seniors. Of the entire sample, 37.2% were freshman, 28.2% were sophomores, 15.4% were juniors, and 19.2% were seniors. Participant demographic information is broken down separately for right- and left-handers in Table 1.

Design

This study used a 2 x 2 design with side of the facial contraction (left vs. right) as a within-participants independent variable and handedness as a between-participants independent variable. The two dependent variables were: 1) the participant's rating of his emotional state before the first facial manipulation and after each manipulation as measured by the Depression Adjective Checklist (DACL) and 2) the participant's rating of his emotional state before the first facial manipulation and after the last manipulation as measured by the Profile of Mood States-Bipolar (POMS-BI). Each participant performed

Table 1

Participant Demographic Information for Right- and Left-Handers

	<u>Right-Handers</u>	<u>Left-Handers</u>
N	40	38
Age	20.05	20.13
Ethnicity (%)		
Caucasian	82.5	81.5
African American	7.5	10.5
Asian American	7.5	2.6
Hispanic	2.5	0.0
Middle Eastern	0.0	5.3
Year in School		
Freshman	37.5	36.8
Sophomore	30.0	26.3
Junior	20.0	10.5
Senior	12.5	26.4

two left-sided and two right-sided face contractions, alternating the side of the contraction each time⁶. The side of initial contraction was counterbalanced across participants, with half of the participants first performing a left-sided contraction (LRLR) and the other half performing a right-sided contraction (RLRL).

Materials

Materials included an informed consent form, participant identification form, medical history questionnaire, participant background and demographic survey, 8-item handedness questionnaire, DACL, and POMS-BI.

Informed Consent Form

The Informed Consent Form (Appendix A) included the following information:

1) that the study involved examining the effects of facial muscle contractions on mood in a normal, healthy population, 2) that the participant would be asked to complete a medical history questionnaire, a background and demographic survey, an eight-item handedness questionnaire, two adjective checklists, 3) that the participant would be asked to pull back and lift one corner of his mouth and to hold that position for 45 seconds, 4) that the participant would perform four such contractions, alternating sides for each contraction, and 5) that the participant would be asked to complete a checklist, as quickly as possible, following each contraction.

⁶ Schiff and Lamon (1993) found that having participants alternate side of facial contraction after each trial (as opposed to performing several sequential same-side contractions) produced more robust and reliable mood states.

Participant Identification Form

On the Participant Identification Form (Appendix B), the participant's name and identification number were recorded for the purpose of maintaining confidentiality. This was the only form that identified and linked the participant name to his identification number. Only the investigator and his designates have access to this information. All other documents have only the participant identification number.

Medical History Questionnaire

The Medical History Questionnaire (Appendix C) asked whether the participant currently or had at any time in the past been clinically diagnosed with any of the following disorders: 1) Major Depression, 2) Bipolar, 3) Generalized Anxiety, 4) Panic, 5) Post Traumatic Stress, 6) Substance Abuse, 7) Schizophrenia, 8) Hypertension, 9) any other emotionally related disorders, or 10) a history of facial paralysis. This measure was created in order to screen out individuals who would be inappropriate for inclusion in the study.

Personal Information and Background Questionnaire

The Personal Information and Background Questionnaire (Appendix D) asked for the participant's full name, age, sex, years of education, academic major, and ethnicity/race.

The Laterality Questionnaire

The Laterality Questionnaire (Appendix E) asked the participant to choose which of the following descriptions best described his general handedness: 1) strongly left-handed, 2) moderately left-handed, 3) ambidextrous (either-handed), 4) moderately

right-handed, or 5) strongly right-handed. It then asked the participant to indicate his hand preference for eight common tasks: 1) write a letter, 2) hammer a nail, 3) throw a ball at a target, 4) unscrew lid of a jar, 5) use a knife to cut bread, 6) use a tooth brush, 7) hold a match while striking it, and 8) hold a tennis racket. These eight items were taken from the 10-item Edinburgh Handedness Inventory (Oldfield, 1971) and are commonly used to assess degree of hand preference (e.g., Peters, 1990; Peters & Servos, 1989; Ponton, 1987). Strength of hand preference was rated on a 5-point Likert Scale, from 1 (always left) to 5 (always right). A laterality index score was created by adding the strength of preference scores for each of the eight tasks. Therefore, scores could range from 8 (exclusive left-hand use for all items, i.e., 8×1) to 40 (exclusive right hand use for all items, i.e., 8×5). Participants were also asked to indicate whether they wrote with an inverted or non-inverted hand posture by circling one of two pictures depicting the two postures. Lastly, participants were asked whether anyone (including themselves) had ever tried to change what hand they used for certain tasks.

The Profile of Mood States - Bipolar (POMS-BI)

The POMS-BI (Lorr & McNair, 1988) is a 72-item paper and pencil test that was constructed to measure six bipolar subjective mood states. Each mood state is defined by a scale consisting of 12 adjectives or phrases. One pole represents the positive aspects of the dimension, the other pole represents more negative aspects. The six mood states are described as follows: 1) composed-anxious, 2) agreeable-hostile, 3) elated-depressed, 4) confident-unsure, 5) energetic-tired, and 6) clearheaded-confused (Appendix F). The participant was asked to rate the degree to which he subscribes to 72 adjectives on a

four-point Likert Scale. The choices were “Much like this” (3), “Slightly like this” (2), “Slightly unlike this” (1), and “Much unlike this” (0). The form is designed to rate the participant’s feelings during the past few minutes. It took between five and seven minutes to complete the POMS-BI.

The construction of the POMS-BI grew in part from the monopolar Profile of Mood States, or POMS (McNair, Lorr, & Droppleman, 1971). Thirty-five of the 72 adjectives in the POMS-BI were taken from the monopolar POMS. Based on evidence from several studies suggesting the bipolar and multi-factorial nature of moods (e.g., Lorr, McNair, & Fisher, 1982; Lorr & Wuderlich, 1980), Lorr and McNair (1988) derived the six bipolar mood states mentioned above for construction of the POMS-BI. Reliability studies indicated that 12 adjectives were sufficient to achieve satisfactory internal consistency. Therefore, in addition to the 35 adjectives taken from the POMS, 37 more adjectives were added so that 12 adjectives represented each of the six hypothesized constructs (half of them positive, half of them negative).

The POMS-BI manual does not provide clear validity and reliability scores from standardized samples. In addition, while the POMS-BI manual summarizes several factor analytic studies of the monopolar POMS, it does not say whether any have been performed on the POMS-BI. It does, however, provide information on the correlations among the six mood scales of the POMS-BI. To examine the correlations among the six mood scales, the POMS-BI was administered to 432 university students (range .40 - .78). To assess the degree of test-retest reliability, 66 participants completed the form a second

time (length of time between administrations was not stated). Correlations between time one and time two ranged from .33 to .72.

Following Lorr and McNair's (1988) protocol, each mood state is to be scored separately using six hand-scoring stencils. The adjectives are scored 0, 1, 2, or 3 as indicated by the four-point Likert mentioned above. Because the scales are bipolar, a scale score would be the sum of the positive item scores minus the sum of the negative item scores. The total score for any of the six mood states is the sum of the positive items minus the sum of the negative items plus 18 ($S_T = S_P - S_N + 18$). The constant of 18 is added to make all possible scores positive. Thus each scale has a possible range from 0-36.

A principle components analysis and series of principle components factor analyses conducted on the first administration of the POMS-BI's completed for this study indicated that there appeared to be only two meaningful factors (see results). Thus, the POMS-BI was not scored according to Lorr and McNair's protocol. Instead, two subscales were created, a Positive Mood Scale (PMS) using the six adjectives that loaded highest on the first factor and lowest on the second factor and a Negative Mood Scale (NMS) using the six adjectives that loaded highest on the second factor and lowest on the first factor. Adjectives from the POMS-BI used to create the PMS were jolly, full of pep, joyful, active, lively, and cheerful. The six items from the POMS-BI used to create the NMS were sluggish, exhausted, fatigued, tired, weary, and drowsy. Scores on the PMS and NMS were simply the sum of all six items. Thus, a person's score on the two scales could

range from 0 to 18, with higher scores indicating increased positive mood on the PMS and increased negative mood on the NMS.

The Depression Adjective Checklist (DACL)

The DACL (Lubin, 1994), originally developed by Bernard Lubin in 1965, is a multiple-item paper and pencil checklist measuring transient moods, feelings, or emotions (Appendix G). Seven parallel forms allow repeated measurement of these factors. Five of the seven forms were used in this study (Forms A, B, C, D, & G). These forms have been shown to be highly inter-correlated (range .85 - .92). The DACL, typically used in research settings, has well-demonstrated test-retest reliability and construct validity (Lubin, 1994). Participants responded by checking the adjectives on the checklist that describe how they felt at that moment. Examples of adjectives include wilted, safe, gloomy, active, desolate, and strong. It took between one and three minutes to complete each DACL.

Forms A, B, C, and D contain 22 negative adjectives and 10 positive adjectives. Form G contains 22 negative adjectives and 12 positive adjectives. The manual provides conversion tables and scoring forms (for both T scores and percentile scores) for state-negative moods, state-positive moods, and state mood-total for each of the seven forms. The manual not only provides normative data for adolescents and adults but also for males and females. The state-mood total raw score is calculated as the sum of the number of negative adjectives endorsed (i.e., state-negative mood) and the number of positive adjectives that were not endorsed (i.e., 10 minus the state-positive mood for DACL A, B, C, and D, and 12 minus the state positive mood for DACL-G) or State Total = 10 - State

Positive + State Negative. For purposes of this study, only the state mood total T-scores were used in any statistical analyses using the DACL.

Procedure

Prior to the start of the experiment, the 78 participants were assigned randomly to either the LRLR or RLRL condition with the constraint that each condition included an equal number of right-handers and left-handers. Packets containing all forms to be used in the study were prepared in advance and number-coded to ensure participant confidentiality.

When the prospective participant entered the testing room, he was seated at a small table across from the experimenter and given an Informed Consent Form to read and sign. This form was also read aloud by the experimenter. Following this, the prospective participant who agreed with the conditions and signed the consent form was given a Medical History Questionnaire to complete. Prescreening measures were apparently successful in eliminating inappropriate participants, as none of the 78 participants reported that they had any histories of emotional distress or facial paralysis. Following this, all participants completed the remaining three pre-test measures: 1) the Laterality Questionnaire, 2) the Profile of Mood States-Bipolar (POMS-BI), and 3) the Depression Adjective Checklist (DACL).

Next, the experimenter, while facing the participant, explained how the participant was to perform the facial manipulations. The following instructions were read:

I want you to pay close attention to the following instructions. Don't do anything yet; just listen. I want you to pull back and raise the left/right side of your mouth

as much as you can, just like this [experimenter demonstrates by making the mirror-image movement]. Now you try it. [After the participant successfully demonstrates the movement] That's fine. When the experiment starts, I want you to hold it in that position for 45 seconds until I say relax.

If necessary, further instructions were given until the participant understood how to perform the facial manipulation. The participant was then asked whether he understood the procedure. Only 7 participants required additional instructions. Once it was clear that the participant knew what he was required to do, the following instructions were read:

Now when I say "start," I want you to pull back and raise the left/right side of your mouth in the same way you just did and to hold that position until I say "relax". Remember to pull back and raise your mouth as much as you can. While you're pulling back and raising your mouth, I want you to breathe normally and to look directly at me. I also want you to pay close attention to your mood, to how you are feeling.

The side of initial contraction depended on a predetermined order to ensure equal cells. After maintaining the contracted position for 45 seconds, the participant was told to relax and to complete one version of the DACL. Following that, he performed the same contraction on the opposite side of the face after which he was asked to complete another version of the DACL. This procedure continued until he performed four contractions and completed four versions of the DACL. After completion of the fourth facial contraction and the fourth DACL, the participant completed another POMS-BI checklist. He then was told that his participation in the study was complete. A debriefing period followed.

For the debriefing period, the participant was asked what he believed to be the nature of the study. The experimenter then explained its actual purpose. The participant was then asked whether he was feeling any emotional residue (either positive or negative) from his participation. None of the 78 participants indicated that they were feeling distress following the completion of the last facial manipulation. The entire procedure took 45 to 60 minutes to complete.

RESULTS

The Laterality Index Score

Of the right-handers, all reported using their right hand for writing. Their mean laterality index score was 36.3 ($SD = 3.27$). Of the left-handers, 37 of the 38 (97.4%) reported using their left hand for writing. Their mean laterality index score was 16.03 ($SD = 7.224$). Consistent with past studies, left-handers, as a group, were more heterogeneous than right-handers (see Figure 2) as indexed by a Levene Test for Homogeneity of Variances, $Levene(1, 76) = 34.91, p < .0001$. Across seven of the eight tasks, left-handers were more heterogeneous than right-handers, the only exception being the question about hand preference for writing a letter (see Table 2).

Consistency of Handedness

Consistency of handedness was determined using Peters' decision rule (Peters, 1990; Peters & Servos, 1989; Ponton, 1987). Respondents who reported left-hand preference for writing and six of seven other common unimanual tasks (hammer a nail, throw a ball at a target, unscrew the lid of a jar, use a knife to cut bread, use a toothbrush, hold a match while striking it, and hold a tennis racket) were classified as consistent left-handers (CLHs). Participants with inconsistent hand preferences (ILHs) were those who preferred the right hand for two or more of the eight items. Of the left-handed sample, 18 (47.4%) were CLHs and 20 (52.6%) were ILHs. Using the same decision rule for right-handers, 30 (75.0%) were CLHs and 10 (25.0%) were ILHs. This classification yielded results consistent with those found in other studies using similar criteria (e.g., Peters, 1990; Peters & Servos, 1989; Ponton, 1987).

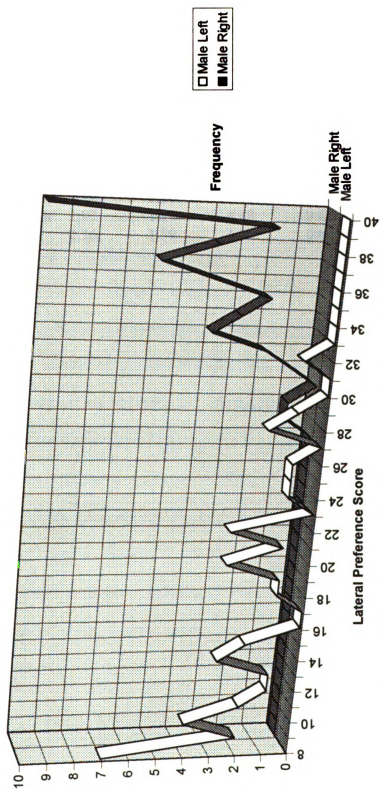


Figure 2. Distribution of laterality index scores for right- and left-handers.

Table 2

Means, Standard Deviations and Tests for the Homogeneity of Variances for the Eight**Items Comprising the Laterality Index Score**

<u>Item</u>	<u>Left-Handers</u>		<u>Right-Handers</u>		<u>p value</u>
	<u>Mean</u>	<u>S.D.</u>	<u>Mean</u>	<u>S.D.</u>	
Write a letter	1.11	0.65	4.98	0.16	< .10
Hammer a nail	2.00	1.25	4.58	0.68	< .01
Throw a ball at a target	1.95	1.56	4.73	0.45	< .01
Unscrew the lid of a jar	2.63	1.48	3.98	1.10	< .01
Use knife to cut bread	2.18	1.43	4.55	0.68	< .01
Use toothbrush	1.92	1.30	4.33	0.83	< .01
Hold a match while striking it	1.97	1.24	4.48	0.68	< .01
Hold a tennis racket	2.26	1.59	4.70	0.61	< .01

POMS-BI Principle Components Analysis and Exploratory Factor Analysis

Because the POMS-BI manual did not provide statistical support (i.e., factor analyses) for its proposed six-factor structure, a principle components analysis was conducted to determine its factor structure.⁷ Because of the relatively small sample size of the current study ($N = 78$) and the number of items in the POMS-BI (72 items), an additional 40 female participants who had completed the POMS as part of another study were included in the factor analysis.

A principle components analysis was first conducted on the POMS-BI in order to obtain estimates of its initial factors. This analysis revealed 18 factors with eigenvalues greater than one (Figure 3). Factors 1, 2, and 3 accounted for 27.0% , 8.8%, and 5.3% of the variance, respectively. As Figure 2 demonstrates, there appear to be two or three interpretable factors. Next, a principle components analysis was performed using the six factor structure proposed by Lorr and McNair (1988). Only the subscale Agreeable had an eigenvalue greater than one (Agreeable = 3.93), which accounted for 65.6% of the variance (see Table 3). The correlations among the six subscales are presented in Table 4. Given that only one subscale had an eigenvalue of greater than one and that the six subscales appear to be highly correlated, there do not appear to be six distinct subscales, contrary to Lorr and McNair's suggestion. Therefore, a series of principle component factor analyses was performed to find the most interpretable solution for testing the current study's hypotheses.

⁷ All factor analyses completed on the POMS-BI used a Varimax (orthogonal) solution in order to simplify the interpretation of the factors.

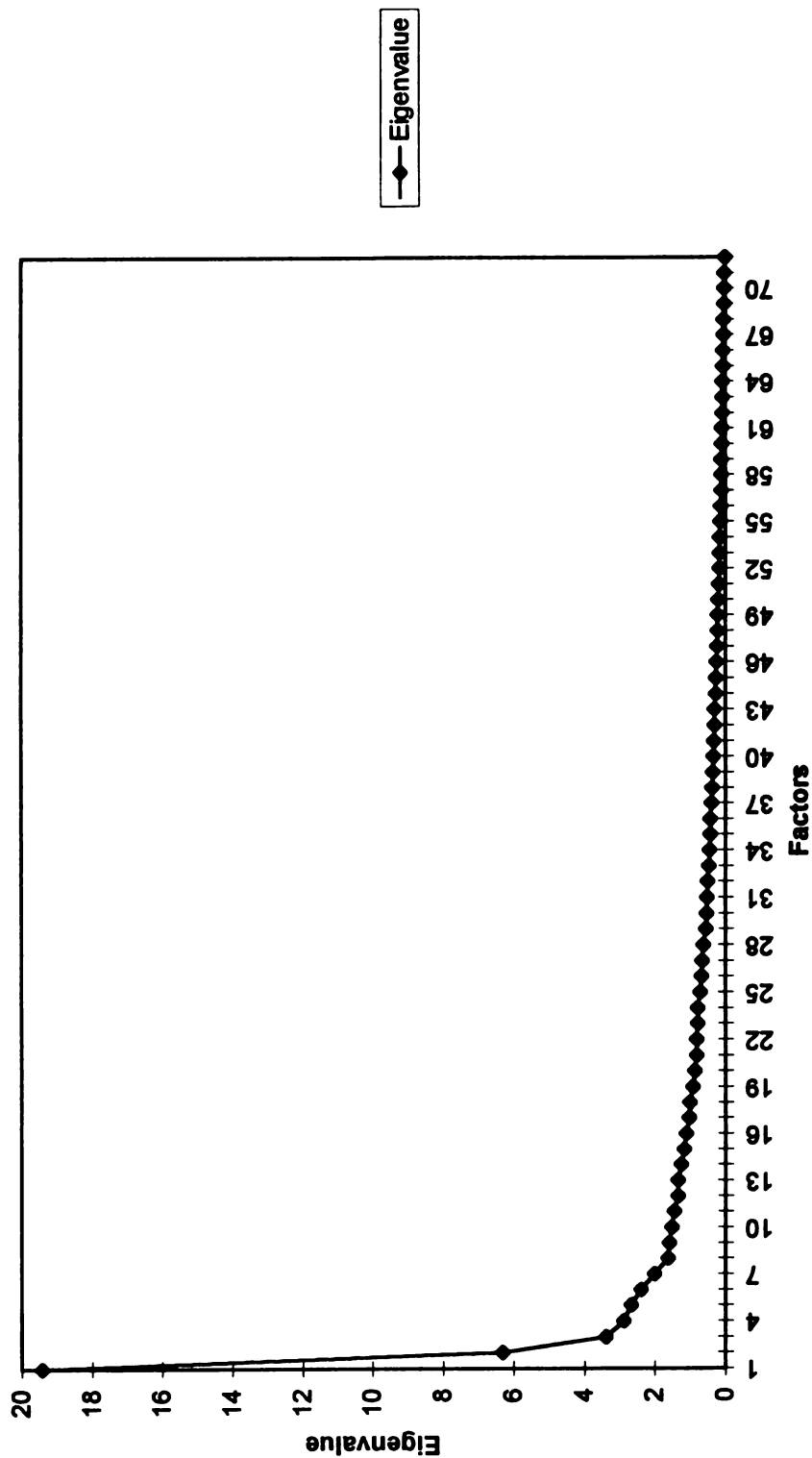


Figure 3. Scree plot of principle components analysis of first POMS-BI administration (n = 118).

Table 3

Principle Components Analysis for the Six Subscales of the POMS-BI (n = 118)

<u>Subscale</u>	<u>Eigenvalue</u>	<u>Percent of Variance</u>
Agreeable	3.93	65.6
Clearheaded	0.74	12.3
Composed	0.52	8.7
Confident	0.35	5.8
Elated	0.25	4.2
Energetic	0.21	3.5

Table 4

Correlations Among Mood Scales for the POMS-BI (n = 118)

		1	2	3	4	5	6
	1	--					
Agreeable	2	.51	--				
Elated	3	.60	.68	--			
Confident	4	.64	.45	.68	--		
Energetic	5	.42	.57	.73	.61	--	
Clearheaded	6	.67	.48	.57	.65	.51	--
Mean		25.43	27.29	24.17	23.92	19.49	94.63
S. D.		5.44	4.89	5.51	4.99	8.23	5.72

A total of six principle components factor analyses were then computed using a one-factor through six-factor solution. An upper limit of six factors was chosen because this was the factor structure proposed by Lorr and McNair (1988). A two-factor solution appeared most interpretable (see Table 5). Using this solution, adjectives describing a negative mood state loaded highly on the first factor, and adjectives describing a positive mood state loaded highly on the second factor. For both factors, items were selected that loaded highest on that factor and least high on the other factor. Once items were selected, reliability analyses and item-total statistics were conducted. Based on the item-total statistic for the alpha *if* item deleted, adjectives were eliminated until the highest alpha level was reached and the alpha *if* item deleted indicated that removing any one adjective would lower the overall alpha level. Table 6 shows the inter-item coefficients, reliability analysis, and item-total statistics for the Positive Mood Scale (PMS) using the six selected items from the POMS-BI two-factor solution. Likewise, Table 7 shows the inter-item coefficients, reliability analysis, and item-total statistics for the Negative Mood Scale (NMS) using the six selected items from the two-factor solution. The PMS and the NMS were used to test specific hypotheses where the POMS-BI was used as a dependent measure.

Statistical Analyses

Several statistical analyses were selected to investigate the three hypotheses. DACL t-scores were first analyzed using a 2 x 2 x 4, handedness (right or left) by order of contraction (RLRL or LRLR) by time (DACL B, C, D, or G) repeated measures ANOVA, with DACL-A as a covariate. DACL t-scores were then analyzed using a 2 x 2 x 2, handedness (right or left) by order (RLRL or LRLR) by face side (left face DACL

Table 5

Principle Components Analysis with Varimax Rotation for the POMS-BI Using a Two-Factor Solution (n = 118)

<u>Item</u>	<u>POMS-BI Proposed Loading ⁸</u>	<u>Factor 1</u>	<u>Factor 2</u>
Lonely	Elated	.80360	- .08672
Jolly	Elated	.79783	- .10215
Full of Pep	Energetic	.77023	- .18136
Lively	Energetic	.74209	- .15993
Joyful	Elated	.73556	- .16487
Active	Energetic	.71660	- .16428
Cheerful	Elated	.68557	- .02424
Drowsy	Energetic	- .66106	.17623
Playful	Elated	- .65139	- .10155
Fatigued	Energetic	- .63042	.25125
Affectionate	Agreeable	.62936	.11592
Exhausted	Energetic	- .62273	.27279
Sluggish	Energetic	- .61684	.36922
Friendly	Agreeable	.60333	- .20688
Agreeable	Agreeable	.59303	- .15172
Kindly	Agreeable	.59194	- 2.4480
Ready-to-go	Energetic	.59047	- .18173
Good-natured	Agreeable	.55859	- .13120
Vigorous	Energetic	.55282	- .02086
Wearry	Energetic	- .54901	.31845
Attentive	Clearheaded	.54726	- .35748
Tired	Energetic	- .52766	.21004
Confident	Confident	.50878	- .46817
Powerful	Confident	.50578	- .19461
Mentally Alert	Clearheaded	.48550	- .42996
Efficient	Clearheaded	.46035	- .36179
Peaceful	Composed	.45455	- .36043
Elated	Elated	.44614	.03020
Strong	Confident	.43137	- .22496
Grouchy	Agreeable	- .42040	.38304
Bold	Confident	.40655	- .03635
Self-assured	Confident	.40430	- .37569
Relaxed	Composed	.38224	- .29422
Lighthearted	Elated	.36602	- .00981
Weak	Confident	- .32550	.32215
Serene	Composed	.32246	.01012
Forceful	Confident	.27835	.15244

⁸ This column contains the mood state or factor that Lorr and McNair (1988) believed the item tapped.

Table 5 (cont'd).

<u>Item</u>	<u>POMS-BI Proposed Loading</u>	<u>Factor 1</u>	<u>Factor 2</u>
Businesslike	Clearheaded	.14404	-.08011
Uncertain	Confident	-.15340	.69659
Unsure	Confident	-.18825	.68881
Self-doubting	Confident	-.17951	.66524
Uneasy	Composed	-.18699	.66011
Discouraged	Elated	-.30835	.65369
Mixed-up	Clearheaded	-.08035	.65215
Downhearted	Elated	-.21135	.63680
Dejected	Elated	-.06253	.63533
Muddled	Clearheaded	.01495	.63454
Perplexed	Clearheaded	-.17812	.63171
Shaky	Composed	-.11793	.62512
Sad	Elated	-.34286	.61697
Jittery	Composed	.13675	.59042
Tense	Composed	-.17158	.58928
Bewildered	Clearheaded	.05184	.56399
Annoyed	Agreeable	-.12555	.56186
Inadequate	Confident	-.14828	.54723
Anxious	Composed	.02529	.52410
Calm	Composed	.16994	-.50787
Nervous	Composed	-.00608	.50447
Timid	Confident	-.03152	.50447
Able to Concentrate	Clearheaded	.36187	-.47793
Angry	Agreeable	-.14673	.46561
Lonely	Elated	-.21740	.46312
Clearheaded	Clearheaded	.40165	-.46010
Confused	Clearheaded	.03287	.44787
Mad	Agreeable	-.23653	.43912
Untroubled	Composed	.28178	-.43745
Gloomy	Elated	-.37178	.43323
Dazed	Clearheaded	-.23839	.42997
Bad Tempered	Agreeable	-.37064	.39601
Sympathetic	Agreeable	.31967	.35215
Furious	Agreeable	-.22017	.35215
Composed	Composed	.15500	-.30364

Table 6

Inter-item Coefficients, Reliability Analysis and Item-Total Statistics for the Positive Mood Scale Created Using Selected Items from the POMS-BI Two-Factor Solution
(n = 118)

Inter-item Coefficients and Reliability Analysis						
	Jolly	Pep	Joyful	Active	Lively	Cheerful
Jolly	--					
Pep	.57	--				
Joyful	.61	.62	--			
Active	.55	.57	.54	--		
Lively	.58	.64	.62	.58	--	
Cheerful	.53	.59	.68	.59	.65	--
Mean	1.44	1.19	1.78	1.86	1.63	1.81
S.D.	.86	.88	.83	.88	.87	.77

Alpha = .90 Standardized item alpha = .90

Table 6 (cont'd).

Item-Total Statistics

<u>Item</u>	<u>Scale Mean if Item Deleted</u>	<u>Scale Variance if Item Deleted</u>	<u>Corrected Item-Total Correlation</u>	<u>Squared Multiple Correlation</u>	<u>Alpha if Item Deleted</u>
Cheerful	7.88	12.91	.67	.46	.89
Lively	8.06	11.99	.74	.55	.88
Joyful	7.97	11.96	.75	.58	.87
Active	7.88	12.23	.69	.48	.88
Jolly	8.25	11.93	.73	.54	.88
Pep	8.56	11.75	.74	.56	.88

Table 7

Inter-item Coefficients, Reliability Analysis Item-Total Statistics for the Negative Mood Scale Created Using Selected Items from the POMS-BI Two-Factor Solution (n = 118)

Inter-item Coefficients and Reliability Analysis						
	Sluggish	Exhausted	Fatigued	Tired	Weary	Drowsy
Sluggish	--					
Exhausted	.69	--				
Fatigued	.66	.74	--			
Tired	.55	.66	.66	--		
Weary	.71	.61	.61	.64	--	
Drowsy	.69	.61	.70	.55	.63	--
Mean	1.23	1.24	1.53	1.90	1.03	1.28
S.D.	.94	1.03	.95	.64	.94	1.02

Alpha = .9167 Standardized item alpha = .9171

Table 7 (cont'd).

Item-Total Statistics

<u>Item</u>	<u>Scale Mean if Item Deleted</u>	<u>Scale Variance if Item Deleted</u>	<u>Corrected Item-Total Correlation</u>	<u>Squared Multiple Correlation</u>	<u>Alpha if Item Deleted</u>
Sluggish	6.64	17.16	.77	.61	.90
Exhausted	6.68	16.96	.77	.61	.90
Fatigued	6.41	17.06	.81	.67	.90
Tired	6.00	17.33	.73	.55	.90
Weary	6.88	17.90	.73	.55	.91
Drowsy	6.59	17.23	.76	.60	.90

T-score composite, right face DACL T-score composite) repeated measures ANOVA, with DACL-A as a covariate. POMS-BI NMS and PMS scores were analyzed using a 2 x 2, handedness by side of fourth facial manipulation ANCOVA. For this analysis, the first POMS-BI administration NMS and PMS scores were used as covariates. Lastly, independent samples t-tests were used to examine handedness differences on pre-mood measures.

Mood and Side of Face Contraction

DACL

A repeated measures ANOVA revealed no main effect for order of facial contraction [$F(1, 72) < 1$]. That is, there were no differences between participants in the LRLR series and the RLRL. This was expected given that subjects were randomly assigned to the two order conditions. The interaction between order and time was also not significant [$F(3, 219) = 1.67, p = .18$]. Next, to create left and right DACL t-score composites the t-scores of the two DACL completed after left facial manipulations were collapsed together as were the two completed after right facial manipulations. Then another repeated measures ANOVA was performed using these DACL T-score composites. This analysis revealed no main effect for side of facial manipulation [$F(1, 74) < 1$]. Given Schiff and Lamon's (1993) observation that the effects of the manipulations often did not occur until the third and fourth manipulations, another repeated measures ANOVA was performed looking at only the last two facial manipulations; likewise, this analysis proved to be insignificant [$F(1, 74) < 1$].

POMS-BI

Similarly, an ANCOVA with the first POMS-BI administration as a covariate revealed no main effect for side of fourth manipulation as measured by the NMS [$F(1, 72) < 1$] and the PMS [$F(1, 72) = 3.31, p = .07$].

Mood and HandednessDACL

Contrary to the hypothesis that right-handers' moods would change to a greater degree than left-handers' after both right- and left- facial manipulations, a repeated measures ANOVA indicated no main effect for handedness [$F(1, 72) = 3.03, p = .09$] nor any interactions or significant differences between handedness and time [$F(3, 219) < 1$]. When order of contraction (LRLR series vs. RLRL series) was taken into account, the interaction between handedness, side of contraction, and time was also insignificant [$F(3, 219) = 1.78, p = 0.15$]. Thus, the results did not support the prediction that right-handers would be more clearly lateralized than left-handers for the *experience* of emotion.

POMS-BI

Likewise, using an ANCOVA with the first POMS-BI administration as a covariate, there was no main effect for handedness on the NMS [$F(1, 72) < 1$]. That is, no significant differences were found between handedness and mood after the fourth facial manipulation (irrespective of whether the fourth manipulation was a left or right contraction), as measured by the NMS. Similarly, the main effect of handedness on the PMS was insignificant [$F(1, 71) = 3.25, p = 0.08$]. Although left handers had a slightly

higher PMS score after completing the fourth facial manipulation ($M = 8.50$, $SD = 4.50$) than right handers ($M = 7.18$, $SD = 4.68$), this difference was not significant.

Taking side of fourth facial manipulation into account, there was no significant interaction between handedness and side of fourth facial contraction as measured by the NMS [$F(1, 72) < 1$]. Likewise, PMS scores indicated no significant interaction between handedness and side of fourth facial manipulation [$F(1, 72) = 2.13$, $p = 0.15$].

Handedness and Pre-mood Measures

DACL

An independent t-test revealed no significant differences between right- and left-handers on the pre-mood induction DACL [$t(76) = -0.17$, $p = 0.87$].

POMS-BI

Similarly, there were no significant differences between handedness and pre-mood measures as measured by the POMS-BI PMS scale [$t(76) = .07$, $p = .95$] or the POMS-BI NMS scale [$t(76) = .09$, $p = .90$].

Mood and Time of Facial Manipulation

DACL

Using a repeated measures ANOVA, a main effect was found for time [$F(3, 219) = 8.76$, $p < 0.01$]. Specifically, participants' T-scores on the DACL increased over time (across manipulations) indicating that the participants' general sense of well-being decreased significantly during the course of the experiment (see Figure 4).

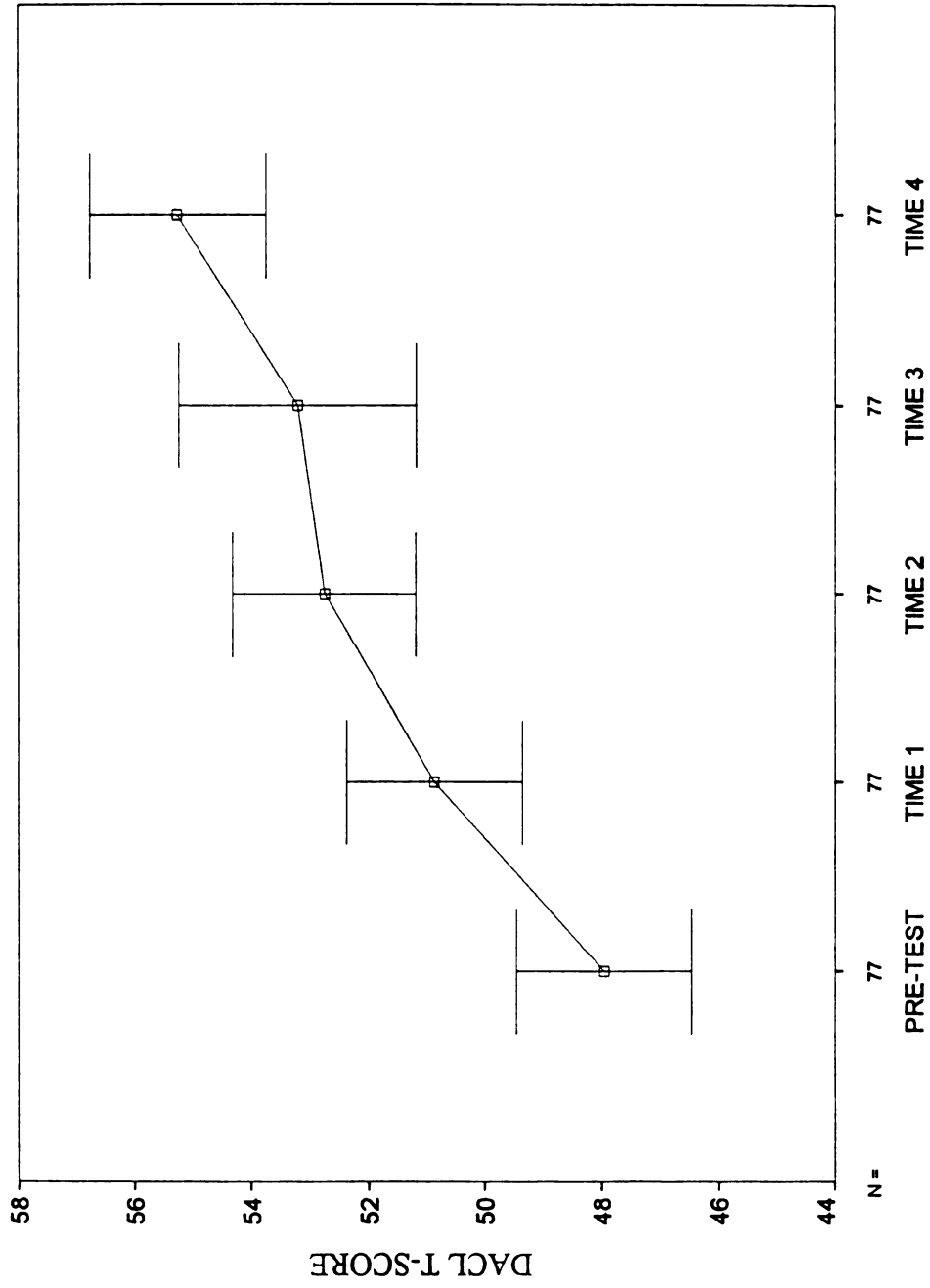


Figure 4. Changes in mood over time collapsing order (LRLR and RLRL).

Supplemental Analyses

Consistent vs. Inconsistent Left-Handers

To determine whether the classification of left-handers into consistent and inconsistent left-handed subgroups acted as a predictor variable for the effects of the facial manipulations on mood, a repeated measures ANOVA with consistency of handedness as a covariate was performed. The covariate was not significant [$t(34) = 0.46, p = 0.65$].

Difficulty of Maintaining Right- Vs. Left Facial Contractions

Early in testing, many participants were observed to remark that one side of the face was *physically* more difficult to hold than the other. Based on these observations, two additional questions were included to be answered at the conclusion of the experiment *after* all other measures were completed. The first question asked which side of the face was physically more difficult to hold and the second asked which side was physically easier to hold. Both questions used a 9-point Likert scale from 1 (Left Side) to 9 (Right Side), with 5 (Same) as a midpoint. Sixty-one participants answered these two questions. Since the two questions were highly correlated with one another ($r = 0.96$), only the first question was further analyzed.

This data were analyzed using a $2 \times 2 \times 4$, handedness (right or left) by order of contraction (RLRL or LRLR) by time (DACL B, C, D, or G) repeated measures ANOVA, with difficulty level and DACL-A as covariates. Difficulty level, that is how persons responded to the physical difficulty question, served as a significant covariate [$t(56) = 3.11, p < .01$].

In light of this finding, it was predicted that changes in participant's DACL scores would be correlated with the reported level of difficulty for holding one side of the face.

To test this prediction, a 'composite mood state change' score was created to determine the direction of change (e.g., increases in negative mood states after left or right manipulations) and the degree or strength of change. The formula for change score was the sum of the T-scores of the two DACLs completed after the right face manipulations minus the sum of the T-scores of the two DACLs completed after the left face manipulations. A positive score, therefore, meant that DACL T-scores were greater after right face manipulations (indicative of a greater negative mood state after right faces); conversely, a negative score meant that DACL T-scores were greater after left manipulations. A bivariate correlation analysis was performed to examine the correlation between the composite mood change score and how participants rated the physical difficulty and ease of the facial manipulations. As can be seen in Table 8, these three variables were significantly correlated suggesting that physical difficulty level of the face and T-scores on the DACLs are related. That is, changes in the DACL may reflect either the physical strain per se of holding the face or the emotions induced by the physical difficulty (see Figures 5 and 6).

Table 8

Correlation Coefficients for Composite Mood Change Score and Reported PhysicalDifficulty or Ease of the Facial Manipulations

	<u>Composite Mood Change Scores</u>	<u>Difficulty Level of the Facial Manipulation</u>	<u>Ease of the Facial Manipulation</u>
<u>Composite Mood Change Scores</u>	--		
<u>Difficulty Level of the Facial Manipulation</u>	* .28	--	
<u>Ease of Facial Manipulation</u>	* - .28	** - .96	--

* $p < .02$ ** $p < .001$

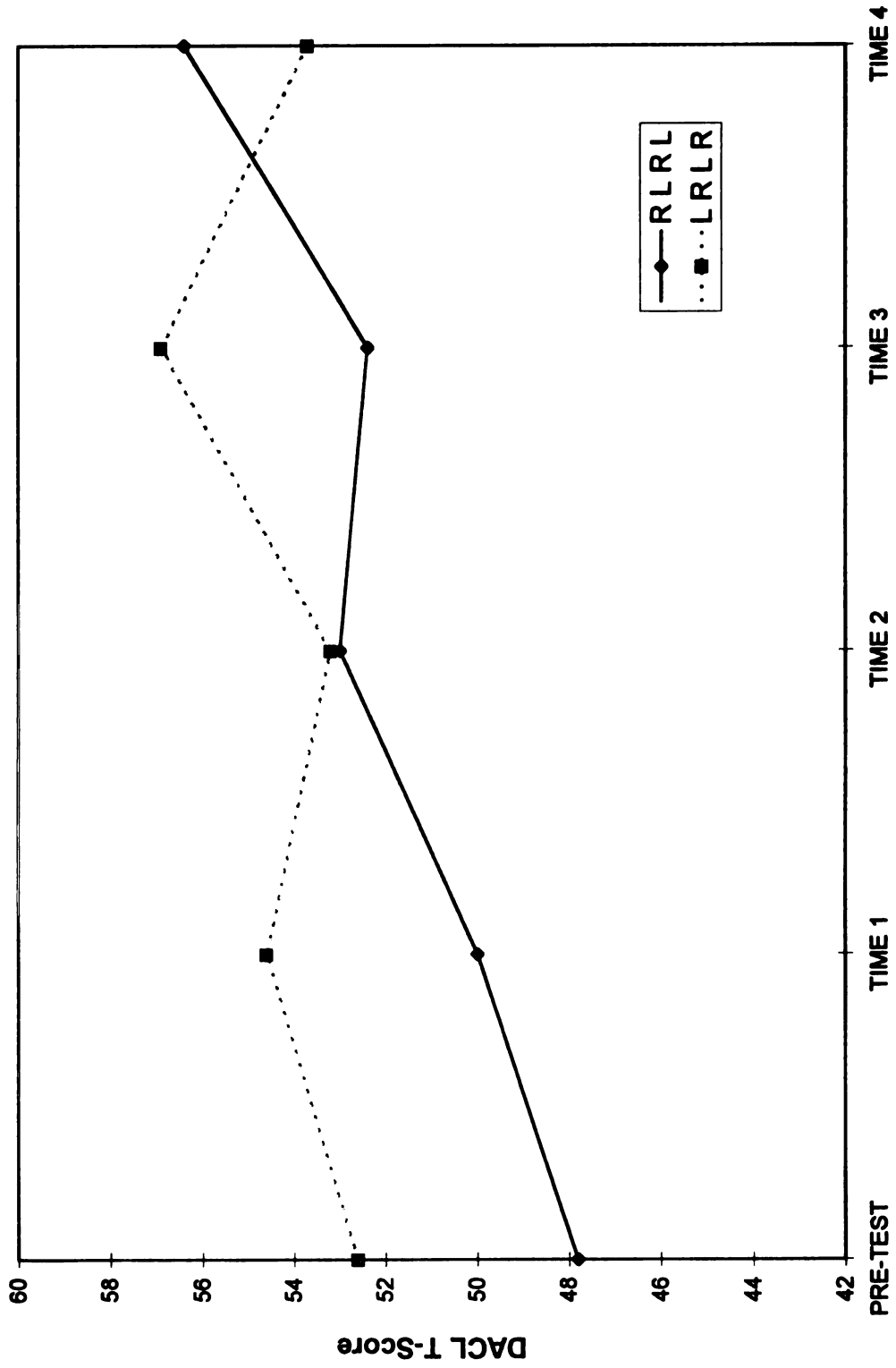


Figure 5: DACL t-scores for 'left-face more difficult' by order.

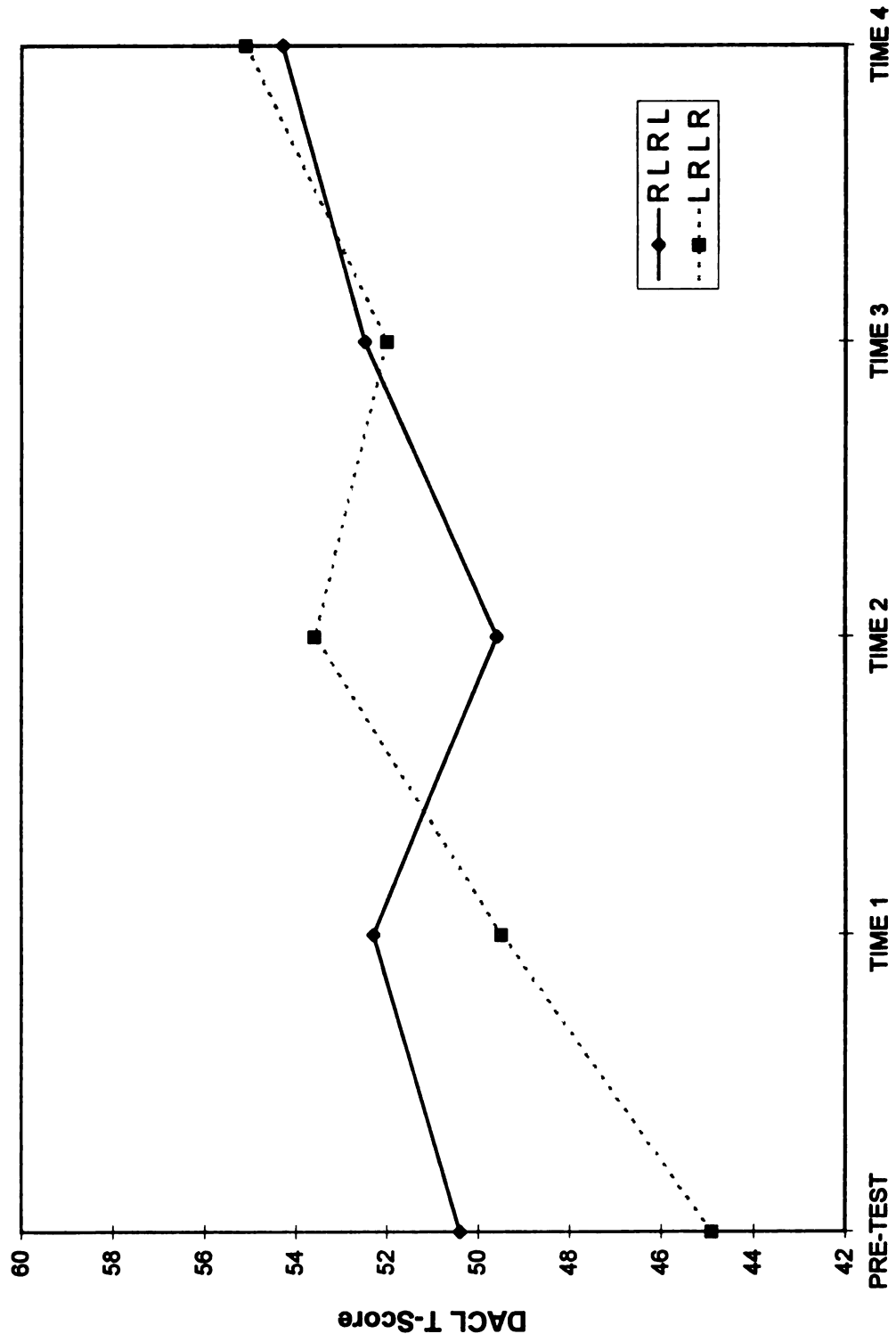


Figure 6: DACL t-scores for 'right-face more difficult' by order.

DISCUSSION

The Failure to Replicate Schiff and Lamon's Study

The prediction that left facial contractions would produce a dysphoric mood and that right facial contractions would produce a euphoric mood was not borne out. That is, the results of both the Depression Adjective Checklist and Profile of Mood States-Bipolar indicate that left- and right-facial contractions did not produce different emotions. There may be a number of possible explanations for these null effects.

Unilateral Facial Contractions and the Induction of Mood

One possibility that should be addressed immediately is that unilateral facial contractions may not, in fact, induce emotional states at all. This explanation, however, would seem premature given that (a) it is based on null results, (b) it does explain the positive results in other studies (Schiff, Esses, & Lamon, 1992; Schiff & Lamon, 1989), and (c) the current study used dependent measures different from those used in studies reporting positive results. Finally, given that the current study followed Schiff and Lamon's (1989) method as outlined by them, it does not appear likely that its null results are due to ineffective manipulation of the independent variables.⁹

Insensitivity of the Current Study's Measures of Mood

A second, more plausible, explanation is that the null findings are due, in part, to the dependent measures' inability to detect any true effects and, relatedly, to the conservative nature of the statistical methods used. As just noted, the dependent measures

⁹ Recall that one of Schiff and Lamon's (1993) arguments for Kop et al.'s (1991) failure to replicate Schiff and Lamon's (1989) study was that Kop et al. did not strictly adhere to the mood induction procedure.

sharply differed from those used by Schiff and Lamon (1989). Whereas Schiff and Lamon used self-report in two experiments and TAT cards in a third, the current study used two different adjective checklists. Because of their high face validity, the accuracy of these checklists to measure mood depends on participants' ability and willingness to report these changes. To the extent that participants were unwilling or unable to report mood changes, the DACL and POMS-BI would be ineffective measures of any mood changes that accompany facial manipulations. By contrast, projective tests like the TAT avoid many of the difficulties created by indirect measures of mood of the sort used in the current study.

At first glance, this explanation of the null findings of the current study seems plausible, but it is called into question when we look at the mood of participants across manipulations. Recall that participants' general sense of well-being decreased significantly over the course of the experiment. If the null results were due to the DACL's insensitivity to mood changes, then it is hard to explain why an effect was still found for mood across manipulations. If the measure was insensitive to mood changes arising from unilateral facial manipulations, it also should have been insensitive to mood changes across manipulations.

The possibility that the null findings reflect the insensitivity of the dependent measures is further called into question by Schiff and Lamon's (1989) first two experiments. In both, participants were asked to report any emotional experiences they had while maintaining the contractions. This use of self-report limits the possibility that the null findings were due to insensitivity of the measures, the high face validity not

withstanding. That is, Schiff and Lamon should have had similar difficulties asking participants *directly* to report on their emotional experiences.

Over-Sampling of Moods

A third possibility is that the current study made too many measurements of mood, that is, that having the participants complete a DACL after every manipulation might have disrupted their effect on mood. This explanation, however, is unlikely for at least two reasons. First, Schiff and Lamon (1989) took self-report measurements after every manipulation in their second experiment and still found an effect. Thus, repeatedly asking their participants to report on their mood did not disrupt the effects of the manipulation. Second, foreseeing the potential hazard of taking measures after each manipulation, the current study also included a second mood measure (the POMS-BI), which was given only before the first manipulation and after the last manipulation (similar to Schiff and Lamon's third experiment). No effect was found for this measure either, which suggests that the null findings are not due to over-sampling the effects of the manipulations.

Physical Difficulty of Facial Manipulations and Mood

Further analysis of the dependent measures in the current study suggests that they may be more sensitive to the physical difficulty of contracting one side of the face relative to the other than to the processes (presumably) measured by Schiff and Lamon (i.e., the activation of sensory and motor pathways in the contralateral hemisphere). Recall that difficulty level of the facial contraction served as a significant covariate and was correlated with participant's mood as measured by the DACL. This suggests that mood changes reflect either the physical difficulty of holding the face in position or the emotions that

arise from that difficulty. Schiff and Lamon (1989) report that 66% of their participants said that the left contraction was easier to perform. They also report that there was no relation between ease of contractions and responses on the TAT. However, they do not report what statistical analyses were performed to lead them to this conclusion or, indeed, whether any statistical analyses were performed at all. Kop et al. (1991), however, examined difficulty of contraction in their replication and found that when participants said that one unilateral contraction was harder to perform than the other, mood changes (as measured by evaluations of drawings) were evaluated more unfavorably after the harder contraction. These results corroborate those found in the current study. Although the current study's results suggest that the physical difficulty of the contraction colors self-reported mood, Kop et al.'s results suggest that it can also color one's perceptions of the evaluations of others (or at least one's perception of favorableness of cartoon characters). Thus, it is possible that the current study's dependent measures were more sensitive to physical difficulty than other processes and that the participants were responding to the physical difficulty of the facial contractions.

Procedural Differences

The null effects could also have stemmed from differences between the two studies, namely the placement of its dependent variables. Whereas Schiff and Lamon's (1989) third experiment used three TAT cards placed after the *fourth* manipulation, the current study had participants complete a POMS-BI and a DACL before the *first* manipulation, DACLs after *each* successive manipulation, and another POMS-BI after the fourth manipulation. Thus, Schiff and Lamon's (1989) method of measuring the effects of

the manipulation appears to be less rigorous on several levels. For instance, their study assessed mood only after the fourth manipulation. The current study, on the other hand, took mood measures after every facial contraction (something that we later will see calls for different, more stringent statistical analyses). Schiff and Lamon also failed to include pre-test mood measures to control for the possible effects that participants' moods prior to performing the manipulations may have had on subsequent manipulations. The current study, on the other hand, took pre-test mood measures and mood measures after each manipulation. It was found that pre-mood affected how a participant responded to the subsequent mood measures, which suggests that before Schiff and Lamon's participants began the experiment, their moods may have affected their responses to the post-test mood measures.

The Use of Different Statistical Analyses

Lastly, the null effects may reflect the use of different statistical analyses in the two studies. If we assume that the mood induction technique is not robust and produces an effect only after the third or fourth manipulation, as Schiff and Lamon (1993) later suggested may be the case, then the current study's inclusion of mood measures after every manipulation in the statistical analysis may have washed out any effect that existed in the first place. Although Schiff and Lamon (1989) said that, "the effects of these contractions...appeared to be fairly robust" (p. 933), this statement may mislead on two levels. First, Schiff and Lamon's method of measuring the effect may not have allowed for a true measurement of its robustness. The reason is that in their third experiment, they measured the effects of only one of the four manipulations. Second, they reported that

over 33% of the responses to a target card were judged to be neutral in emotional tone. These neutral responses were discarded from the analyses of left and right contractions, whereas the current study included all responses in its statistical analyses. Furthermore, as Kop et al. (1991) point out, although Schiff and Lamon reported that propositions had a more positive tone after right than left contraction, this finding was based on only one of nine t-tests that could have been performed. Kop et al. (1991) went on to say that it is questionable whether this result would still be significant if Bonferroni-corrections had been used. Lastly, because Schiff and Lamon failed to obtain pre-mood measures, there is no way to determine whether negative, positive, or neutral stories told after the fourth manipulation represent a change toward an increase or decrease in pre-mood emotion states.

Until now, the focus has been largely on Schiff and Lamon's third experiment because this is the one that the authors called the most rigorous. The first two experiments also deserve consideration because the procedures used were different from the third; thus, the criticisms of the third experiment may not necessarily apply to the first two. The first two experiments also are procedurally more similar to the current study in that measures were taken after each manipulation.

As mentioned earlier, the first two experiments employed self-report where participants were to "pay attention to whatever emotional experiences they might have while maintaining these contractions, to let them occur without judgment, and to report on them when they were asked to relax" (Schiff and Lamon, p.926). The first experiment was performed to explore the possibility of inducing emotions while maintaining unilateral

contractions of the facial muscles; no statistical analyses were performed. The second experiment was performed in an effort to replicate the first study “in the laboratory to see if the emotional changes would be detected under standardized experimental test conditions and measurements” (p. 929). Both experiments reported finding support for inducing emotions via the maintenance of unilateral contractions.

Statistical Analyses Revisited

Several of the aforementioned possible explanations for the discrepancies in results between the current study and Schiff and Lamon’s third experiment also apply to a comparison of their first two experiments. It is possible, for instance, that the current study’s independent measures were ineffective in measuring changes in mood because of their high face validity. As already noted, however, this explanation does not explain why mood did change significantly over time. Also, one would assume that Schiff and Lamon’s use of self-report would have higher face validity than the adjective checklists used in this study.

The different statistical analyses used in the two studies may provide a more plausible explanation for the discrepant findings. Specifically, it appears that Schiff and Lamon (1989) used less stringent statistical procedures to measure effects. Recall that in their second experiment, Schiff and Lamon (1989) had participants report on their mood after each manipulation. These reports were audiotaped and transcribed onto separate pages, and order was randomized; therefore, there was a total of 120 mood reports from 30 participants. Two judges then “independently judged each report as having followed a left or a right contraction, or as ‘unknown’ for those which they could not classify”

(p. 929). Fourteen reports were dropped because the judges classified them differently. Of the remaining 106 reports, the judges agreed that 50 could not be classified. Of the 56 reports left, an equal number were predicted to have followed each facial contraction. The *accuracy* of the judges' predictions was then assessed for those 56 remaining reports. Of the left face, 75% (21 out of 28), and of the right face, 71% (20 out of 28) of the classifications were correct. Several questions arise from these data. First, how did the judges classify the reports? Did they code for emotional statements, number of words uttered, ratio of negative to positive statements, or did they use still other criteria? Second, classifications could be made only on 56 of the 114 (53%) of the reports. Why were the remaining 50 responses (47%) excluded from further analyses? If they had been included, would this have washed out the effect? If all 120 responses had been included, then only 75% of the responses (from the 53% that could be classified) were accurately predicted to have occurred after left facial contractions. Similarly, from those 53% that could be classified, judges were only able to predict that 71% of those occurred after right facial manipulations. Thus, it appears that Schiff and Lamon (1989) somewhat misrepresent the data when they state, "the judges were able to distinguish between responses that followed a left face contraction from those that followed a right face contraction with a high degree of reliability" (p. 930). It may be more accurate to say that the judges were able to distinguish between responses that followed a left face contraction from those that followed a right face contraction with a high degree of reliability for those 56 (53%) reports that they were able to classify. In addition, there is no report of what position in the series the classifiable responses came from. Did they come from a

particular subset of participants, or did each participant produce an equal number of classifiable responses? Did they come from the first few manipulations in the series, from the concluding manipulations, or did placement in the series not matter?

In comparison to Schiff and Lamon's statistical analyses, the current study's analyses were more rigorous. Pre-mood measures were taken to eliminate the effects of participants' pre-moods on subsequent manipulations, and *all* responses were included in the analyses. If facial manipulations do not always produce classifiable mood reports, it suggests that inclusion of all mood reports in the analyses may have washed out the effect if any existed.

Conclusions

There may be at least two plausible explanations for the null results of the current study. The first is differences in methodology, namely the placement of the dependent measures and the subsequent statistical analyses performed. That is, given that Schiff and Lamon (1989) were able to find classifiable responses only 53% of the time, the current study's inclusion of all responses may have washed out an effect if any existed. Second, the current study used dependent measures that may have been more sensitive to the effects of physical difficulty on mood rather than to processes that Schiff and Lamon measured (assuming more than one process occurred).

Handedness Differences

Given the failure to support Schiff and Lamon's mood induction technique, it is difficult to say what this might mean in terms of the valence hypothesis for the experience of emotion. For instance, the failure to find differences between side of facial

manipulation and mood may cast doubt on the valence hypothesis for the experience of emotion, or it may simply mean that the current study failed to detect any differences for any of the reasons discussed earlier. For the same reason, it is difficult to understand the lack of support for the prediction that right-handed males would be more clearly lateralized than left-handers. The question still remains whether the null results for handedness mean that the neuropsychological systems for the experience of emotion are the same in right- and left-handers or whether differences do exist but are masked by the insensitivity of the procedures and statistical measures to detect real differences.

Because of the null effects, we cannot examine the valence hypothesis as it relates to handedness and the experience of emotion. We can, however, examine the relation of handedness to participants' moods at the start of the experiment as well as to changes in mood over time irrespective of side of facial manipulation. This examination, too, indicated no significant differences between right- and left-handers' pre-induction moods. Recall that the literature suggests a weak relation between handedness and measures of emotionality — sometimes it is there, sometimes it is not — so it is not surprising that this study failed to achieve any differences. Focusing on handedness and mood across all manipulations, no handedness differences were found. However, with a larger sample size the results suggest that handedness differences would become significant. This was indicated by both dependent variables. The problem, however, is that differences go in the wrong direction, namely that left-handers' mood states are less negative (more positive) across manipulations. How could these differences be explained had they been significant? One possibility is that the increased bilaterality of left-handers makes them less susceptible

to the negative effects of the manipulations regardless of side of manipulation. The results of the POMS-BI, however, suggests that there are no differences between handedness and negative mood states. The difference approached significance with left-handers showing slightly higher positive mood states after the fourth manipulation. Again, there is no obvious explanation for these findings. In addition, the difference in mood is again in the opposite direction of the one predicted (recall that when differences have been found between right- and left-handers, left-handers showed more negative mood states).

General Conclusions and Future Directions

Given the several factors that may have contributed to this study's null findings, it is not safe to draw any conclusions about Schiff and Lamon's (1989) mood induction procedure as it relates to the valence hypothesis or to handedness and the neuropsychology of the experience of emotion. The current results do suggest that the manipulations produce subtle effects that may not occur all of the time and that are difficult to detect when they do occur. It still remains peculiar that three of the ten participants in Schiff and Lamon's (1989) first experiment began to *weep*. Although, none of the 78 participants in the present study showed such reactions, this suggests that the effects of the manipulations have the potential to be quite dramatic. It is also noteworthy that Schiff and his colleagues are the only ones to demonstrate successfully the effects of their mood induction across different domains (self-report, responses made to TAT cards, chimeric faces, and social cognitive judgments). Schiff himself (personal communication, September 12, 1996) recognizes the difficulty in inducing mood via their technique: "emotion reports are hard to get...at the best times undergraduates are guarded or poor at

reporting on what they are feeling.” If so, then the current study also suggests that undergraduates are poor at *recognizing* their emotions given that they were provided with a list of adjectives related to mood that they could choose from. If this is, indeed, the case, it would not explain why differences in mood were achieved over time. This suggests that the participants were able to recognize and report on their mood on some level (though, as discussed earlier, it may have been on a more physical level). Again, this points to the elusiveness of this mood induction technique.

Although the current study’s failure to replicate Schiff and Lamon’s findings does not allow us to examine the valence hypothesis for the experience of emotion or its relation to handedness, it does contribute to the literature in several other domains, namely in the areas of mood induction techniques and self-report measures of mood.

The current study sheds light on the limitations of Schiff and Lamon’s mood induction technique and points to areas to examine in the future. Clearly the effect was not so robust as described in Schiff and Lamon’s first experiment. Initially it was hoped that their technique could be used one day to treat various clinical populations. One could imagine a depressed client raising the right side of the face to temporarily lift mood. Although these hopes are not erased by the current study’s null findings, this study does suggest that the effects of the technique might not be as robust as was once hoped and that there are still many unanswered questions about the factors that enhance or inhibit the effect. It is not until more information is collected about these factors that we can begin to focus more closely on the method’s applied functions. Perhaps by studying specific clinical populations (i.e., individuals with major depression) we can determine whether

such individuals have stronger responses to the manipulations, greater shifts from one manipulation to the next, or appear different in some other way from other clinical or non-clinical populations. It may be that in the future we could create a laterality index score for the experience of emotion (similar to the handedness laterality index scores that are tabulated using performance scores on motor tasks). In turn, this score might allow us to meaningfully subclassify persons according to their laterality score in a way that has both diagnosis and treatment implications. Before these issues are examined, however, attention must be paid to the conditions under which the mood manipulation proves effective or ineffective. In short, we must first get a clearer picture of the limitations of this mood induction technique before its applications can be examined.

Despite its potential limitations, Schiff and Lamon's method of mood induction still appears to be one that may eventually offer a way to better understand the lateralization of the experience of emotion. Recall that it offers the single most "pure" measure of the experience of emotion; to the extent that other methods also measure the perception or experience of emotion, they cannot provide information about lateralization of the experience of emotion. Given that the unilateral contraction of facial muscles may not be enough to produce strong and reliable effects, it may be necessary to employ other muscle groups as well. Schiff and Truchon (1993) have demonstrated that unilateral contraction of hand muscles can affect perceptions of chimeric and neutral faces. Perhaps a combination of hand and face contractions, along with foot contractions, would enhance the effects of the mood induction. As mentioned earlier, it is only when we better understand the conditions under which this mood induction occurs and what it means in

terms of the valence hypothesis for the experience of emotion that we can begin to effectively examine its usefulness in clinical settings.

In addition to the information the current study provides about the limitations of Schiff and Lamon's mood induction technique, it also underscores the many difficulties in using self-report measures of mood. First, it demonstrates that measures of mood state do not always measure what they intend or report to measure. The POMS-BI was believed to measure six underlying dimension of mood (and initially included for that reason), whereas the current results indicate that it measures just two dimensions, namely positive and negative mood states. Thus, to the extent that one seeks to examine changes in and interactions between different mood dimensions, it is crucial that one first determine whether the measure chosen is one that is in fact able to measure these dimensions. Unfortunately for the current study, one of the measures lacked the ability to discriminate between the six mood states as reported by Lorr and McNair (1988). This finding is corroborated by Lorr and Wunderlich (1988), who also found the POMS-BI to measure two higher-order dimensions (positive and negative affect). Second, the current study shows that certain persons, when reporting their mood, may be responding in a "physical" manner. That is, they may describe their moods in terms of their "physical" well-being rather than their "emotional well-being" (i.e., feeling tired versus feeling sad). If this is the case, then to the extent that a chosen measure emphasizes the measurement of "physical well-being," the effects of the manipulation independent of those related to the difficulty of holding the face may be obscured. This finding has important implications for future replication attempts. To elaborate, it will be necessary to find those instruments that provide the "purest" measure of emotional well-being so that we can more accurately

examine mood changes that currently appear to be masked by the physical effects of the manipulation. Related to this point, to the extent that reports of physical symptoms reflect participants' reluctance to report other changes in mood (i.e., their guard is up), then it will be important to determine how to create an environment conducive to producing accurate mood reports. It is only then that we can more effectively examine the valence hypothesis for the experience of emotion.

APPENDICES

APPENDIX A

INFORMED CONSENT FORM

This is a study of the effects of facial muscle contractions on mood in normal, healthy people. It is a “normative study”, which means that we don’t know how normal, healthy people will respond, and we want you to help us find out. There are no right or wrong ways to respond. For example, you may feel a change in your mood or you may feel no change at all. Either response is possible, and that is why there is no right or wrong way to respond. The study will take about one hour to complete. You will receive one hour of research credit for participating.

Your record will be kept completely confidential. To ensure this, you will be assigned a participant number, which will be the only way to identify you in any reports about the study. Only the experimenter will have access to files and lists that can be used to link a name with a participant number. Any publications resulting from this work will not identify you by name or in any way that would allow your identity to be discovered.

For this study, you will be asked to complete several tasks.

1. On the *Participant Identification Form*, you will be asked to write your name. This is the only form that can identify you by name and link you to the participant identification number that has been assigned to you. Only the experimenter and his designates will have access to your file. To ensure confidentiality, all other documents you fill out will have only your participant identification number.
2. On the *Medical History Questionnaire*, you will be asked whether you have a history (either past or present) of clinical depression, bipolar episodes, substance abuse, anxiety disorders, hypertension, and facial paralysis. This form is a screening measure that will be used to identify and exclude individuals with any of the above-mentioned histories. For this study, such individuals cannot be included.
3. On the *Personal Information and Background Questionnaire*, you will be asked to provide your age, sex, ethnicity/race, years of education, and academic major.
4. On the *Laterality Questionnaire*, you will be asked to identify which hand you prefer to use for a variety of common tasks. You will be asked whether anyone (including yourself) has tried to change your hand preference.
5. On the *Profile of Mood States-Bipolar* form, you will be asked to check off adjectives on a list that describe how you feel at a given time.

6. After completing these questionnaires, you will be asked to perform four *facial manipulations*, specifically, to move the lower part of your face into a certain position and then to hold that position for 45 seconds.

7. After each facial manipulation, you will be asked to complete another mood check list. For this measure you again will be asked to check off adjectives describing how you feel.

8. Lastly, you will be asked to complete a different *Profile of Mood State-Bipolar* check list.

A debriefing period will follow your participation in the experiment. You will receive one hour of research credit for your participation. You have the right to discontinue your participation at any time and for any reason, and to do so without explanation or penalty. There is also an alternative method of earning extra course credit if you do not wish to participate in this or other experiments. If you wish to seek this alternative, speak with your Introductory Psychology professor for specifics. The assignment may vary from professor to professor, but it is usually to write a short paper.

If you would like further information regarding your rights as a research participant, you may contact the Office of the UCRIHS at Michigan State University by telephoning (517) 355-2180.

After the entire study is completed, if you have any questions or if you want a written summary of the general results, you may contact the investigators at their university offices.

I have read this consent form, I understand the conditions, and I voluntarily agree to participate in this study.

Participant's Signature

Date

Investigator's Signature

Date

APPENDIX B

Appendix B

PARTICIPANT IDENTIFICATION FORM

This is the only form that can identify you by name and can link you to the participant identification number that has been assigned to you. Only the investigator and his designates will have access to this form. To ensure confidentiality, all other documents you fill out will have only your participant identification number.

Please print your full name.

Participant Name: _____ **Identification Number:** _____

APPENDIX C

Appendix C

MEDICAL HISTORY QUESTIONNAIRE

Please check whether you have, or at some time in the past have had, any of the following conditions:

	CURRENT		PAST	
	Yes	No	Yes	No
Major Depression	—	—	—	—
Bipolar Disorder	—	—	—	—
Generalized Anxiety	—	—	—	—
Panic Disorder	—	—	—	—
Post Traumatic Stress Disorder	—	—	—	—
Substance Abuse	—	—	—	—
Schizophrenia	—	—	—	—
Other Emotional Disorders:				
_____	—	—	—	—
Hypertension	—	—	—	—
Have you ever suffered from any				
type of facial paralysis?	—	—	—	—

If yes, please describe:

APPENDIX D

Appendix D

PERSONAL INFORMATION AND BACKGROUND QUESTIONNAIRE

1. What is your age? _____
2. Are you? Male: ____ Female: ____
3. What year in school are you in now? _____
4. What is your academic major? _____
5. Which ethnic/race category best fits you?

Caucasian:	_____	Asian:	_____	
African-American:	_____	Hispanic:	_____	
Native American:.	_____	Other:	_____	Define: _____

APPENDIX E

Appendix E

LATERALITY QUESTIONNAIRE

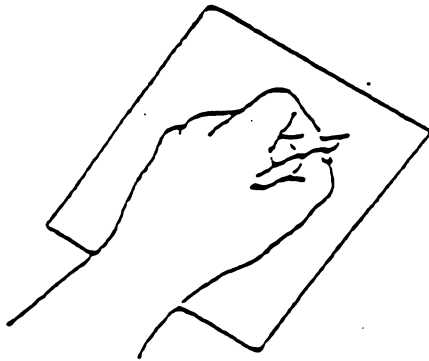
A. General Handedness

Circle the description that best applies to you:

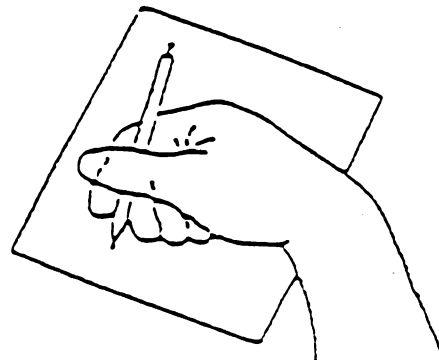
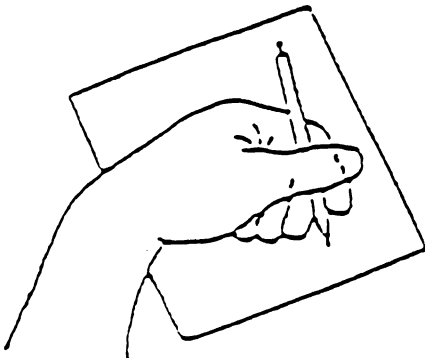
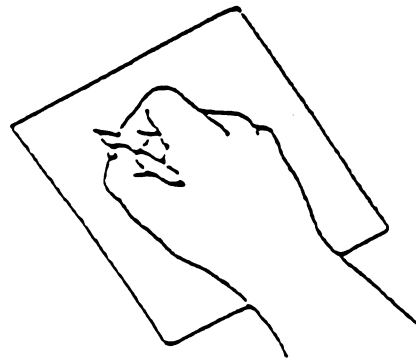
- a. Strongly left-handed
- b. Moderately left-handed
- c. Ambidextrous (either-handed)
- d. Moderately right-handed
- e. Strongly right-handed

Circle the picture which best depicts how you hold a pencil when writing.

Left-Handed Writers



Right-Handed Writers



B. Hand Use for Specific Tasks

For each of the tasks listed below, check the column that corresponds to the hand you would use to perform that task.

	Always Left 1	Usually Left 2	Both 3	Usually Right 4	Always Right 5
Hand Use					
1. Write a letter	___	___	___	___	___
2. Hammer a nail	___	___	___	___	___
3. Throw a ball at a target	___	___	___	___	___
4. Unscrew lid of a jar	___	___	___	___	___
5. Use knife to cut bread	___	___	___	___	___
6. Use tooth brush	___	___	___	___	___
7. Hold a match while striking it	___	___	___	___	___
8. Hold a tennis racket	___	___	___	___	___

Has anyone (including yourself) tried to change what hand you use for any of the tasks listed above or for any other tasks?

No

Yes

If yes, please identify the task(s) and describe the circumstances.

APPENDIX F

Appendix F

Profile of Mood States-Bipolar (POMS-BI)

Below are words that describe feelings and moods people have. Please read EVERY word carefully. Then circle ONE number which best describes how you are feeling RIGHT NOW AT THE PRESENT MOMENT. Suppose the word is *happy*. Mark the one answer closest to how you are feeling RIGHT NOW AT THE PRESENT MOMENT.

- 0 = MUCH UNLIKE THIS
 1 = SLIGHTLY UNLIKE THIS
 2 = SLIGHTLY LIKE THIS
 3 = MUCH LIKE THIS

Composed	1 2 3 4	Vigorous	1 2 3 4	Serene	1 2 3 4	Ready-to-go	1 2 3 4
Angry	1 2 3 4	Dejected	1 2 3 4	Bad tempered	1 2 3 4	Discouraged	1 2 3 4
Cheerful	1 2 3 4	Kindly	1 2 3 4	Joyful	1 2 3 4	Good-natured	1 2 3 4
Weak	1 2 3 4	Fatigued	1 2 3 4	Self-doubting	1 2 3 4	Weary	1 2 3 4
Tense	1 2 3 4	Bold	1 2 3 4	Shaky	1 2 3 4	Confident	1 2 3 4
Confused	1 2 3 4	Efficient	1 2 3 4	Perplexed	1 2 3 4	Businesslike	1 2 3 4
Lively	1 2 3 4	Peaceful	1 2 3 4	Active	1 2 3 4	Relaxed	1 2 3 4
Sad	1 2 3 4	Furious	1 2 3 4	Downhearted	1 2 3 4	Annoyed	1 2 3 4
Friendly	1 2 3 4	Lighthearted	1 2 3 4	Agreeable	1 2 3 4	Elated	1 2 3 4
Tired	1 2 3 4	Unsure	1 2 3 4	Sluggish	1 2 3 4	Inadequate	1 2 3 4
Strong	1 2 3 4	Jittery	1 2 3 4	Forceful	1 2 3 4	Uneasy	1 2 3 4
Clearheaded	1 2 3 4	Bewildered	1 2 3 4	Able to Concentrate	1 2 3 4	Dazed	1 2 3 4
Untroubled	1 2 3 4	Energetic	1 2 3 4	Calm	1 2 3 4	Full of pep	1 2 3 4
Grouchy	1 2 3 4	Lonely	1 2 3 4	Mad	1 2 3 4	Gloomy	1 2 3 4
Playful	1 2 3 4	Sympathetic	1 2 3 4	Jolly	1 2 3 4	Affectionate	1 2 3 4
Timid	1 2 3 4	Exhausted	1 2 3 4	Uncertain	1 2 3 4	Drowsy	1 2 3 4
Nervous	1 2 3 4	Powerful	1 2 3 4	Anxious	1 2 3 4	Self-assured	1 2 3 4
Mixed-up	1 2 3 4	Attentive	1 2 3 4	Muddled	1 2 3 4	Mentally alert	1 2 3 4

APPENDIX G

Appendix G

ST-DACL

Form A

Directions: Below you will find some words that describe different kinds of moods and feelings. Check the words that describe how you feel right now - at this moment. Some of the words may sound alike, but we want you to check all of the words that describe your feelings. Work rapidly and check all of the words that describe how you feel right now. If you need to change an answer, clearly erase the incorrect answer.

List A

- | | |
|---|--|
| ☐ 1. Wilted | ☐ 17. Strong |
| ☐ 2. Safe | ☐ 18. Tortured |
| ☐ 3. Miserable | ☐ 19. Listless |
| ☐ 4. Gloomy | ☐ 20. Sunny |
| ☐ 5. Dull | ☐ 21. Destroyed |
| ☐ 6. Lively | ☐ 22. Wretched |
| ☐ 7. Low-spirited | ☐ 23. Broken |
| ☐ 8. Sad | ☐ 24. Lighthearted |
| ☐ 9. Unwanted | ☐ 25. Criticized |
| ☐ 10. Fine | ☐ 26. Grieved |
| ☐ 11. Brokenhearted | ☐ 27. Dreamy |
| ☐ 12. Downcast | ☐ 28. Hopeless |
| ☐ 13. Enthusiastic | ☐ 29. Oppressed |
| ☐ 14. Failure | ☐ 30. Joyous |
| ☐ 15. Afflicted | ☐ 31. Weary |
| ☐ 16. Active | ☐ 32. Droopy |

ST-DACL**Form B**

Directions: Below you will find some words that describe different kinds of moods and feelings. Check the words that describe how you feel right now - at this moment. Some of the words may sound alike, but we want you to check all of the words that describe your feelings. Work rapidly and check all of the words that describe how you feel right now. If you need to change an answer, clearly erase the incorrect answer.

List B

- | | |
|--------------------------------------|--|
| ☐ 1. Downhearted | ☐ 17. Clean |
| ☐ 2. Lively | ☐ 18. Dispirited |
| ☐ 3. Unfeeling | ☐ 19. Moody |
| ☐ 4. Alone | ☐ 20. Pleased |
| ☐ 5. Unhappy | ☐ 21. Dead |
| ☐ 6. Alive | ☐ 22. Sorrowful |
| ☐ 7. Terrible | ☐ 23. Bleak |
| ☐ 8. Poor | ☐ 24. Light |
| ☐ 9. Forlorn | ☐ 25. Morbid |
| ☐ 10. Alert | ☐ 26. Heavyhearted |
| ☐ 11. Exhausted | ☐ 27. Easygoing |
| ☐ 12. Heartsick | ☐ 28. Gray |
| ☐ 13. Bright | ☐ 29. Melancholy |
| ☐ 14. Glum | ☐ 30. Hopeful |
| ☐ 15. Desolate | ☐ 31. Mashed |
| ☐ 16. Composed | ☐ 32. Unlucky |

ST-DACL**Form C**

Directions: Below you will find some words that describe different kinds of moods and feelings. Check the words that describe how you feel right now - at this moment. Some of the words may sound alike, but we want you to check all of the words that describe your feelings. Work rapidly and check all of the words that describe how you feel right now. If you need to change an answer, clearly erase the incorrect answer.

List C

- | | |
|--------------------------------------|---------------------------------------|
| ☐ 1. Cheerless | ☐ 17. Buoyant |
| ☐ 2. Animated | ☐ 18. Tormented |
| ☐ 3. Blue | ☐ 19. Weak |
| ☐ 4. Lost | ☐ 20. Optimistic |
| ☐ 5. Dejected | ☐ 21. Low |
| ☐ 6. Healthy | ☐ 22. Deserted |
| ☐ 7. Discouraged | ☐ 23. Burdened |
| ☐ 8. Bad | ☐ 24. Wonderful |
| ☐ 9. Despondent | ☐ 25. Crushed |
| ☐ 10. Free | ☐ 26. Somber |
| ☐ 11. Despairing | ☐ 27. Interested |
| ☐ 12. Uneasy | ☐ 28. Joyless |
| ☐ 13. Peaceful | ☐ 29. Crestfallen |
| ☐ 14. Grim | ☐ 30. Lucky |
| ☐ 15. Distressed | ☐ 31. Chained |
| ☐ 16. Whole | ☐ 32. Pessimistic |

ST-DACL**Form D**

Directions: Below you will find some words that describe different kinds of moods and feelings. Check the words that describe how you feel right now - at this moment. Some of the words may sound alike, but we want you to check all of the words that describe your feelings. Work rapidly and check all of the words that describe how you feel right now. If you need to change an answer, clearly erase the incorrect answer.

List D

- | | |
|--|--------------------------------------|
| ☐ 1. Depressed | ☐ 17. Fit |
| ☐ 2. Elated | ☐ 18. Lonesome |
| ☐ 3. Awful | ☐ 19. Unloved |
| ☐ 4. Lifeless | ☐ 20. Glad |
| ☐ 5. Griefstricken | ☐ 21. Grave |
| ☐ 6. Inspired | ☐ 22. Sunk |
| ☐ 7. Woeful | ☐ 23. Shot |
| ☐ 8. Lonely | ☐ 24. Merry |
| ☐ 9. Suffering | ☐ 25. Wasted |
| ☐ 10. Mellow | ☐ 26. Washed out |
| ☐ 11. Drooping | ☐ 27. Clear |
| ☐ 12. Rejected | ☐ 28. Gruesome |
| ☐ 13. Fortunate | ☐ 29. Tired |
| ☐ 14. Dreary | ☐ 30. High |
| ☐ 15. Lousy | ☐ 31. Worse |
| ☐ 16. Good | ☐ 32. Drained |

ST-DACL**Form G**

Directions: Below you will find some words that describe different kinds of moods and feelings. Check the words that describe how you feel right now - at this moment. Some of the words may sound alike, but we want you to check all of the words that describe your feelings. Work rapidly and check all of the words that describe how you feel right now. If you need to change an answer, clearly erase the incorrect answer.

List G

- | | |
|--|---|
| ☐ 1. Heartsick | ☐ 18. Enthusiastic |
| ☐ 2. Healthy | ☐ 19. Bleak |
| ☐ 3. Sad | ☐ 20. Griefstricken |
| ☐ 4. Afflicted | ☐ 21. Eager |
| ☐ 5. Lonesome | ☐ 22. Drained |
| ☐ 6. Fine | ☐ 23. Desolate |
| ☐ 7. Alone | ☐ 24. Miserable |
| ☐ 8. Gloomy | ☐ 25. Merry |
| ☐ 9. Depressed | ☐ 26. Dull |
| ☐ 10. Alive | ☐ 27. Melancholy |
| ☐ 11. Heavyhearted | ☐ 28. Interested |
| ☐ 12. Failure | ☐ 29. Unwanted |
| ☐ 13. Glad | ☐ 30. Gruesome |
| ☐ 14. Despondent | ☐ 31. Whole |
| ☐ 15. Sunk | ☐ 32. Oppressed |
| ☐ 16. Optimistic | ☐ 33. Lifeless |
| ☐ 17. Jovial | ☐ 34. Elated |

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