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FACIAL EXPRESSIVITY AND SOCIAL INTERACTION

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Bachelor of Arts

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Abstract

The capacity for accurate communication is crucial to one’s ability to function in a social setting. In addition to written and spoken language, one important means of human communication is the face. Facial displays modify verbal communication as well as convey meaning on their own. Researchers in the field of facial behavior, such as Paul Ekman and Alan Fridlund, believe that human facial displays represent a system of signals that evolved to communicate messages about one’s emotions or one’s needs in regards to social interaction. The fact that the six major human facial displays (i.e., disgust, fear, joy, surprise, sadness, and anger) are recognized with a high degree of accuracy in both literate and nonliterate cultures (Ekman, 1973a), and are present in individuals with limited exposure to facial displays, such as socially isolated individuals and the congenitally blind, represents evidence that many individual facial displays, as well as the general existence of facial display as a communicative signal system, have an evolved and biologically based, as well as a social, component.

If one views the issue from an evolutionary viewpoint, then, it could be hypothesized that those people who are more facially expressive would be more likely to have 1) more satisfying and 2) more frequent social interactions because they are most effective in communicating their social needs through facial displays. I have tested this hypothesis by having 19 volunteer subjects self-report their social interaction patterns, including satisfaction with social interaction and frequency of social interaction (encompassing total number of interactions and average length of interaction), then assessing the subjects’ facial expressivity as they are videotaped recounting a past embarrassing experience. Based on the video, I have measured facial expressivity as a general construct (designated throughout the thesis as “general facial expressivity”) using three variables. These include 1) a subjective expressivity score (Notarius &
Levenson, 1979) for each subject; 2) each subject's number of embarrassment displays per minute (Keltner & Anderson, 2000; Keltner & Buswell, 1997) and 3) each subject's number of non-Duchenne smiles (often called 'social' smiles) per minute. I examined correlations between the three measures of general facial expressivity and the subjects' satisfaction with their social interaction and the frequency of their social interactions. I found that subjects who scored higher on the subjective expressivity score tended to be more satisfied with their social interactions. No correlation was found between number of embarrassment displays or non-Duchenne smiles and satisfaction with social interaction, or between any of the three expressivity measures and any of the measures of frequency of social interaction.

The Evolution of Theory: A Review of Research on Facial Behavior and Its Social, Expressive and Communicative Functions

Facial Behavior Research before Darwin

Until the 19th century, the study of the face and its behavior was primarily limited to physiognomy. This speculative "science," practiced as far back as ancient Egypt and Arabia and pre-Confucian China (Fridlund, 1994), operated on the assumption that character and personality were revealed by the static physical characteristics of the face, in contrast to modern research's focus on the study of facial movements (Darwin, 1998). Aristotle is usually credited with writing the first treatises on physiognomy (e.g., the Physiognomonica and the Historia animalium). He believed that physiognomic traits were best discerned by comparing humans and animals. Among Aristotle's assertions were that fat ears like those of an ox indicated laziness and that prominent upper lips like those of an ape or a donkey indicated stupidity. However, Aristotle's writing considered only the face's permanent characteristics. He considered the "passions" — i.e.,
emotional expressions — as displayed in the face to be so short-lived as to be largely uninformative about a person’s character traits (Fridlund, 1994).

Throughout the Middle Ages, physiognomy and phrenology, a similar practice that involved “reading” the bumps on one’s head, were regarded as forms of fortune-telling in addition to indications of one’s personality. Although physiognomy’s methods became more systematic over time - analytical systems cataloguing bony and muscular structures of the face and the traits they indicated were developed in the eighteenth and nineteenth centuries - physiognomy’s assumptions regarding facial structure as an indicator of personality and character did not change. By the mid-nineteenth century, physiognomists had begun to study stigmatized segments of society, such as criminals and the mentally ill, as distinct groups. With evolutionary theory in the Darwinian sense not yet having been developed fully or widely accepted, many scientists of the time concluded that these people represented atavisms, or evolutionary reversions, exacerbating their widespread stigmatization and mistreatment by society. Physiognomy remained influential in the social sciences well into the 19th century (Fridlund, 1994). Anatomical knowledge taken from physiognomists’ work proved arguably useful – Darwin’s Expression of the Emotions in Man and Animals drew upon this evidence – but beyond this, physiognomists’ claims about the meaning of facial structure and movement have proved largely irrelevant to modern facial behavior research. For example, there is no scientifically based evidence for differences in static facial structure in criminals or the mentally ill or for Aristotle’s assertions that static facial traits were related to personality characteristics.

By the mid-19th century, pre-Darwinian scientists had moved beyond physiognomy and phrenology’s emphasis on the face’s static characteristics to attempts at analyzing the movements commonly referred to as “facial expressions” or “facial displays.”
the mid- to late 19th century focused on explaining the function of displays, mostly via creationist explanations, and on identifying the physical mechanisms behind facial movements. Oken, in 1810, and Huschke, in 1821, theorized that the head and face were analogous to the rest of the body; for instance, one of Oken’s illustrations of social greetings pointed out that arms opened wide in friendly greeting are often accompanied by a smile in which the mouth is opened widely. Charles Bell, in 1806, offered a simplistic explanation: pleasant emotions relaxed the facial muscles, while unpleasant ones tensed them. Bell assumed, taking the creationist view prevalent in science prior to Darwin’s theory of evolution, that the facial muscles were given by God to allow humans to express the “passions,” i.e., emotions. G. B. Duchenne de Bologne, in 1859, had a theological explanation similar to those of Bell, Huschke, Oken and other early theorists (Fridlund, 1994). Duchenne, however, used physiological methods such as galvanizing (i.e., using electricity to contract) the facial muscles of an elderly male subject with a decreased ability to feel facial discomfort in order to produce artificial representations of common facial expressions (Darwin, 1998). He then photographed the resulting involuntary movements, in the process obtaining information about the face’s muscular anatomy. Because of Duchenne’s study of the face’s physical structure and the physical aspect of its movement, some of his findings remain relevant, although mainstream science has since discarded the theological explanations behind them. Darwin relied upon Duchenne’s findings for much of his anatomical evidence. He also showed Duchenne’s photographs of artificial facial displays to observers in order to study recognition of facial movements. Additionally, the Duchenne marker, the cheek raise producing wrinkling at the corners of the eyes by which Duchenne and non-Duchenne smiles (to be explained below) are differentiated, is named after Duchenne de Bologne (Darwin, 1998).

Darwin, Facial Behavior and Evolutionary Theory
Charles Darwin, in his 1872 book *The Expression of the Emotion in Man and Animals*, henceforth *Expression*, was, as we have seen, not the first to study facial displays. Previous scientists had questioned which types of facial expressions existed and how and when they occurred. Darwin was the first to attempt a scientific explanation for why particular facial actions occurred in the forms they did without resorting to divine creation as an explanation (Darwin, 1998). In this still-influential and, at the time of its publication, best-selling book, Darwin set forth general principles of the expression of a wide range of emotions in humans and other animals and proceeded to support them with data from observations on each. Although he was limited in his ability to collect data by an illness that confined him to his home for most of the last 42 years of his life, his use of information from diverse sources, including observations by others of adults in his native England as well as of people from different cultures, infants, children, the mentally ill, the blind, and non-human animals, lends a unique strength to his research (Darwin, 1998). Indeed, although his claims were not subjected to rigorous testing until a century later (Fridlund, 1994), Darwin’s assertion that displays of emotion are, at least in part, produced in forms consistent within the human species and among some other animal species, has been supported by the results found by modern research (Darwin, 1998).

To understand *Expression* in its proper historical and ideological context, it is necessary to understand the prevailing assumptions of research of the time, as well as Darwin’s reasons and strategy for opposing them. Darwin is perhaps best known for his theory of evolution – set forth in his 1859 book *On the Origin of Species*, published thirteen years before *Expression* and henceforth referred to as *Origin* - which challenged the idea, prevalent among scientists as well as theologians in his time, that humans were a divinely created species entirely separate from other animals in their origin (Darwin, 1998). As discussed earlier, prior to Darwin, most
scientists had explained functionality in human form and behavior by asserting that a Creator, i.e.,
God, had designed things to be as they were. In Darwin’s time, this argument took two forms.
One form of the creationist argument, special creation, asserted that the Creator had designed all
organisms with the forms appropriate to their environments. Special creation assumed that
species were constant, and thus that the environments in which organisms lived had not changed
and would not change. The second form, directed evolution, was the idea that the Creator had
directed the evolutionary process, with humans as the culmination (Fridlund, 1994). Directed
evolution took into account organisms’ adaptation to a changing world, but still identified the
cause as an intelligent Creator. Darwin’s work, however, sought to explain functionality as the
result of natural selection, or the tendency of organisms best suited to their environment to be
more likely to survive and produce more offspring.

Darwin’s theory of descent with modification through natural selection, as stated on page
68 of Origin, explained evolution thus:

“As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form” (Darwin, 1979)

Thus, according to Darwin’s theory, functionality in human and other animal form and
behavior can be viewed as the result of generations of organisms’ “struggles” to adapt to the
changing environment in which they live. This is in contrast to the creationist explanation,
which assumes a creator designed organisms, presumably thousands or millions of years ago, in
the forms that still exist today.

Darwin’s research for Expression began as part of his work on 1871’s The Descent of
Man, which applied the ideas in Origin to the study of human evolution, but the notes became so
numerous that he developed them into a separate book (Fridlund, 1994). He states in *Expression* that he began collecting his observations on the expression of emotion in humans and other animals in 1838, by which point he already believed in the principle of evolution (meaning generally, he states, "the derivation of species from other and lower forms"). He found Bell's assertion that facial muscles had been created by God specifically for expression "unsatisfactory," and this led him to write *Expression* (Darwin, 1998). *Expression* and *The Descent of Man* supported the theory of evolution by natural selection Darwin had set forth in *Origin*.

Significantly, however, *Expression* actually helped Darwin to advance his theory by characterizing facial displays as not necessarily adaptive, as will be discussed in more detail later. *Expression* was written not only to support Darwin's theory of evolution by natural selection, but also to pose a direct challenge to the prevailing creationist worldview. With *Expression*, Darwin intended to challenge in particular the work of Charles Bell, who stated that there were certain muscles in the human face without equivalents in other animals, which had been designed by the Creator specifically for the display of emotions (Darwin, 1998).

*Expression* supported Darwin's theory of evolution by natural selection by providing evidence for consistency in expression in humans cross-culturally and among some other animal species, and also providing evidence that many of the expressive movements of newborns and young children were similar to those of adults. For his research in *Expression*, Darwin personally observed infants, the institutionalized mentally ill, and animals. He administered surveys to people living in other cultures to obtain evidence on the expression of emotion in other cultures and showed Duchenne's photographs of "expressions" – facial movements produced artificially by asking subjects to pose or by galvanizing their facial muscles - to people
to determine whether the emotions being expressed were recognizable (Darwin, 1998). His conclusion, based on this evidence, was that expressive movements were consistent across cultures and, while not entirely similar among species, showed patterns of similarity. Thus, he reasoned, there was an instinctive, biological component to expressive movements. As biologically based traits with consistency within and between species, expressive movements must have therefore evolved, and thus they provided support for his theory of evolution.

As Darwin discussed each category of emotions and their expressions, he cited not only evidence of human emotional expression in various cultures and different stages in the life cycle, but also evidence for continuity in expressive behavior between humans and other animals. In the initial discussion of his three general principles of expression and his sections on “Means of Expression” and “Special Expressions of Animals,” he presents anecdotes and drawings of animal behavior alongside the discussions of human behavior, showing the similarities among various animal species in emotional expression as well as the similarities of humans to other animals (Darwin, 1998). An example Darwin gives on page 247 is the baring of the canine teeth in a snarl to convey anger, which occurs in dogs as well as humans and some species of apes and monkeys. Darwin also observed that humans, while in a state of concentration, tend to close their lips firmly to avoid disturbing their movements by breathing. On page 141 of Expression, Darwin discusses how he observed an orangutan doing the same thing while appearing to concentrate on killing flies that were buzzing around the windows of its cage (Darwin, 1998).

This serves to emphasize the consistency of expressive behavior within the human species, as well as the similarities in expressive behavior among human and other animal species, that Darwin was trying to convey. Continuity across cultures and species was recognized as
evidence for a biological, rather than a learned or cultural, basis for a functional physical or behavioral trait, and thus as support for evolution by natural selection.

Paradoxically, however, Darwin argued that although these traits were products of evolution, they did not have an adaptive function. This assertion, and Darwin’s evidence for it, provided a piece of evidence that proved to be a key argument against previous theories of evolution that rested on creationist assumptions. This argument, however, would complicate later research on expressions as communicative devices.

As Fridlund points out, Darwin’s intent in presenting facial displays as nonadaptive is frequently misunderstood. While results of more recent research on nonverbal communication have indicated that facial displays do indeed serve an important adaptive purpose, Darwin’s identification of them as nonadaptive was, as we will see, perhaps the most effective strategy Darwin could have employed in using emotional expression as evidence for his theory of natural selection. While the functionality of certain physical characteristics or behaviors of humans or animals is consistent with, and provides evidence for, the theory of evolution by natural selection, the “perfection” of functional traits has also been used to support the argument that the world and everything in it were designed by a Creator, thus rendering this argument inadequate as evidence for evolution.

The persistence of nonadaptive traits can only be explained from an evolutionary perspective if the traits in question are either linked with another, adaptive, trait, or if they were formerly adaptive and are no longer so. Darwin asserted that facial displays of emotion were preserved by natural selection because they were associated with other movements that were adaptive, even though the facial displays themselves were not adaptive. In Expression, he put forth three principles of expression which, he asserts, govern expressive movements in humans
and animals. He supports this viewpoint throughout Expression with evidence from accounts of human and animal behavior. The first principle, "serviceable associated habits", states on page 34 of Expression that "Certain complex actions are of direct or indirect service under certain states of mind, in order to relieve or gratify certain sensations, desires, etc., and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not then be of the least use" (Darwin, 1998). An example Darwin gives on page 38 of Expression is closing one's eyes or turning away when one is thinking of something unpleasant; although the unpleasant object is not actually present, thinking about it produces the same state of mind as if it were, causing a similar reaction (Darwin, 1998).

Darwin's second principle of expression is that of "antithesis". This can be summarized as the idea that, if certain states of mind induce particular expressive movements, the opposite state of mind may produce an opposite expressive movement, although such a movement may serve no practical function. An example Darwin gives is the shrug, which, although it may be argued that it is often more of a gesture than an unconscious emotional display, is present as an expression of impotence, helplessness or apology in almost all known cultures. The shrug, according to Darwin, is opposite in its form to movements indicating the intent to resist, such as the movements involved in pushing someone or something away (Darwin, 1998).

The third principle in Expression, according to Darwin on page 69 of the book, is that of the "direct action of the excited nervous system on the body" to express an emotional state. This principle is explained somewhat more vaguely than the other two. It includes involuntary actions such as trembling and perspiration in humans (Darwin, 1998).
A major 19th-century proponent of creationism, William Paley, gave the example of the structure of the eye in a piece he wrote in 1816, saying that "the examination of the eye is a cure for atheism" (Fridlund, 1994). Therefore, the existence of behaviors which serve no practical function provide a counterargument to the evidence for divine creation—a hypothetical intelligent designer would not have endowed the beings it created with nonfunctional traits. For an example of Darwin’s assertion that emotional expressions were not useful, we may revisit the earlier example of closing one’s eyes or turning away at the thought of something unpleasant that is not actually present. This action in itself (i.e., independent of its meaning as a symbol within a nonverbal communicative system) serves no function—it cannot, of course, remove an unpleasant object, especially one that is not actually there—yet still we do it. If emotional expressions were not especially functional or adaptive, and yet humans and animals retained them, then creationists could not use the “functionality” of emotional expressions as support for the arguments of either special creation or God-directed evolution.

It is unclear to what extent Darwin actually considered the adaptive function of facial behavior as a form of symbolic communication—a concept which is explored by much of the more recent research in this field. In any case, in Expression he offered only a minimal discussion of facial behavior as a form of communication. The modern reader cannot ask Darwin about his intent, so one must assume he either did not consider the idea of facial expressions as communicative adaptations, or that he considered the idea, but chose to avoid discussing it in Expression.

Although the idea of expressions as nonadaptive ultimately proved incompatible with modern knowledge of human and animal nonverbal communication, Fridlund views this standpoint as a necessary strategy in Darwin’s effort to upset theology’s hold on the study of
human and animal behavior. It provided a key piece of support for Darwin’s theory of evolution by natural selection in that it was consistent with his theory, but incompatible with creationism. The presence of an alternative to theological explanations for human and animal expressive behavior helped clear the way for contemporary scientific research on emotional expression and nonverbal communication (Fridlund, 1994).

*From Darwin to the 1960s*

Although *Expression* was a popular book in Darwin’s time, selling 5,267 copies on the day of publication alone (Ekman, 1973b) and nine thousand within the first four months (Darwin, 1998), it had little influence on the scientific community for about 90 years following its publication. Various researchers identify several possible reasons for this (Ekman, 1973b).

Ghiselin, according to Ekman, suggests that Darwin’s use of anthropomorphism in writing about animals may have led some scientists to misunderstand or condemn his work. This may have been attributable to Darwin’s emphasis on the evolutionary continuity linking species (Ekman, 1973b). Ghiselin and Petrinovich, according to Ekman, have also interpreted it as simply a stylistic device which Darwin used to help him communicate with his readers. The advent of behavioristic thinking, which emphasized the study of observable behaviors over that of internal states, also led many researchers to discount inferences about things that were not directly observable, such as emotions (Darwin, 1998).

Darwin’s use of anthropomorphism, however, may not have been entirely misleading. Chevalier-Skolnikoff writes that many primatologists “are fairly confident that the interpretation of the emotional nature of facial behavior is correct” for nonhuman primates, based on research conducted free of the assumption that primates experience emotions. Although researchers cannot directly assess the emotions primates feel, they have constructed what they
consider to be reliable interpretations of primate emotion based on the social contexts of
behavior and on similarities between the brains of human and nonhuman primates. Chevalier-
Skolnikoff has shown through diagrams that the forms of contextually equivalent expressions in
macaques, chimpanzees and humans - particularly those conveying fear and anger - do, despite
some differences, appear strikingly similar among all three species. In anger expressions, for
example, the lowering and bringing together of the eyebrow region; a hard, intense glare; and the
baring of the teeth are present in all three species. Chevalier-Skolnikoff's observations show
similarities in the forms of all three species' expressions, as well as a maintenance of
everevolutionary trends evident in the development of facial musculature in the three species
(Chevalier-Skolnikoff, 1973).

Darwin's use of anecdotal rather than systematic evidence has also been criticized. As
any researcher knows, anecdotal evidence is questionable because it is difficult, if not impossible,
to test through replication, and it is prone to incompleteness and observers' biases. Darwin was
aware of this problem with much of his evidence (Ekman, 1973b), placing more confidence in
reports which described the full circumstances of a behavior (Darwin, 1998). However, confined
to his home by illness while he wrote *Expression*, he was limited in his methods of data
collection. For his cross-cultural evidence, for example, he sent a list of 16 questions about
expressive behavior to people working in other countries, receiving a total of 36 responses from
observers. His respondents knew from his questions what facial patterns Darwin expected to see
associated with each emotion. Additionally, in most cases, he relied on only one observer for the
observation of each expressive phenomenon, and the observers' judgments were largely
subjective given the absence of a standardized measurement system (Ekman, 1973a).
Despite this questionable data, however, one of Darwin's great strengths was his use of diverse sources of data drawn from various populations using various methods; no one writing about expression today has used such a variety of sources (Darwin, 1998). In addition to his cross-cultural observer questionnaires, his sources of data include detailed diaries he kept on the development of his own children, including their expressive behavior (Charlesworth & Kreutzer, 1973); his own and others' observations of animals; and drawings and photographs obtained from researchers and others (Darwin, 1998).

Additionally, despite its shortcomings, naturalistic observation has its advantages, and Darwin acknowledged these. He was convinced that natural situations, free of experimental equipment and procedure, provided an ideal setting for the observation of the impact of evolutionary influences (Charlesworth & Kreutzer, 1973).

It is also known that Darwin explained the origin of some of the expressions he described through Lamarck's idea of the inheritance of acquired characteristics. This idea was widely accepted at the time of Darwin's writing, but was known by later researchers to be false and thus caused many to discount *Expression* as a whole. Inheritance of acquired characteristics is the idea that, when an organism develops characteristics throughout its lifetime as a result of living in a changing environment, these acquired characteristics can be inherited by the organism's offspring. Although Darwin relied on his own principle of natural selection to account for the evolution of emotional expressions (Ekman, 1973b), he may not have fully understood how these characteristics were inherited (Darwin, 1998). In Darwin's time, most scientists did not understand the mechanisms by which genes are transmitted. Scholars have argued about the extent to which he actually accepted inheritance of acquired characteristics, but *Expression* shows evidence that Darwin did, at times, rely on it for explanation (Darwin, 1998).
Another reason why Darwin's work on expression was virtually ignored for so long was that he assembled much of his evidence after having developed his views on expression, providing cause for its objectivity to be questioned. Darwin claimed in *Expression* to have arrived at his three principles of expression only after completing his observations; however, his notebooks from 1838 and 1839 contain mention of the principles (Darwin, 1998).

An additional problem with *Expression* was that it explained the origin of nonverbal displays based solely on their role in expressing emotions rather than also discussing their communicative function. Because he did not deal with communication, many researchers in nonverbal communication considered *Expression* irrelevant. In the last chapter of *Expression*, he devoted a paragraph to acknowledging the communicative value of nonverbal displays, but did not discuss how this related to their evolution. One possible reason for this, Ekman writes in the introduction to the 1998 edition of *Expression*, is that Darwin felt such a discussion would undermine his attack, discussed earlier, on Bell's view that nonverbal displays had been designed by a Creator specifically for communication (Darwin, 1998). Fridlund also supports this argument, saying that Darwin portrayed expressions as accidents of the nervous system or as nonfunctional behaviors preserved by evolution because of their association with functional behaviors. In any case, Darwin failed to develop the idea of expressions as potential communicative devices beyond a brief mention, and proponents of his theories did not, for the most part, explore this idea until much later (Fridlund, 1994).

Between Darwin's time and the mid-20th century, research in the area of facial behavior took place, but studies were relatively few and the quality and relevance of the research that took place during this time is debated. Two particularly well-known studies from this time are Landis' 1924 and 1929 studies, which led to the conclusion that facial behavior did not provide
information about emotional state. Landis sought to eliminate the methodological problems that he felt had led researchers to conclude that internal state did not correspond to external display. His 1924 study focused on this issue, comparing subjects' verbal responses to elicitors of emotion with their physical reactions (Landis, 1924). His 1929 study looked at whether subjects could interpret the emotions of others based on others' facial expressions (Landis, 1929). He concluded that subjects' verbal responses regarding their emotional states did not reliably correspond with their facial displays and that others could not interpret emotional state from facial expression. Landis himself, in fact, points out "certain obvious defects" in his work and describes it as "largely a matter of trial and error"; these statements, especially when one considers that they come from the researcher himself, lead the reader to question the authoritativeness of his claims (Landis, 1924). Numerous methodological problems have been identified in Landis' work, and recent reanalyses and replications of his studies have produced results indicating the opposite of his original conclusion (Rosenberg, 2005).

Rosenberg cites a few well-conducted studies from this period by Goodenough & Tinker in 1931, and Woodsworth in 1938 (Rosenberg, 2005), whose results indicated that people could consistently recognize displays of emotion in the face.

Tagiuri, in a 1969 review of research on nonverbal behavior in social cognition, provides no shortage of examples of facial behavior research, but notes that "[w]e must come to the chastening conclusion that the literature is sufficiently haphazard to preclude a simple answer" as to the extent to which emotions are recognizable from nonverbal behavior (Tagiuri, 1969). Tagiuri's review, however, seems to oversimplify the issue, ignoring the potential value to be found in individual research findings because the answer provided by the overall picture is unclear. He does, however, accurately identify the main problem that plagued facial behavior
research at the time, i.e., the lack of a consistent theoretical or methodological framework (Tagiuri, 1969)

Rosenberg (2005) argues that Tagiuri’s conclusion that the face did not offer accurate information about emotions – originally put forth in an earlier (1954) edition of the review – was a misrepresentation of early research in the field. She also asserts that the field of facial expression research received little attention until the 1960s and 1970s and writes that systematic, quantitative research in this area did not exist until the mid- to late 20th century (Rosenberg, 2005).

Fridlund offers examples of other research relevant to studies of human facial behavior, particularly in the fields of ethology and other non-human animal research (Fridlund, 1994). Research on non-human animal behavior – free from the moral implications of the “nature versus nurture” question in humans – continued regardless of the state of human behavior research, with researchers such as Lorenz and Tinbergen emphasizing the innateness of some nonhuman behavior. These researchers viewed organisms as attuned to respond to “sign stimuli” that triggered appropriate behavior patterns called “fixed action patterns” (Fridlund, 1994). Some ethologists – that is to say, researchers whose focus was the biological basis of behavior in animals - did extend their findings to human behavior. Studies of animal behavior in the 1930s and 1950s were structured on a new approach, popular in ethology and sometimes anthropology, that aimed to eliminate errors, objectify data collection through removing anthropomorphic biases and anecdotal accounts, and focus on inductive experiments, which were better suited to answering the questions formulated through deductive procedures (Chevalier-Skolnikoff, 1973).

Whatever the reason, the prevailing view at the time was that the face did not provide accurate information about emotional states. As such, research proceeded with this assumption
until later studies, mostly beginning in the 1960s and 1970s, began to contradict it; as a result, few researchers found it worthwhile to study facial behaviors as they related to emotion (Rosenberg, 2005).

In addition to the prevalence of the behaviorist viewpoint, which will be discussed in more detail later, two factors, both related to methodological issues in research, helped explain the dearth of useful research in facial behavior during much of the 20th century. First, early research in facial behavior appeared to suggest that facial behavior did not provide any information about emotional state, and much of it produced inconsistent results.

Secondly, methodological problems likely played a major role in the incorrect and inconsistent conclusions that characterized much of the research, such as Landis' studies. Many inconsistent or debatable results among early researchers were likely attributable to methodological problems. Among the most significant of these problems were measurement limitations. A few researchers tried to measure the face directly, but in the absence of a standard measurement system for facial displays, they relied mostly on judges' subjective interpretations of photos or videos (Rosenberg, 2005). The lack of a consistent and objective way of measuring facial displays plagued early facial behavior research, particularly that which dealt with the cross-cultural study of facial behavior. Although many emotions have indeed been shown to be experienced, and associated with similar facial displays, in all cultures studied, the situations or experiences that elicit these emotions, and the display rules governing the expression of emotion in each culture, may differ (LaFrance & Mayo, 1978) A funeral, for instance, would elicit very different emotional reactions in a culture where it was considered a form of mourning or other "sad" event versus one where it was considered a celebration of the life of the deceased or other "happy" event. Language barriers compound this problem. If, for instance, an investigator
studies a culture with whose language he or she is not fully familiar, he or she must be careful to verify that the words he or she has chosen to describe an emotion have the intended connotations when translated into the subjects' language (Ekman, 1973a).

Employing operational definitions that involve implications of particular emotions creates a danger of imposing the researcher's personal and cultural worldview upon the results and interpretation. By the 1970s, more objective methods of measuring facial movement, including electromyography (EMG); Paul Ekman and Wallace Friesen's Facial Action Coding System (FACS), developed in 1978; and Carroll Izard's Maximally discriminative facial movement coding system (MAX), developed in 1979, had reduced many of these problems (Rosenberg, 2005).

Perhaps the most important reason, however, why Expression was virtually ignored was the overwhelming emphasis on behaviorism in the social sciences for much of the 20th century. Behaviorism emphasized the role of experience and learning and rejected notions about consciousness, advocating that investigation in social science should limit itself to overt behavior - namely, that which could be objectively measured and verified (Hockenbury & Hockenbury, 2003). John Watson, its founder and one of its chief proponents, stated that behaviorism's aim was the prediction and control of behavior (Petrinovich, 1973). It rejected any concern with consciousness and introspection. Perhaps most relevant to the study of facial behavior, behaviorists rejected the study of emotion, considering it unobservable and thus not worth studying (Rosenberg, 2005). Additionally, while behaviorism is not antithetical to evolutionary theory as it applies to physical characteristics of organisms, behaviorism's concept of the mind at birth as a "blank slate" precludes any notion that behavior could be genetically influenced. Thus, most mainstream research in facial behavior during this time proceeded in accordance with the
behaviorist paradigm; the idea of facial displays as part of an evolved communicative system was not explored until later.

Two factors helped behaviorism gain popularity. Behaviorism's emphasis on rigorous research methods, including quantification, objectivity and studying observable behaviors under tightly controlled laboratory conditions, increased its appeal to the scientific community (Hockenbury & Hockenbury, 2003). Extreme behaviorism, which virtually ignored the possibility of any innate determinants of behavior, also gained popularity among scientists and the general public because it represented a backlash against several destructive viewpoints of the time, including eugenics, Nazism, and the misnamed "Social Darwinism." These threats to human rights and social stability were associated with the notion that behavior was biologically based, and any research involving the possible biological basis of behavior fell under suspicion (Darwin, 1998). (Ironically, it should be noted that Darwin's work stressed the biological similarity of all humankind rather than biologically based differences.)

Thus, the safest option for many researchers was to align themselves with behaviorist ideas, and research concerning the biological components of behavior – including research on facial expression as a means of communicating or expressing emotion - suffered as a result. Many behaviorist psychologists and cultural relativist anthropologists rejected a universal, biological basis for facial behavior out of fear of association with other groups emphasizing biology's role in behavior. Some social scientists, such as cultural relativist anthropologist Margaret Mead, decided specifically not to consider biological aspects of behavior in their research to avoid possible associations with eugenic ideas (Darwin, 1998). The anthropologist Ray Birdwhistell – perhaps the most influential proponent of the view that facial behavior was not universal or biologically based – concluded, based on his cross-cultural research in kinesics
(his term encompassing facial and body movement and posture), that there were no universal expressions of emotion (Darwin, 1998).

Proponents of the idea that facial behavior was learned, including Birdwhistell, Mead, and another anthropologist and communication theorist, Gregory Bateson, also tended to focus on facial displays as communicative signals rather than expressions of emotion. Ethologists, who focus mostly on measuring behavior in nonhuman animals, tend to share this focus. The views of facial behavior as communicative and facial behavior as emotionally expressive are not mutually exclusive, but much of research has tended to focus on either the emotional aspect or the communicative aspect of facial displays rather than emphasizing both (Darwin, 1998).

The exclusion of biological factors in facial behavior research, despite its well-intentioned concerns, served mostly to hinder the progress of social science (Ekman, 1973b). Behaviorism no doubt had an impact on the course of research, but exactly how much of an impact is debatable. As discussed earlier, research in facial behavior did take place, but much of the research based in behaviorism was either not methodologically or theoretically relevant to modern research or was not objective or standardized enough to offer significant findings.

Research After 1960

Rosenberg writes that two influences were instrumental in helping to reestablish the study of the face as a legitimate enterprise. The first was Silvan Tomkins’ theory of affect, published in 1962, which identified the face as central to emotion. Additionally, cross-cultural work by Paul Ekman, Carroll Izard, Wallace Friesen, and others was published. With the resurgence of research came, finally, efforts to address the lack of a consistent and objective method of studying facial behavior, which resulted in the development of systems like FACS, MAX and EMG, mentioned earlier (Rosenberg, 2005).
FACS and MAX, Rosenberg writes, are both coding systems that describe facial movement in terms of observable, constituent components. Rosenberg writes that MAX is theoretically derived because it codes only facial movements that Izard believed were components of universally recognized facial expression of emotions, whereas FACS can be used to code all facial movements (Rosenberg, 2005). FACS is the most frequently used system for facial movement coding. According to Rosenberg, it is the only comprehensive, anatomically based system for measuring facial movements (Rosenberg, 2005). It measures all facial movements, not just emotion-related movements. It describes all visually apparent facial movements based on 44 action units (AUs) and several categories of head and eye movements. Each AU involves a set of known facial muscles, although there is not a one-to-one correspondence between certain muscles and AUs. FACS also allows researchers to code the intensity of a facial movement on a five-point scale from A (indicating a trace of the movement) to E (indicating extreme intensity) (Ekman & Friesen, 1978). Combinations of facial movements are called “events”; an event can describe what is commonly called a facial expression without imposing the assumption of a certain emotion or intent.

Electromyography (EMG) is another way of measuring facial movement. It involves measuring the electrical potentials of facial movements to determine when muscles contract. Surface electrodes are typically placed on the skin of a subject’s face, and changes in potential are measured. It can be used to detect muscular activity that is not observable to the naked eye, giving it an advantage over visual coding schemes like FACS and MAX. However, unlike FACS and MAX, EMG is obtrusive, and subjects may become more self-conscious of their facial behavior and thus alter their movements. Additionally, muscle movements surrounding
the area being measured may interfere with the measurement of the muscle group in question (Rosenberg, 2005).

Since the development of objective systems like FACS, MAX and EMG for measuring facial movements, much recent research has focused on the correspondence of facial displays with emotions and the function of facial display within social settings.

Paul Ekman, who is among the best-known researchers in facial behavior, entered the field of facial behavior research in the late 1950s. Ekman, a clinical psychologist trained in psychoanalytic and behaviorist techniques, became interested in the study of nonverbal behavior as a method of assessing clinical improvement in patients. Having been trained as a behaviorist, he thought it unlikely that facial display could be universal or biologically based. Ekman initially entered the field of facial behavior research with the goal of settling the dispute over whether nonverbal behavior was universal (Darwin, 1998). Ekman's original view was that it was for the most part not universal; however, his research convinced him that it likely was.

After consulting with the field's experts of the time – he identifies among them Birdwhistell, Mead, Bateson, and Tomkins – Ekman planned his first experiment, a 1966 cross-cultural study of how well people could recognize the six basic emotions from photographs. These emotions include happiness, sadness, fear, anger, surprise and disgust (Darwin, 1998). These are the emotions generally agreed upon by researchers, although various theorists have identified more or fewer. Ekman and Carroll Izard independently conducted such experiments on individuals in a total of 21 literate cultures. Among these were Japan, Brazil, Chile, Argentina and the U.S. in Ekman's (1968) study and the U.S. England, Germany, Sweden, France, Switzerland, Greece, Japan and Africa in Izard's study. In each culture, the researchers found that the majority of participants agreed on which faces represented happiness, sadness, and
disgust. In most cultures, participants agreed on displays of surprise (20 of 21 cultures), fear (19 of 21), and anger (18 of 21) (Darwin, 1998).

Birdwhistell pointed out to Ekman that, since the studies were conducted in literate cultures, the participants could conceivably have learned the expressions from media, such as television or movies, that were common to all the cultures. Ekman then conducted a modified version of his recognition experiment among the South Fore of New Guinea, a culture which did not have a written language and whose members, for the most part, had never seen an outsider. He also conducted an experiment in which he asked the Fore to produce expressions representing given emotions (as indicated by emotion-related stories). After examining his own and others’ extensive footage of the Fore and of the Agape of Papua New Guinea, another isolated culture, Ekman and his colleague Wallace Friesen found that there were no expressions unfamiliar to them and that, for films where they knew enough of the social context to check whether their interpretation of the expression was correct, they could accurately perceive expressions. The results effectively refuted Birdwhistell’s suggestion that the expressions had been learned through media common to multiple literate cultures (Darwin, 1998).

Ekman and Friesen did another cross-cultural study in which they analyzed the facial expressions of American and Japanese college students as the students watched films. Each group of students was filmed both alone and in the presence of others. They found that the subjects’ expressions were similar when they were alone, but that the expressions of subjects in different groups differed from one another when the subjects were in the presence of others. These results provided evidence for Ekman and Friesen’s theory of display rules – rules within a culture about what is appropriate and inappropriate in terms of display that operate on, and modify, the basic expressions of emotion common to all people (Darwin, 1998).
Research by others in the field of facial behavior further supports the idea of an underlying biological basis for facial displays. Individuals who are congenitally blind or who became blind at a young age, who receive minimal or no visual exposure to facial displays, produce recognizable and socially appropriate spontaneous facial displays as children; Schmidt & Cohn (2001) and Charlesworth and Kreutzer (1973) both cite a number of studies that support this. Posed facial displays are recognizably different between blind and sighted individuals (Schmidt, 2001). The frequency of facial activity in the blind may also decline with age, possibly due to the fact that they are not reinforced for producing socially appropriate facial displays, but displays in the blind and the sighted do seem to be quite similar in the very young (Charlesworth & Kreutzer, 1973).

Evidence that nonhuman primates produce facial displays (Chevalier-Skolnikoff, 1973) provides additional evidence for an evolved and thus biological basis to facial displays. Although the displays of nonhuman primates are not identical to those of humans, they display visible similarities and a continuation of evolutionary trends apparent from muscle and bone structures (Chevalier-Skolnikoff, 1973).

Strong empirical evidence supports the assertion that, although culture-specific emotion elicitors (i.e., contexts, situations, or experiences that cause a person to experience a certain emotion) and display rules may modify facial behavior, facial displays share a common biological heritage. Researchers have identified six basic facial displays - anger, fear, joy, sadness, surprise and disgust – agreed upon by most researchers and shown to assume forms consistent enough to be recognized cross-culturally (Ekman, 1973a; Schmidt & Cohn, 2001).

Based on his findings, which seem to indicate patterns of facial display that are present cross-culturally as well as display rules that account for differences in facial display, Ekman has
put forth his "neurocultural theory." He characterizes display as an "open program" or "facial affect program" — a behavioral device which functions in basically the same way in all normal humans, but which is open to influences from the environment (Darwin, 1998). Thus, some facial displays of emotion may be culture-specific because of differences in the elicitors of the emotions, display rules indicating when and for whom it is appropriate to make a given expression, and the consequences of displaying an emotion. However, underlying these, there is a universal program in the human nervous system that links particular movements with particular emotions. A facial muscular movement for a particular emotion will occur in essentially the same way universally, with modification by culture-specific display rules (Ekman, 1973a).

Ekman's theory discusses the biological basis of facial behavior, and although it does not discount an evolutionary perspective on facial behavior, it does not emphasize it either. Fridlund (1994) has advanced an alternative theory, his "Behavioral Ecology View." Fridlund's theory is rooted more in comparative psychology and ethology than is Ekman's view, although the two views are not incompatible.

Fridlund's theory emphasizes the evolutionary basis and adaptive function of facial displays. Fridlund conceptualized facial displays as evolved social signals, with the production of displays and the vigilance for them, or tendency to recognize and correctly interpret them in others, necessarily having co-evolved. Neurobiological evidence, particularly studies of dissociate deficits (for example, cases in which a person with brain damage loses the ability to perceive facial displays but not to produce them, or vice versa) supports the idea that separate neural mechanisms exist for display production and vigilance (Schmidt & Cohn, 2001). Fridlund characterizes systems of facial behaviors in humans and other animals as signal systems that are almost entirely communicative in function and heavily dependent on the social context, with
little to no important role for the expression of internal emotional states (Fridlund, 1994). Fridlund puts forth a series of explanations as to why facial displays, even when produced in isolation, have a social component. Even displays one produces when alone are social, Fridlund writes, because we often treat ourselves, as well as nonhumans and inanimate objects, as interactants; act as if or imagine that others are present when they are not; or "rehearse" social interactions (Fridlund, 1994).

However, as Ekman writes, recognizing that expressions function to communicate interaction and have been shaped through evolution "does not mean, however, that we have to throw out the idea that these are expressions of emotion." Therefore the two views are not necessarily incompatible. Facial displays can be viewed as expressions of emotion without specific fitness consequences, or as adaptive social signals facilitating social interaction.

Facial expression, Schmidt & Cohn write, is "unambiguously social" (Schmidt & Cohn, 2001), an assertion supported by evidence from Fridlund (1994) and from Chovil's finding that facial displays are mediated by the extent to which individuals can participate in social interaction (Chovil, 1991). If facial displays are evolved social signals, write Schmidt, Cohn & Tian (2003), they are the result of selection pressures for "conspicuous, stereotyped and redundant communication," ensuring the efficiency of using a signal to communicate among members of a species. That is to say, the form of a given facial display was shaped and preserved through natural selection over time, so that display will tend to have a largely predictable appearance.

An example Schmidt et al. provide is smiling, in which people tend to produce conspicuous changes in facial appearance which are consistent in form across cultures, and to smile repeatedly, often as many as three times per minute. Additionally, smile onsets follow a
consistent time course in addition to involving a consistent configuration of features (Schmidt, Cohn, & Tian, 2003).

The role of internally experienced emotion in a view of facial expressions as adaptive social signals is debated. Adaptive explanations of facial expressions as social signals may or may not give consideration to the role of emotion.

While Fridlund's behavioral ecology view asserts that the idea of emotion limits the scientific usefulness of explanations because of its vagueness (Fridlund, 1994), other researchers, such as Hauser and Keltner & Gross, cited by Schmidt & Cohn, have offered explanations of the functions of emotions posited to underlie facial behavior (Schmidt & Cohn, 2001). Adaptive explanations of facial behaviors as emotional expressions require that the relationships between experienced emotions and facial displays be explored, but not necessarily that other adaptive consequences of experiencing that emotion be explained (Schmidt & Cohn, 2001).

For facial displays to be viewed as adaptations, specific fitness consequences and ecological contexts of displays must be identified. Because different facial displays are associated with different contexts and different fitness consequences, multiple adaptive explanations for different facial displays must be considered (Schmidt & Cohn, 2001). Schmidt & Cohn (2001) have proposed a set of general socioecological contexts for facial displays, including infant/caregiver or parent/offspring interaction, cooperative interactions, speech, competitive interactions, play, mate-seeking or sexual signals, and conflict resolution.

**Justification and Hypothesis**

Let us briefly review the relevant developments in the theory and ideas presented in the last section. Strong support for a biological basis to facial displays comes from studies of
humans in various cultures and of nonhuman primates (Chevalier-Skolnikoff, 1973). Although not identical to those found in humans, facial displays of emotion are also found in nonhuman primates, with consistency in displays occurring within primate species. Additionally, as discussed in the previous section, when comparisons are made among primate species, including humans, it becomes evident that the forms of these displays and the underlying musculoskeletal structure illustrate evolutionary trends (Chevalier-Skolnikoff, 1973). If facial displays are biologically based, they have likely evolved over time. Thus, a genetically based predisposition to expressing emotions facially is passed on from parent to child, although its specific expression is culturally influenced. This explains why many displays remain consistent across cultures and are found in humans' closest evolutionary relatives, nonhuman primates (Darwin, 1998) (Chevalier-Skolnikoff, 1973).

If facial displays have evolved, then, there is some reason why natural selection has consistently selected for them through so many generations. Darwin's *Expression of the Emotion in Man and Animals* introduced the idea of the evolved basis of facial displays, but popularized what most researchers now consider a misconception about their function. Darwin argued that although facial movements were expressive, they were "of no use." Instead, he wrote that natural selection had preserved them because they had become associated by force of habit with actions that *did* have a practical function (Darwin, 1998). Chevalier-Skolnikoff (1973) explains Darwin's "serviceable associated habits" discussed earlier, which she calls "intention movements," as communicative movements that evolved from the incomplete or preparatory phases of initially noncommunicative activities, such as attack and protective movements, as illustrated in the previous section.
Darwin's concept of facial displays as largely nonadaptive helped to advance his theory of evolution, as we have seen in the review of the literature, by presenting an instance of a supposedly nonadaptive yet evolved trait—something antithetical to a creationist view of anatomy or behavior. However, it proved detrimental to the study of facial expression.

Most modern researchers, including Paul Ekman and Alan Fridlund, who are two of the major researchers in the field, disagree with the idea of facial display as nonadaptive. Instead, they state that its function is to communicate what one intends to do (e.g., Fridlund's behavioral ecology view), (Fridlund, 1994), and/or to express emotion (e.g., Ekman's neurocultural theory) (Ekman, 1973a). Fridlund's theory emphasizes communication of social signals and gives little importance to the role of emotion. Ekman characterizes facial displays as displays of emotion, but does not discount the role of communication. Regardless of what researchers believe facial displays communicate, however, it is generally accepted that they are in fact communicative in function, and this idea is a central component in my approach to the study of facial behavior. Indeed, it is difficult to imagine characterizing them as adaptive if one does not view them as communicative.

In summary, based on the literature on the topic, we can theorize that facial displays are signals that evolved to communicate emotions and social intentions. Facial displays, verbal or auditory communication, prosody (nonverbal features of speech) and gestures which involve parts of the body other than the face, when considered together, form a multimodal communication system that allows the communicator to fine-tune the accuracy of his or her message and to ensure that, should one communication channel be unavailable, the communicator has an alternative option for sending the message. (For instance, if one were
attempting to communicate a message in the dark, facial and gestural cues would be unavailable, but verbal and prosodic channels could convey the message.)

The ability to communicate accurately confers a reproductive advantage in that an individual's ability to signal his or her own intent and to know the intent of another individual gives both individuals knowledge about the situation that might affect their actions and therefore their survival (Fridlund, 1994). For instance, if someone conveys through his or her face the fact that he or she is about to attack you, it is obviously in your best interests, in terms of survival and ultimately reproduction, to either defend yourself or run away – neither of which you would have known to do had you not seen and correctly interpreted the facial display as a forewarning of the action the other person was about to take.

**Facial Expressivity and Social Interaction**

The more facially expressive a person is in the sense of producing facial displays that are, to quote Schmidt, Cohn & Tian (2003) again, “conspicuous, stereotyped and redundant,” the better able he or she would be to communicate his or her intents or emotions. Additionally, displays that more accurately convey a person’s emotion or intent would be more conducive to promoting his or her social relations. “Accurate” facial displays would be those most commonly recognized as signaling a certain intent or emotion – i.e., those that conform more closely to the stereotyped form of that facial display. A greater capacity for communication, including facial displays, would confer a greater advantage for reproduction and survival.

We can also postulate that facial displays, as part of a multimodal communication system that also includes gestures and vocalizations (including language and prosody in humans), help to fine-tune messages and provide an additional context where they can be communicated, enabling better understanding of an individual’s intent. In addition to the benefits of greater
general facial expressivity, more accurate facial displays are more energetically efficient; if a message is communicated accurately and received correctly on the first attempt, the communicator uses up less energy in communicating.

However, to my knowledge, the correlation between greater general facial expressivity and better social interaction ("better" in that it is more frequent and better satisfies the interactor's social needs) that could be hypothesized from this theory has not been empirically tested. Obviously, we cannot test this for all stereotyped facial displays. Although most researchers agree on the six basic facial displays common to all people, the full extent and exact number of emotions and intents in social interaction that are expressed using the face is, and perhaps will remain, unknown. Trying to define operationally, measure and quantify all known stereotyped facial movements and their associated emotions and/or intents would be a difficult if not impossible task; culture-specific variations in elicitors of emotions and display rules would further complicate matters. It is thus necessary to test this hypothesis by choosing one or a few of the myriad facial displays in existence to measure.

In addition, there is no way of knowing for certain what a person's true emotion or social intent is; although self-report measures might allow some measurement of this, the possibilities exist that 1) subjects harbor emotions or intents of which they are not conscious or 2) subjects may deliberately misrepresent their emotion or social intent or the degree to which they are experiencing it. It is thus further necessary to include a subjective measure of general facial expressivity in addition to measuring a specific display or displays objectively.

From a methodological standpoint, it is important that the facial actions being measured satisfy two criteria. They must be nonposed, spontaneous signals of the emotion or social intent in question, as differences have been shown to exist between posed and spontaneous facial
displays. Additionally, posed facial displays, in which someone is asked to show what the display of a given emotion would look like, are affected by individuals' concepts of what joy or anger, for example, "should" look like, and thus by influences from their culture regarding what emotions are or are not appropriate to show. Posed facial displays reveal more about the displayers' acting abilities than they do about the underlying emotions or intents, and thus studying them is not very useful for learning about the relationship between facial display and emotion and/or intent. Culturally based concepts of facial displays cannot tell us much about the display's evolved biological basis, which is what the present study attempts to examine. Thus, the emotion or social intent whose associated display is to be studied must be something that a researcher can induce subjects to experience spontaneously in an experimental setting within the bounds of ethical research. To meet the second criterion, the display being studied should be a display on which previous research has been done, so the researcher can identify known characteristics of the display. For reasons that are discussed in more detail later, I have chosen to study the embarrassment display, which meets both of these criteria.

Subjective Measurement of General Facial Expressivity

A subjective measurement of general facial expressivity, to its disadvantage, necessarily includes some degree of subjectivity. However, it has the benefit of being able to be measured independently of assumptions about a subject's emotional state or social intent. Notarius & Levenson (1979), in coding subjects' degree of facial responsiveness to a video, utilized a scale from 0 to 10 to measure their subjects' facial expressiveness, and I utilized a similar scale. My scale took into account subjective frequency and intensity of all movements of the face and head, as well as subjective frequency and intensity of movements specific to the social and emotional context, i.e., non-Duchenne smiles and embarrassment displays.
My intent in including this measure was to minimize problems arising from several sources. I am relatively inexperienced in the use of specific systems such as FACS to code facial actions, and possible inaccuracy in the results arising from my own errors in coding was a concern. FACS certification requires extensive training, comprising a manual with lessons on individual facial movements, practice coding of still photographs and videos, and a final video-coding test. Additionally, as mentioned earlier, there is no way of providing a completely accurate assessment of a subject’s emotional or social intent, although self-report measures might be somewhat useful. A subjective measure of general facial expressivity would help to counteract problems arising from discrepancies, unknown to the researcher, between subjects’ facial displays and their social intents or emotional states.

Finally, I realized in the process of analyzing my results that I had neglected to include a measure of subjects’ internal state or social intent. Without such a measure, my coding of non-Duchenne smiles and embarrassment displays rested on an assumption that subjects all felt embarrassed, and felt embarrassed to the same degree, when asked to recount the story of an embarrassing experience. This, coupled with the uncertain reliability of my coding — which may have been reflected by the lack of strong correlations between non-Duchenne smiles and embarrassment displays per minute in my results - was ultimately what led me to include a subjective measure of subjects’ general facial expressivity based on their videos.

*The Smile as an Example*

The smile, because it has been extensively researched, is a good example of a specific facial display by which to explain facial displays as social signals. Some smiles, particularly Duchenne smiles (i.e., those which include the Duchenne marker, a cheek raise that wrinkles the corners of the eyes) are considered to express genuine happiness or joy. The non-Duchenne
smile, which does not include the Duchenne marker, is believed to act as a way of defusing tension, expressing agreement, or appeasing someone with whom one is interacting (Fridlund, 1994) (Prkachin & Silverman, 2002).

Appeasement displays also exist in species other than humans. Fridlund theorized that, since fighting and conflict can inflict both physical damage and damage to one’s social relationships, both of which threaten survival and reproduction, evolution would have equipped individuals with negotiation tools in the form of displays that can either indicate the intent to attack before the attack actually happens — giving the individual that would be attacked a chance to prepare and react — or that can allow individuals to repair social relations after an attack has occurred. Reconciliation among nonhuman primates, Fridlund says, is well-documented in the form of affiliative interactions with opponents or their relatives, regardless of dominance relations within the species (Fridlund, 1994).

Human smiling, write Schmidt & Cohn, is an example of an adaptive social signal with positive fitness consequences; they write on page 15 of their 2001 article on facial expressions as adaptations that “There is evidence to suggest that facial expressions function to increase cooperation and affiliation during interaction” (Schmidt & Cohn, 2001). Smiling is associated with happiness and increased sociability and tends to give others the impression that they are liked. Cases where a person does not smile or produce other facial expressions regularly or properly also help to illustrate this; people with flat affect (lack of, or minimal, facial expressivity) due to disorders such as schizophrenia, depression, Parkinson’s disease and facial paralysis tend to have social difficulties. Smiling affects, in particular, social variables such as status (Schmidt & Cohn, 2001). This influences fitness and reproductive success by affecting
one’s access to reproductive partners and the likelihood that others in one’s social group will share resources.

The Embarrassment Display

As I mentioned earlier, to empirically test the hypothesis that greater general facial expressivity is correlated with more satisfying and more frequent social interactions, I have chosen to study the embarrassment display because it 1) can be induced spontaneously in subjects and 2) has been the subject of previous research. Keltner has studied the embarrassment display extensively. He has identified a prototypical embarrassment display (Keltner, 1995) that consists of a gaze aversion, a smile control (i.e., an action of the lower face to inhibit the smile), a non-Duchenne smile (i.e., a smile that does not include the “Duchenne marker,” or the cheek raise producing wrinkling at the corners of the eyes), head movements down and to the left, a gaze shift, a second smile control, and a second gaze shift (Keltner & Buswell, 1996) (Keltner & Buswell, 1997). Keltner found that 46% of participants showed embarrassment displays that followed the prototypical pattern (Keltner, 1995).

Photos of the embarrassment display were identified as embarrassment by 51.3% to 55.9% of American observers (Keltner & Buswell, 1996) and by significant percentages of observers in both the U.S. and India in both forced-choice or closed-ended questions (those in which subjects selected choices from a predetermined list) and open-ended or free-response (those in which subjects gave their own answers) formats (Haidt & Keltner, 1999). This seems like a small number, but the ability of general observers to distinguish among embarrassment, guilt, and shame – three similar but distinct emotions which occur following perceived social or moral transgressions – may be a reason for this. The cross-culturally consistent recognition of
the embarrassment display provides evidence that the display itself is cross-culturally consistent, and therefore that it probably has a biological component.

Keltner and Anderson assert that embarrassment serves an appeasement function in that it helps in "reconciling social relations following transgressions of social norms" (Keltner & Anderson, 2000). Keltner and Buswell argue that embarrassment is a distinct emotion. Its antecedents (i.e., situations that produce it) generally involve the violation of a social convention, i.e., a "transgression" involving the "outer" or public self, rather than the "inner" or private self - in contrast to shame, which is evoked by "transgressions" involving the inner or core self, and guilt, which involves violations of moral norms (Keltner & Buswell, 1997). Evolutionary theory can be applied to embarrassment when one considers the possible consequences of ostracism or loss of social standing that may result from such "transgressions of social norms." Loss of or damage to one's social network leaves one vulnerable to a plethora of problems ranging from issues of physical survival to those of emotional health and support, all of which affect in some way the ability to survive and reproduce. Thus, from an evolutionary perspective, it would make sense that an adaptive mechanism to reconcile social relations following such transgressions - namely, embarrassment - exists.

The embarrassment display satisfies the first criterion in that it is easy to measure as a spontaneous facial display. It is a particularly apt facial display to study because, in theory, there would be no reason not to display embarrassment if one were feeling embarrassed. Because embarrassment, according to Keltner & Buswell's definition, involves "violations of social conventions that increase social exposure" (Keltner & Buswell, 1997), it is rarely, if ever, advantageous not to show it where it might help to repair social relations potentially damaged by whatever violation led to the displayer's feeling embarrassed. It is thus easy for the researcher to
observe embarrassment — in the majority of cases, the presence of an embarrassment display implies that the displayer is actually feeling embarrassment, and vice versa.

Although limited research (Haidt & Keltner, 1999) shows evidence for cross-cultural consistency of the existence of embarrassment and the form of its display (to be discussed in more detail later), as well as the presence of embarrassment-related behaviors in non-human species, social norms — and thus the actions that violate them — vary widely among societies. Thus, any biologically based adaptive component to embarrassment would have to involve a general vigilance for, and tendency to follow, social norms, as well as a stereotyped display associated with reconciling social norms following transgressions of such norms, rather than a propensity toward specific behaviors.

As discussed earlier, the embarrassment display is appropriate for the current study examining the relationship between facial expressivity and social interaction because it can be easily induced in a laboratory setting and, as Keltner’s research shows, it has been studied in previous research. Subjects can be asked to relate an embarrassing event to an investigator; discussing the event may in itself be an easy way for a researcher to evoke spontaneous embarrassment. Keltner’s and others’ research provides sufficient background information to identify a consistent set of antecedents, form, and function within social interactions for the embarrassment display.

One way to measure the display of embarrassment is by identifying the presence of a non-Duchenne smile, the “appeasement” or “social” smile — distinguished from the Duchenne smile, which is often considered to be the display by which genuine happiness or joy is expressed. The non-Duchenne smile, it is believed, may function to defuse tension or express agreement when the topic of conversation is negative (as in, often, when one is talking about
something embarrassing one has done or experienced) (Fridlund, 1994) (Prkachin & Silverman, 2002). Since smiles have been extensively researched as facial displays, the presence of a non-Duchenne smile in the context of the complete display theorized to be unique to embarrassment might be a good way for a researcher to assess embarrassment. The frequency of non-Duchenne smiles can also be used as a way to assess embarrassment subjectively.

**Hypothesis**

In light of Keltner’s findings and general findings on the social functions and evolutionary origins of facial expressions, I propose that people who are more facially expressive, i.e., those who produce more frequent facial movements that are appropriate to the social context, will be able to communicate their social needs better and thus will have a better chance of having them met. Consequently, they will be more likely to report that their social interactions are more frequent and more satisfying than will less facially expressive people.

I will focus on the embarrassment display, including the non-Duchenne smile, as a specific means of testing this hypothesis. I will, additionally, include a subjective measure of facial expressivity as a means of testing the hypothesis.

Additionally, I am interested by Keltner’s claim (Keltner, 1995) that only 46% of people, when apparently embarrassed, display this sequence of behaviors that is cross-culturally recognized as embarrassment. Cross-cultural consistency and a stereotyped form of the display imply some biological basis, and the fact that nearly half of participants displayed embarrassment in the same way shows that the display was not produced by chance. However, if the embarrassment display is evolved, it should be much more widespread than this – virtually everyone with normal facial movement and emotional capacities should show it in some circumstances. Do the 46% of people who show the display when embarrassed have some
advantage in terms of social interaction over the rest, who do not — or did those who did not show the display in Keltner’s experiments simply not show embarrassment because they did not feel embarrassed by the situation in Keltner’s experiment?

In order to avoid this problem in my research and ensure that subjects whose expressed embarrassment I was assessing actually felt embarrassed, I allowed subjects to self-define embarrassment by having them relate the story of an event that they considered embarrassing.

Methods

I obtained approval for the project as an expedited review from the Institutional Review Board for the Protection of Human Subjects (IRB) at IUP. I obtained permission for the collection of data on subjects’ facial movements and self-reported social interactions for the period of March 10, 2006 to March 10, 2007. (See Appendix C for the specific forms used to collect data.) Nineteen volunteer subjects were recruited between March and November 2006 from among my classmates, co-workers, and peers and from summer and fall 2006 sections of the Contemporary Anthropology (ANTH110) courses at Indiana University of Pennsylvania (IUP).

All subjects were women over the age of 18 who indicated they had not experienced any facial movement disorders (e.g., Bell’s palsy, facial nerve disorder, etc.). I chose to recruit only female subjects because previous research has indicated differences in patterns of facial expressivity between men and women (Chovil, 1991). Because of these differences, failing to control for gender might introduce confounds in regards to data analysis, the results of the research, and the study’s external validity.
There are several reasons why the final number of subjects from whom data was collected was not higher. For one thing, my method of selecting subjects consisted of asking classmates, co-workers, peers and students in anthropology courses if they would like to participate. Using a broader selection method, such as e-mailing information about the survey to IUP students, might have yielded a higher number of subjects.

Additionally, subject attrition rates proved to be high throughout the project – about half of those who initially expressed interest in being subjects did not complete the study.

Attrition occurred for various reasons. Some people expressed interest, but did not complete a consent form, so they could not begin the study. Others chose, after completing part of the study, not to finish it. In one case, a subject completed the study, but the data had to be excluded because the subject failed to indicate satisfaction scores for any of the seven days of the sociality questionnaire.

Subject attrition was likely high because of the involved nature of the study; subjects had to complete seven forms as well as schedule a video, which presented a challenge considering the fact that many students have very busy schedules. This may have introduced some element of self-selection bias into the research. Those subjects who remained in the study may have differed in some way from those who did not, such as having fewer scheduling commitments or a greater interest in the research and thus more willingness to commit to participating.

There is likely no way to resolve these problems in regards to the current study; however, it is important that the reader be aware of potential problems with the data that are associated with it.

This number of subjects, however, was sufficient to conduct between-subjects comparisons. Prior to subject recruitment, a list of subject numbers – one which would
correspond to each subject — was developed for purposes of maintaining confidentiality of the data in storage.

When I completed the analysis, I assigned each subject a new subject number so the numbers would be sequential, as the high subject attrition rates described earlier led to gaps in the numbering of subjects. Although no subject numbers appear in the thesis (other than in Appendix D), I have recorded each subject's original as well as new subject number in my data.

Questionnaire

To reduce errors in self-report, subjects were asked to complete a series of seven identical questionnaires, one for each of seven consecutive days, describing their social interactions. The repeated questionnaires were necessary to get a picture of a subject's typical social interaction patterns, better indicated by analyzing multiple days than only one day which may have included events or interactions atypical for that subject, and to minimize errors resulting from self-report.

Social interaction was defined as any voluntary (as opposed to mandatory for school or work, e.g., a scheduled meeting with a professor or talking to customers for a job) contact with other people. This was because such nonvoluntary interactions are typically conducted for purposes other than meeting one's social needs.

The variables measured in the questionnaire component of the study were as follows (see Appendix C for a copy of the questionnaire used):

Social interaction. Subjects were asked to describe each social interaction briefly in free-response format.

Sociality. This was reported per interaction. Subjects rated each interaction using a four-point Likert scale ranging from 1 (least social) to 4 (most social), self-reported by the subject. Sociality categories were adapted from Chovil (1991).
Because Chovil’s study occurred in a carefully controlled experimental context, it did not include additional forms of social interaction, such as computer-based communication, which I had to take into consideration in creating self-report questionnaires.

Additionally, Chovil measured subjects’ facial behaviors when hearing another person speak rather than when subjects themselves were speaking, which my study measured. The categories on the sociality scale were as follows:

- 1: Situations in which the person a subject was interacting with was neither physically present or responding immediately; for instance, an e-mail message or written letter.
- 2: Situations in which the people with whom the subject was interacting were not physically present and the two people could not hear one another’s voices, but in which communication took place instantly; for example, instant messaging or chat rooms.
- 3: Situations in which the subject and the person with whom she was interacting could hear one another’s voices and communicate instantly; for example, talking on the phone.
- 4: Situations in which the subject engaged in face-to-face interaction.

**Length of time (minutes).** This was reported per interaction. Subjects indicated the length of time during which they participated in a given interaction. This was self-reported by the subject.

**Total number of people interacted with.** This was reported per interaction. Subjects reported the number of people with whom they interacted during a given interaction. This was self-reported by the subject.
Planned/unplanned interaction. This was reported per interaction. Subjects indicated whether each interaction in which they engaged was planned or unplanned.

Satisfaction with social interaction. This was reported per day. Subjects indicated, on a five-point Likert scale, the degree of satisfaction, from 0 (least satisfied) to 5 (most satisfied) that they felt based on the total of their social interactions for a given day. Measures of satisfaction with social interaction were adapted from a scale by Wikstrom (Wikstrom, 2002); the number of potential levels of satisfaction was increased from 4 levels, as Wikstrom’s scale used, to 6 levels, as my scale used, in order to make ratings more specific.

Total number of interactions. This was reported per subject. When I conducted the data analysis, I added each subject’s total number of interactions (excluding those that were edited out because of uncodable responses; see Appendix D for a list of these).

Videotape

In the videotape component of the study, I looked at subjects’ facial displays associated with embarrassment, as described earlier, including 1) the embarrassment display as studied by Keltner and others, and 2) the non-Duchenne smile. As the non-Duchenne smile is a component of the embarrassment display, it was expected that these measures would be correlated. Although the non-Duchenne smiles are a component of the embarrassment display, they were included because they might on their own reveal something of interest in relation to the study. Subject videos varied in length, so these two measures are given in the analysis as per-minute averages of the numbers of non-Duchenne smiles and embarrassment displays. I also included a subjective measure of general facial expressivity for each subject.

Digital recording of subjects took place on a MiniDV camera in either the Indiana University of Pennsylvania library group study rooms or in Indiana University of Pennsylvania
residence hall study lounges. These settings were selected to minimize potential distraction caused by other people or objects in the room. Videotapes of each subject were made for the purpose of analyzing subjects’ facial movements.

Subjects were instructed to relate a story of an embarrassing event that happened to them recently. As described earlier in this paper, Keltner and Anderson (2000), Keltner and Buswell (1997), and Keltner (1995) have documented a stereotyped display, which they theorize has an appeasement function, including a non-Duchenne (zygomaticus major activity without orbicularis oculi activity, or in Paul Ekman’s Facial Action Coding Syndrome, AU 12 without 6 or 6+7) smile with smile control associated with relating past embarrassing events. Keltner (1995) found that this display seems to be produced by about 46 percent of embarrassed participants.

Variables analyzed in the videotape component of the study were based on researcher observation of subject videos. These variables are as follows (see Appendix C for a copy of the script used by the researcher prior to each video, as well as a copy of the post-study debriefing sheet that was given to subjects)

Sociality. Prior to subject selection, each subject number was randomly assigned to a “solitary” or “social” condition for the video component of the research. The definitions of “solitary” and “social” were adapted from Schmidt, Cohn & Tian (2003). Although the definitions were the same, the procedures used were different – Schmidt et al.’s study involved subjects in the solitary condition watching a video, rather than responding to a prompt, in a room alone, and subjects in the social condition seated face-to-face with an interviewer and responding to the interviewer’s questions (Schmidt et al., 2003).
For this study, the solitary condition involved subjects first reading a sheet of paper with the prompt for the video (see Appendix C), then waiting for the researcher to leave the room after beginning recording. Subjects then described their embarrassing events while in a room alone. In the social condition, I read the prompt to the subject, then began recording and sat face-to-face with subjects as they described their embarrassing event.

Prior research (Chovil, 1991; Schmidt et al., 2003) has indicated a difference in facial expressivity between solitary and social situations, even within the same individual. For purposes of analysis in SPSS, and on the tables in Appendix A, the solitary condition has been indicated as 0 and the social condition as 1. Of the 19 subjects who completed the study, 10 were assigned to the social and 9 to the solitary condition.

**Length of video.** This was reported per subject. This indicates, in minutes and seconds, the length of time for which a subject’s face was visible during a video.

**Number of embarrassment displays per minute.** This was reported per subject. This represented the number of embarrassment displays divided by the length of a subject’s video.

**Number of non-Duchenne smiles per minute.** This was reported per subject. This indicates the number of non-Duchenne smiles divided by the length of a subject’s video.

**Expressivity.** This was reported per subject. This is a subjective rating from 0 (least expressive) to 10 (most expressive), as per Notarius & Levenson’s (1978) definition, indicating a subject’s degree of facial expressivity.

**Analysis**

In the analysis, I examined correlations among variables in the questionnaire and variables in the video component of the study. Bivariate correlations were performed among all variables. I conducted three sets of analyses: one including all subjects regardless of video
sociality condition, one including only subjects in the social video condition, and one including only subjects in the solitary video condition. The correlations I have selected for discussion in the results section are the most relevant given the findings of previous literature on the subject; a complete list of correlations is included in Appendix A. All per-subject and per-day variables were averaged into a single, per-subject number for each variable. (These averaged values are assumed to be representative of a typical interaction and/or a typical day for that subject.) Additionally, all unusable data (i.e., any interaction including values that were missing, out-of-range, etc. – for instance, sociality coded as 5 – was edited out for the final analysis, and interaction numbers were shifted to reflect this. See list of edits (Appendix D) for an explanation of how and why each edit was done. Measures of frequency of social interaction include total number of interactions and average length of time per interaction. Measures of expressivity include subjective expressivity score, number of non-Duchenne smiles per minute, and number of embarrassment displays per minute. Because of the small sample size, a p-value of .1 was considered significant, rather than the standard alpha level of .05.

Results

Overall Analysis

Table 1. Overall (social and solitary conditions) analysis of correlations among relevant variables

<table>
<thead>
<tr>
<th>Questionnaire Variables</th>
<th>Expressivity</th>
<th>Number of non-Duchenne smiles/minute</th>
<th>Number of embarrassment displays/minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average satisfaction with social interaction</td>
<td>.388/.100*</td>
<td>.126/.607</td>
<td>.071/.773</td>
</tr>
<tr>
<td>Total number of interactions</td>
<td>.324/.176</td>
<td>.225/.355</td>
<td>-.279/.247</td>
</tr>
<tr>
<td>Average length of interactions</td>
<td>.199/.414</td>
<td>-.491/.033**</td>
<td>-.134/.584</td>
</tr>
</tbody>
</table>

*p .1; ** p .05, all two-tailed. Correlations are given as Pearson's r, followed by p-value.
Measures of expressivity and satisfaction with social interaction. A correlation between subjective expressivity score and satisfaction with social interaction was significant at the .1 level \( (r = .388, p = .100) \). Per-minute measurements of individual facial movements, including non-Duchenne smiles per minute and embarrassment displays per minute, were not significantly correlated with satisfaction with social interaction \( (r = .126, p = .607) \) for non-Duchenne smiles per minute and \( r = .071, p = .773 \) for embarrassment displays per minute).

Measures of expressivity and measures of frequency of social interaction. Total number of interactions per subject was not significantly correlated with subjective expressivity score \( (r = .324, p = .176) \), with non-Duchenne smiles per minute \( (r = .225, p = .355) \), or with embarrassment displays per minute \( (r = .279, p = .247) \). Average interaction length was not significantly correlated with subjective expressivity score \( (r = .199, p = .414) \) or with embarrassment displays per minute \( (r = .134, p = .584) \), but was significantly negatively correlated with non-Duchenne smiles per minute, a correlation that was significant at the .05 level \( (r = -.491, p = .033) \).

Analysis of Results in Social vs. Solitary Conditions

Table 2. Analysis of correlations among relevant variables for subjects in the social condition only

<table>
<thead>
<tr>
<th>Questionnaire Variables</th>
<th>Expressivity</th>
<th>Videotape Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number of non-Duchenne smiles/minute</td>
</tr>
<tr>
<td>Satisfaction with social interaction</td>
<td>.418/.230</td>
<td>.064/.860</td>
</tr>
<tr>
<td>Total number of interactions</td>
<td>.481/.160</td>
<td>.132/.715</td>
</tr>
<tr>
<td>Average length of interactions</td>
<td>.051/.888</td>
<td>.012/.974</td>
</tr>
</tbody>
</table>

Correlations are given as Pearson's \( r \), followed by \( p \)-value.
In the overall analysis, significant correlations were found between sociality condition (social versus solitary, with an 0 indicating solitary and a 1 indicating social) and two of the expressivity measures, non-Duchenne smiles per minute ($r = .571, p = .011$) and embarrassment displays per minute ($r = .497, p = .030$). (See Appendix A for these results.) No significant correlation was found between subjective expressivity score and sociality condition ($r = .151, p = .536$). This finding was consistent with previous research (Chovil, 1991) that found that in situations that were more social, subjects tended to produce more frequent facial displays. In light of this finding and the fact that sociality condition was a variable manipulated by the researcher, separate analyses of subjects in the social condition and subjects in the solitary conditions were performed based on the hypothesis that significant correlations between measures of subjects’ facial expressivity, satisfaction with social interaction and frequency of social interaction might be easier to identify if the sociality condition were held constant. The hypothesis was that with subjects in the social condition, expressivity would be more pronounced and correlations would be stronger.

Social condition. For subjects videotaped in the social condition, satisfaction with social interaction was not significantly correlated with subjective expressivity score ($r = .418, p = .230$), with non-Duchenne smiles per minute ($r = .064, p = .860$), or with embarrassment displays per minute ($r = .287, p = .421$). For subjects videotaped in the social condition, subjective
expressivity score was not significantly correlated with total number of interactions ($r = .481, p = .160$) or with average interaction length ($r = .051, p = .888$). For subjects videotaped in the social condition, expressivity as measured by non-Duchenne smiles per minute was not significantly correlated with total number of interactions ($r = .132, p = .715$) or with average interaction length ($r = .012, p = .974$). Expressivity as measured by embarrassment displays per minute was not significantly correlated with total number of interactions ($r = -.415, p = .233$) or with average interaction length ($r = .202, p = .576$).

**Solitary condition.** For subjects videotaped in the solitary condition, satisfaction with social interaction was not significantly correlated with subjective expressivity score ($r = .312, p = .414$) or with non-Duchenne smiles per minute ($r = -.052, p = .895$). Satisfaction with social interaction was significantly *negatively* correlated with embarrassment displays per minute at the .1 level ($r = -.623, p = .073$). For subjects videotaped in the solitary condition, non-Duchenne smiles per minute was not significantly correlated with total number of interactions ($r = .399, p = .288$), but was significantly *negatively* correlated with average interaction length, a correlation that was significant at the .05 level ($r = -.730, p = .026$). For subjects videotaped in the solitary condition, embarrassment displays per minute was not significantly correlated with total number of interactions ($r = -.254, p = .509$) or with average interaction length ($r = -.115, p = .768$).

**Discussion**

**Summary of Results and Interpretation**

I hypothesized that people who were more facially expressive, or showed a higher degree of general facial expressivity (as measured in this study by subjective expressivity score, number of non-Duchenne smiles per minute and number of embarrassment displays per minute) would
have more satisfying social interactions (as self-reported on a scale by subjects) and more frequent social interactions (as measured by average length of time per social interaction and total number of interactions per subject). As stated in the Methods section, I conducted three sets of analyses – one including all subjects, one including only subjects in the social condition, and one including only subjects in the solitary condition.

**Expressivity variables and satisfaction with social interaction.** Of the three variables measuring general facial expressivity, only one, subjective expressivity score, was significantly correlated in the overall analysis with subjects’ self-reported satisfaction with their social interactions, and this correlation was marginal ($r = .388, p = .1$). This represented the only correlation throughout the results that was consistent with the hypothesis. Although it is a weak correlation, repeating the study with a larger sample size might provide confirmation that it is significant.

Subjects were separated by video sociality condition (see Methods). In the social condition, none of the three general facial expressivity variables was significantly correlated with subjects’ self-reported satisfaction with their social interaction. In the solitary condition, neither subjective expressivity score nor number of non-Duchenne smiles per minute was significantly correlated with subjects’ satisfaction with their social interaction, but number of embarrassment displays per minute was significantly negatively correlated with satisfaction with social interaction. This correlation, however, was also marginal ($r = -.623, p = .073$). One explanation for this might be that producing facial displays uses energy, and using energy unnecessarily – e.g., when producing facial displays in a nonsocial context – might create a disadvantage.

Although it is not directly related to the hypothesis, an additional interesting finding to note is that 17 of the 19 subjects produced at least one embarrassment display. This is inconsistent with Keltner’s finding that only about 46 percent of people appear to produce these
displays when embarrassed. This inconsistency can likely be explained by differences between the coding used in this study and the coding used in Keltner's research – i.e., Keltner used FACS and other more sophisticated coding methods, whereas I did not. As FACS is an extensively tested, objective coding system, it is likely that Keltner's analysis is more accurate than mine, and future research should incorporate standard, reliable coding systems like this.

The analysis did not indicate a correlation, or results approaching one, between non-Duchenne smiles per minute and satisfaction with social interaction in any of the analyses. It is unclear why this was. It is possible that the non-Duchenne smile as an indicator of subjects' embarrassment is, on its own, not as accurate an indicator of subjects' expressivity as is the full embarrassment display or the subjective expressivity score. Indeed, the non-Duchenne smile is only one component of the embarrassment display. On its own, it has been theorized to mean a lot of things, among them being desire to appease or please another and desire to interact (Fridlund, 1994). It is also possible that this finding is attributable to researcher error.

Expressivity variables and frequency of social interaction. Results of correlation analyses between variables measuring general facial expressivity and variables measuring frequency of social interaction did not support the hypothesis. None of the three variables measuring general facial expressivity was, in the overall analysis, the analysis of subjects in the social condition, or the analysis of subjects in the solitary condition, significantly correlated with subjects' total number of social interactions. Average interaction length was not significantly correlated with subjective expressivity score or number of embarrassment displays per minute in any of the analyses.

However, both the overall analysis and the analysis of subjects in the solitary condition revealed a significant negative correlation between average interaction length and number of
non-Duchenne smiles per minute ($r = .491, p = .033$ in the overall analysis, and $r = .730, p = .026$ in the solitary condition). In the social condition, average interaction length and number of non-Duchenne smiles per minute were not significantly correlated.

This finding suggests that people who are more facially expressive, as measured by non-Duchenne smiles per minute, tend to have, on average, shorter social interactions. As mentioned above, this may not be directly related to the hypothesis, as my study dealt with facial displays of embarrassment, and non-Duchenne smiles alone may not be a very accurate indicator of embarrassment. However, given the strength of the correlation between non-Duchenne smiles per minute and average length of social interaction in both the overall analysis and the solitary condition – these two correlations were, in fact, the two strongest among those in the relevant results – it is likely worth exploring this further.

There are several things this finding could indicate. It is unclear what, exactly, shorter interactions mean in relation to the study – one possibility is that subjects’ individual interactions are shorter, but that they have a greater number of individual interactions. The results, however, do not indicate anything to support this. Another, and more likely, possibility is that these shorter average interactions may indicate that people who are more facially expressive tend to have interactions that are more superficial – for instance, greeting someone briefly as opposed to having a longer conversation. However, the study did not include a way of measuring how meaningful an interaction was; this might provide an interesting direction for future research. A third possibility is that these correlations are simply due to random chance, which is feasible given the small sample size.

An additional interesting finding in regards to the correlation between average interaction length and number of non-Duchenne smiles per minute was that the correlation between the two
variables, significant in both the overall analysis and the analysis of subjects in the solitary condition, was virtually zero. The negative correlation between average length of interactions and number of non-Duchenne smiles per minute, apparent in the solitary condition, was consistent with the finding in the overall analysis and actually seemed to show a stronger correlation between the two variables. It is unclear why this was evident in subjects videotaped in the solitary, but not the social, condition.

Problems

One problem was that results were for the most part inconsistent between the overall analysis and the analyses by sociality condition. I had hypothesized that, as found in previous research (Chovil, 1991), subjects would be more facially expressive in the social condition, and any correlations found in the overall analysis would become more apparent in the analysis of subjects in the social condition. However, this was not the case. The most likely explanation for these inconsistencies is the small sample size. The correlations found seem to be weak even in the overall analysis, and reducing the sample size to only 10 subjects for the social condition and 9 for the solitary condition likely rendered the sample too small to produce significant results.

Another consideration is that the sociality condition may have influenced subjects’ performance. Although both sociality conditions took place in the same type of setting – a library study room or residence hall study lounge, depending on what was available – there is the possibility that subjects may have perceived the solitary setting as more lab-like, whereas the social condition might have been perceived as more informal and more closely resembling a real-life social interaction.

Additionally, some subjects mentioned that the situation itself may have been perceived as somewhat awkward and embarrassing, particularly in the solitary condition, in which subjects
were in a room alone talking into a camera. This may have created a confound between the embarrassment evoked by recounting an embarrassing moment and the embarrassment created by the “lab” setting, and may have led to an increase in embarrassment displays and embarrassment-related movements, particularly among subjects in the solitary condition, that were due to the experimental setting rather than the topic of conversation.

Perhaps the most significant problem, however, was the wide discrepancy across the three measures of general facial expressivity in degree of correlation with satisfaction and frequency measures. As many facial movements are thought to be redundant (Schmidt et al., 2003), the overall degree of a subject’s expressivity as measured by a subjective scale would be expected to correlate with the number of facial displays appropriate to the social/emotional context that the subject produced.

However, this was not the case. In the overall analysis, embarrassment displays per minute and non-Duchenne smiles per minute are significantly correlated with one another ($r = .488, p = .034$; see Appendix A for these results). This is probably because the non-Duchenne smile is a component of the embarrassment display. However, neither is correlated with subjective expressivity ($r = .153, p = .532$ in the case of embarrassment displays per minute and $r = .142, p = .561$ in the case of non-Duchenne smiles per minute; see Appendix A for these results).

The implication, based on these results, is that the subjective expressivity score and the objectively coded number of individual facial movements, including embarrassment displays per minute and non-Duchenne smiles per minute, are actually measuring two different things. The question is thus raised as to which of the three measures provides the most accurate assessment of general facial expressivity.
One reason for this inconsistency could be my failure to assess the degree to which subjects actually felt embarrassed when recalling the antecedent of their embarrassment. The assumption that all subjects actually felt embarrassed, and that all felt equally embarrassed, represents a serious oversight on my part in the methods of data collection. If a subject is feeling emotions at the same level of intensity, the subject's overall degree of general facial expressivity would likely remain constant regardless of what specific emotion she is feeling or social intent she is trying to convey, but the rate of production of specific facial movements would no doubt differ depending on the subject's internal emotional state and social intent. Future studies should include an assessment of a subject's internal emotional state and social intent as well as the intensity thereof.

The results imply that the discrepancy among the three expressivity measures resulted from a faulty assumption about the subjects' internal states or social intents — that is to say, the experimental design assumed all subjects felt embarrassed, and felt embarrassed to a similar degree, when recalling the antecedents of embarrassment. As discussed in the hypothesis section, one problem with previous research that I had hoped to overcome was that of whether subjects actually felt embarrassed — something which previous research appeared not to address. I attempted to overcome this problem by allowing subjects to self-define embarrassment. However, my method of doing this contained the assumption discussed above, which rendered this attempt unsuccessful.

If we can conclude that the expressivity measures, intended to be three ways of measuring the same quality, measure in fact two or more different qualities, the interpretation of the results then depends on which measure is the most accurate.
In light of the assumption described above and the associated problems with using non-Duchenne smiles or embarrassment displays per minute as a reliable indicator of a subject's expressivity, it is likely that the subjective expressivity score represents the best measure of a subject's general facial expressivity, as it is the only one of the three measures that is independent of this assumption. If this is the case, the hypothesis appears to be supported by the results.

It is alternatively possible that the objective measures of facial movements are the most accurate measures of general facial expressivity. If this is the case, the hypothesis is in fact refuted.

If, in fact, none of the three measures is truly accurate, the results can be taken as inconclusive, and the study should be repeated using a more accurate measure of facial expressivity and questions designed to clarify a subject's internal state and social intent, such as a self-reported scale of how embarrassed a subject felt, to overcome the problems with the current study as well as with previous research.

The measurement of subjects' social needs, assessed in this study by measuring their satisfaction with their social interaction, is another area that might be improved upon in future research. One possibility might be including a measurement of extraversion, such as the NEO-PI-R Introversion-Extraversion subscale, which has been used to measure sociability and need for social stimulation (Costa & McCrae, 1992) or the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975). Other standardized measures of social needs and the degree to which they are being met -- for instance, a measure of loneliness such as the UCLA Loneliness Scale (Russell, 1996) -- might help to better assess 1) subjects' social needs and 2) how effective subjects' social interactions are at meeting their social needs. Directly assessing subjects'
effectiveness at meeting their social needs, as measured by more specific instruments such as those mentioned above, might provide a more accurate measure than simply asking subjects whether they are satisfied with their social interactions.

Allowing subjects to self-report data, as I did in the questionnaire component of the study, has a number of inherent problems that may have skewed the results, and this may explain the fact that correlations consistent with the hypotheses seem to be weak at best.

Some measures, including the scaled measures of satisfaction and, often, sociality, were subjective and thus affected by individual subjects' perceptions, which may have differed. A number of interactions (see Appendix D for a list of these) were edited out completely due to uncodable responses.

Additionally, self-report of interactions was dependent upon what individual subjects defined as an “interaction,” which, I discovered, often varied widely.

Finally, I collected data on a number of variables that I included in the correlation analyses (see Appendix A), but ended up not mentioning in the Results section because the variables either turned out to be irrelevant to the hypothesis, or were measured in such a way that the meaningfulness of results was questionable. These included total number of people interacted with, sociality of interactions, and whether interactions were planned or unplanned.

While including these extraneous variables in the study did not directly impact the results of other correlations, their presence made the study more complicated and time-consuming for the subjects completing questionnaires as well as for myself as I completed the analysis. Future studies in this area should include only variables that are directly relevant to the hypothesis so as to minimize confounds and cut down on the investment of time and energy for both subjects and researcher(s).
Alternative explanations

Although the fact that the results did not support the hypothesis is likely due to the problems described above, several alternative explanations are theoretically possible. My hypothesis is based on assumptions from the field of evolutionary psychology – namely, that 1) aspects of human behavior are shaped by the need to survive and reproduce; 2) the ability to function in social situations is a vital component of the ability to survive and reproduce; 3) facial behavior is an important part of social functioning; 4) facial behavior is shaped, at least in part, by evolutionary forces; and 5) satisfaction with social interaction, or congruence between one’s social needs and one’s social interactions, is an accurate indicator that one is behaving adaptively.

One possibility is that the study’s results did not support the hypothesis because evolutionary psychology is an invalid theoretical paradigm, although it is unlikely that this is the case.

Another is that evolutionary psychology is in fact a valid paradigm, but that my assumptions about the evolutionary reasons for the relationships between facial behavior and social interaction are inaccurate. I assumed in the Justification and Hypothesis section, for instance, that it would always be advantageous to show embarrassment if one felt embarrassed, because it is theorized to be a means of repairing social interactions damaged by violations of social norms (Keltner & Buswell, 1997). In addition, I measured subjective expressivity, which could include expressivity in situations where it is not necessarily advantageous to be more facially expressive (e.g., when one is lying and is trying not to let it show on his or her face).

There is thus the possibility that there are situations in which being less facially expressive might be more advantageous, and in these situations, being more facially expressive might not be associated with more satisfying social interactions. Future studies should address these possibilities.
Conclusion

The results seem to suggest that expressivity as measured by a subjective score may be weakly correlated with satisfaction with social interaction. Expressivity as measured by the number of facial movements relevant to the social context is either not correlated with satisfaction with social interaction, or was not accurately measured in the current study. Expressivity is likely either not correlated, or negatively correlated, with frequency of social interaction.

Repeating this study with a larger sample size and with more reliability coding might help to clarify whether there are, in fact, correlations between these variables. In addition, more accurate assessments of variables, as described in the Discussion section, might help to clarify the relationship between general facial expressivity and social interaction patterns. For the questionnaire component of the study, self-report measures might be enhanced with the addition of an observation component of the study – for instance, observing subjects at random times throughout the day or having a researcher follow subjects for a day. Additional satisfaction measures, such as the NEO-PI-R, Eysenck Personality Inventory and UCLA Loneliness Scale mentioned in the Discussion section, might be included to help elucidate this otherwise vague concept, or subjects might simply be asked, for instance, to what degree they felt lonely, overwhelmed by too much social interaction, etc. based on that day’s social interactions. A per-interaction measure of satisfaction with social interaction, in addition to, or in place of, the existing per-day measure, might also be included.

For the video component of the study, future studies in this area should include self-report measures of subjects' emotional state and/or social intent in order to remedy problems
with consistency between emotional state and/or social intent and outward expression, discussed in the Justification and Hypothesis and Discussion sections, that appear to be present in both the current study and previous research. A more consistent setting might also be helpful (i.e., doing all videos in the same room versus different rooms that are similar). Finally, it might be useful to analyze the video portion of the study using a standard coding system such as FACS to lessen the subjectivity present in the current study.

References


## Appendix A: Complete Results (see Appendix B for abbreviations)

### Overall Results

#### Correlations

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a. Cannot be computed because at least one of the variables is constant.
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* Correlation is significant at the 0.05 level (2-tailed).
Variables Analyzed

Variables are listed here by SPSS designation, followed by full variable name (in parentheses) and definition/explanation.

Questionnaire Variables

SOCQ (Questionnaire Sociality): This value represents the average of sociality ratings over all individual interactions for each subject. On the questionnaire, each individual interaction received a subjective sociality rating from 1 to 4, self-reported by the subject.

INTLENGTH (Length of Interaction): This value represents the average length of time of all of a subject’s interactions. Subjects self-reported the length of time for which they participated in each interaction.

PEOPLE (Number of People Interacted With): This value indicates the average number of people a subject interacted with during an individual interaction. Subjects self-reported the number of people with whom they interacted during each interaction; this was averaged over each subject’s number of interactions to obtain a single value for each subject.

INTTOTAL (Total Number of Interactions): This value represents the total number of interactions a subject had.

PU (Planned/Unplanned): This value indicates the average degree of “planned-ness” for all of a subject’s interactions; the closer to 0, the more planned interactions a subject had. Subjects reported whether each interaction they had was planned ahead of time or unplanned (i.e., spontaneous). These were converted to numbers for the data analysis - a value of 0 indicated a planned interaction while 1 indicated an unplanned interaction.

SATIS (Satisfaction): This value indicates a subject’s average degree of satisfaction with her social interactions. Subjects self-reported a subjective score, from 1 to 5, each day to indicate their satisfaction with the total of their interactions that day. These values were averaged based on the number of days (usually 7) for which a subject provided scores.

Video Variables

SOCV (Video Sociality): This indicates whether a subject was assigned to the social or the solitary video condition. These were converted to numbers for the data analysis - a value of 0 indicates that the subject was assigned to the solitary condition, while a value of 1 indicates that the subject was assigned to the social condition.

VIDLNGTH (Video Length): This indicates the length of time, in minutes and seconds, for which a subject’s face was visible during her video.
NDSMIN (Non-Duchenne Smiles per Minute): This indicates the average number of non-Duchenne smiles per minute a subject displayed per minute in her video; this was obtained by dividing non-Duchenne smiles by video length.

EMDISMIN (Embarrassment Displays per Minute): This indicates the average number of embarrassment displays (as per Keltner’s definition) a subject displayed per minute in her video; this was obtained by dividing embarrassment displays by video length.

EXPRESS (Expressivity): This is a subjective rating from 0 to 10, as per Notarius & Levenson’s (1978) definition, indicating a subject’s degree of expressivity based on her video.
Debriefing

For the study you have just participated in, we measured the frequency of your social interaction, the types of social interactions in which you participate in a typical week, the number of people you interact with in a typical week, and your satisfaction with these social interactions. We also measured your patterns of facial movement after being asked to describe a recent embarrassing event. Specifically, we will be recording the number of and length of smiles you produce in your recording. In explaining the study, I did not specify what facial movements would be recorded because this would make participants self-conscious about their facial movements and possibly bias the results. Previous research has suggested a facial display associated with embarrassment that includes a non-Duchenne smile, which is typically defined as the upward movement of the lip corners without wrinkling at the corners of the eyes, like this [demonstrate a non-Duchenne smile]. This facial behavior is also sometimes called an appeasement smile because it is theorized that its function is to appease others with whom a person is interacting. When it is associated with embarrassment, which researchers theorize often follows an event involving real or perceived breaking of the norms that govern social interactions, the appeasement smile makes it likely that the person with whom one is interacting will “forgive” whatever norm violation led to the embarrassment.

Additionally, researchers have proposed evolutionary accounts of facial movement that theorize that facial displays (I avoid using the term “facial expressions” because it implies the expression of an emotional state when not all researchers agree that this is the case) are evolved signals that mediate social interaction. Thus, what I am testing in this study is whether people who produce more frequent and longer non-Duchenne smiles when the social situation is appropriate have more social interactions with more people and whether they are more satisfied in their social interactions.

This research may be published in scientific journals or presented at scientific meetings, but your identity will be kept strictly confidential. If you would like a copy of the completed thesis paper when the study is finished so that you can read the results, let me know. If you have any further questions about the study, please contact me at E.L.Fontana@iup.edu or through the Anthropology Department at (724) 357-2841.

Thank you for your participation!
INSTRUCTIONS:

Please record all social interactions you had today. A social interaction is defined as any voluntary social contact you have with another person. Voluntary social contact means it is for primarily social purposes – for example, formal meetings for class/work, talking to customers at a job, etc. do not count. Interactions can be face-to-face, voice only, or neither (see sociality scale below).

With each interaction, please report the approximate length of time in minutes, the rating on the sociality scale below, and the total number of people (excluding yourself) that you interacted with during that interaction. For example, if you were studying at the library with a friend and two other friends showed up and then left, the maximum number of people you interacted with during that particular interaction would be 3. Include only people you directly interacted with; following the previous example, do not include, for example, people at the next table in the library with whom you had no contact. Additionally, for each interaction, indicate whether it was planned (i.e., you had set a time beforehand to have dinner with a friend) or unplanned (spontaneous – for example, you ran into a friend while walking to class and had a conversation).

Please try to fill this out in as timely a manner as possible to ensure accuracy in reporting your social interactions. Please write your subject number and the date, but NOT your name or other identifying information, on the top of the page on which you record your interactions in the space provided. If you have any questions, please contact me at E.L.Fontana@iup.edu or (724) 516-2802.

Thank you!
Erica Fontana
Sociality Scale:

1 – person(s) you are interacting with are neither physically present nor immediately receiving or responding to your communication. Examples: e-mail, Facebook messaging, letter writing.

2 – person(s) you are interacting with are not physically or vocally present, but immediately receive and respond to your communication. Examples: instant messaging, chat room.

3 – person(s) you are interacting with are not physically present, but you can hear one another’s voices. Examples: talking on a telephone, cell phone, or voice chat program.

4 – face-to-face contact, i.e., anything in which you and the other person(s) can physically see one another. Examples: having dinner with a friend, playing team sports, attending a party.

How satisfied are you with the social interaction you had today? (Please circle a number)

0 1 2 3 4 5
Not at all Mostly Somewhat Somewhat Mostly Completely unsatisfied unsatisfied satisfied satisfied

Please include any comments relevant to your responses on the back of this page.

Thank you!
Script for Recording Subjects

For this portion of the study, you will be asked to tell the story of a recent embarrassing event that happened to you. You will be recorded using a digital camera with video capability for the purpose of recording your facial movements. [Show subject the camera.] Neither what you say nor any prosodic – that is to say, the aspects of what you are saying that are not specific to the words themselves, such as stress, pitch, and intonation – will be used in the data analysis. The only part of this recording that will be analyzed are your facial movements. Please try not to pose facial movements for the video or think too much about your facial movements when responding to the prompt – the object of recording is to capture your natural facial movement behaviors as accurately as possible.

Do you have any questions? [Wait for questions]. Okay, I’m going to read you the prompt now. Close your eyes and try to remember the last time you felt embarrassed. Try to remember it in as much detail as possible. Remember, what you say will not be used in the data analysis, and there is no time limit for your response. Let me know when you are finished giving your response.

Okay, are you ready to start? [Wait for subject response; when subject says ‘yes,’ begin recording. Stop recording when subject indicates that she is finished.]
Appendix D: Edits to Data and Notes

Note: Subject numbers mentioned in this appendix are original subject numbers, unless otherwise indicated.

All unusable data (i.e., any interaction including missing, out-of-range, etc. values – for instance, sociality coded as 5; response such as “all day” for length of time) was edited out for the final analysis, and interaction numbers were shifted to reflect this. See list of edits for an explanation of why each interaction that was completely removed was edited out.

Ranges of data were averaged and treated as single values; for instance, if a subject indicated “10 to 15 minutes” for the length of an interaction, this would appear in the analysis as 12.5 minutes.

Satisfaction Responses

The following subjects had one day of satisfaction responses missing, and therefore their satisfaction score represents an average of 6 days rather than 7: 9, 15, 26. Subject 21 gave more than one satisfaction response for some days; such responses were averaged within that day and each was treated as a daily satisfaction score.

Video Problems

The recording devices were malfunctioning for Subject 20’s video. Although the problem was not severe enough to preclude coding completely, it must be kept in mind that this may have distorted the results.

Individual interactions edited out of analysis

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<td>18-37-7-2 became 18-37-7-1</td>
<td>Missing number</td>
</tr>
<tr>
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<td></td>
<td>of people</td>
</tr>
<tr>
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<td>19-38-3-2</td>
<td>19-38-3-3 through 19-38-3-12 became 19-38-3-2 through 19-38-3-11, respectively</td>
<td>Sociality coded</td>
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<tr>
<td>19-38-3-10</td>
<td>19-38-3-11 (see above) became 19-38-3-10, respectively</td>
<td>Sociality coded</td>
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<tr>
<td>19-38-5-3</td>
<td>19-38-5-4 through 19-38-5-13 became 19-38-5-3 through 19-38-5-12, respectively</td>
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<td>19-38-7-3</td>
<td>19-38-7-4 through 19-38-7-6 became 19-38-7-3 through 19-38-7-5, respectively</td>
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<td>19-38-7-5</td>
<td>19-38-7-5 (see above) became 19-38-7-4</td>
<td>Sociality coded</td>
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<tr>
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<td>as “5”</td>
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