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Is the Startle Reaction an Emotion?

Paul Ekman and Wallace V. Friesen
Department of Psychiatry University of California at San Francisco

Ronald C. Simons
Michigan State University

In this study, we examined startle reactions in which the subjects did and did not know when a blank pistol would be fired. In addition, we asked subjects to suppress their startle response and to simulate a startle when there was no gunshot. Detailed measurement of facial muscular actions supported most of the findings reported by Landis and Hunt (1939), but our findings suggested that startle be considered a reflex not an emotion. The findings are considered in terms of current disagreements about exactly what constitutes an emotion, including the argument between Zajonc (1980) and Lazarus (1984) about the role of appraisal.

Despite the wealth of information provided by Landis and Hunt's (1939) pioneering study, emotion theorists have disagreed about whether the startle reaction is a reflex or an emotion. Bull (1951), Lindsley (1951), Plutchik (1962, later Plutchik, 1980, reserved judgment), Tomkins (1962), Wenger, F. N. Jones, and M. H. Jones (1956), and Woodworth and Schlosberg (1954), all considered startle to be an emotion, related to the emotion of surprise. Kemper (1978), Leventhal (1980), Mandler (1975), and Schacter and Singer (1962) all ignored the startle reaction. Averill (1980) and Lazarus (1982) were explicit about their decision to consider a startle a reflex rather than an emotion because cognition does not play a causal role in eliciting it. Landis and Hunt took an intermediate position, considering it to be "preemotional" because a startle is simpler in organization and expression than "true" emotions.

The issue of whether or not startle should be considered an emotion has drawn renewed interest since Zajonc's (1980) proposal (like Tomkin's before him) that affect does not require prior cognitive appraisal. Lazarus's (1984) recent rebuttal cited the findings reported in this article as supporting his contrary view. Although begun before the Zajonc-Lazarus debate, our study provides data relevant to it, by determining the extent to which the startle reaction is influenced by three cognitive activities. One experimental condition examined the role of expectations by telling subjects exactly when they would be startled. Another condition explored how well the startle expression can be suppressed, and a third condition investigated how well the startle expression can be simulated. We also sought to verify Landis and Hunt's account about the remarkable uniformity and brevity of the startle expression, features that might distinguish a startle from emotions such as anger or fear.

We also remedied some of the methodological defects in Landis and Hunt's study. Although their study was exemplary for its time, Landis and Hunt did not report how they made their behavioral measurements, they did not mention interobserver reliability, and often they omitted the quantitative data and significance tests that presumably were the bases for many of their key findings.

Method

A .22 caliber blank pistol shot was chosen to elicit the startle reaction, because Landis and Hunt reported it to be the most effective stimulus. The pistol was mounted on a tripod and placed 1.5 m behind the subject's chair. An experimenter sat directly facing the subject. A cinematographer was also present in the room, located 3 m from the subject. A 16-mm motion picture camera recorded behavior at 50 frames per second. This faster than usual (24

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Requests for reprints should be sent to Paul Ekman, Human Interaction Laboratory, University of California, San Francisco, California 94143.

frames per second) rate of recording was adopted because Landis and Hunt claimed that the startle reaction is so brief that high-speed cinematography is needed to record its component facial and bodily changes.

Experimental Conditions

Unanticipated startle. Although subjects knew the pistol would be fired sometime within the 1-hour session, they did not know precisely when. After about 15 min the pistol was fired while the experimenter was giving instructions for a memory test.

Anticipated startle. After a short interview (approximately 5 min) about previous startle experiences, the experimenter explained the countdown procedure. Starting with the number 10, he listed numbers at the rate of 1 number per second. When he reached zero he fired the pistol.

Inhibited startle. Subjects returned on another day to participate in the inhibited and the simulated conditions. The instructions for the inhibited condition were as follows:

> This time I want to see how well you can keep from showing any visible response. See if you can act so that someone seeing the film with the sound off won't know that anything has happened. Try not to let anything show as you wait for the gun to go off, and when it does go off, and afterward, until I say "cut!" Try to look relaxed all the way through. See if you can fool the person who'll be studying this film. Again I'll count down from 10.

Simulated startle. After about 5 minutes the experimenter said:

> This time I'll count down from 10, but the gun won't go off. Instead, that little light, which you can see in the mirror will come one, like this. (demonstrates) When it does I'd like you to pretend to be startled, just as though that light was an actual gunshot. See if you can act so that someone seeing the film without sound will think that the gun went off and you were really startled. See if you can fool the person who will be studying this film. During the countdown try to look relaxed. I'll say "cut!" to tell you when to stop pretending.

The unanticipated and anticipated conditions were not counterbalanced because pilot studies suggested that the gunshot lost some of its novel impact in the unanticipated condition if it were to follow an anticipated presentation. The pilot studies and Landis and Hunt's findings both suggested little decrement in response when 5 min separated the unanticipated and anticipated conditions. The simulated startle condition was always placed last so that subjects would have had maximal experience with the startle experience before attempting to imitate it.

Subjects

Seventeen individuals who did not consider themselves especially easily startled and who did not have any history of being teased because they were so, comprised the normal group of subjects. There were 10 women and 7 men in this group. They were paid $4.50 per hour for participating. Three of the subjects participated only in the unanticipated and anticipated startle conditions, before the inhibited and simulated conditions were devised.

Because of a clinical interest in individuals who are startled especially easily and readily (Simons, 1980), a second group of such "hyperstartlers" were also tested. Eleven persons, 9 women and 2 men, responded to a newspaper advertisement seeking such easily startled persons as part of a research project. They participated in only the anticipated and unanticipated conditions. Although the results are reported here, the few differences found between the normal and hyperstartlers are discussed in a separate report, which includes other cross-cultural data on hyperstartlers (Simons, Ekman, & Friesen, 1985).

Measurements

We focused our most detailed measurement on the facial part of the startle response because of recent work on the role of facial expression in emotion (e.g., Ekman & Oster, 1979) and because of the availability of a new technique that allows precise, detailed measurement of facial movement. Facial activity was scored with Ekman and Friesen's Facial Action Coding System (FACS; 1976, 1978), which distinguishes 44 *action units.* These are the minimal units of facial activity that are anatomically separate and visually distinguishable. Scoring involves decomposing a facial movement into the particular action units that produced it, either singly or in combination with other units. In addition, FACS provides for rating the intensity of each action unit on a 5-point scale.

Head, neck, and trunk movements were scored less precisely. The most commonly seen head movement was a small, brief tremor. This and all other head movements were combined into a head activity score. The most frequent neck movement was due to the action of the platysma muscle. This and all other neck movements were combined into a neck activity score. Similarly, a trunk activity score included all trunk movements.

The most exact measurement of the timing of any movement would require specifying the particular frame when any change was observed. Because the film had been exposed at 50 frames per second, specifying the exact frame would provide data in 20-ms units. Such precise measurement is very costly, however, requiring repeated viewing in slowed motion. This precise, micromeasurement (20-ms units) was performed only on a subsample of 6 subjects and only in the unanticipated condition. For these subjects, micromeasurement was made for each element of a movement (for facial action units and for head, neck, or trunk activity scores), recording when it first appeared (onset), when it reached maximum muscular contraction (start of apex), when it began to decay (start of offset), and when it disappeared (end of offset).

A more macromeasurement of latency was made for all subjects, in all four conditions, for each element of a movement that had been identified. To obtain this macrolatency measure, time from the point when the pistol was fired was divided into 100-ms (5-frame) blocks. We determined the 100-ms blocks when each action unit began.

Reliability of Measurement

Two coders who did not know about the controversy regarding startle, nor about Landis and Hunt's findings, performed the FACS scoring. Each coder scored about half of the sample, and both of the coders independently scored a subsample of of 28 startle reactions, the responses of 7

Table 1
Actions Evident Within 200 Milliseconds in the Unanticipated Startle Shown by the Majority of Subjects

Action	Number of subjects showing the action (N = 27)	Latency of action in ms[a]	
		M	*SD*
Muscles around the eye			
orbicularis occuli, pars lateralis	19	71.1	41.89
orbicularis occuli, pars medialis			
Horizontal lip stretch	19	76.3	45.24
risorius			
Neck muscle activity	26[b]	84.6	48.52
platysma or sternocleidomastoii, or both			
Eyes closed	25[c]	54.0	20.00
blink or other longer closure			
Head movements	26[d]	100.0	50.99
Trunk movements	24	125.0	44.23

[a] Measurement made in 100-ms blocks.
[b] Neck not visible for one subject.
[c] Eyes were already closed when gun was fired for 2 subjects.
[d] One subject showed this action just after the 200 ms cutoff (not included).

subjects across all four experimental conditions. The extent of intercoder agreement was evaluated for three aspects of facial measurement: (a) identification of the elemental muscular units acted to produce a movement, (b) location of when the movement began and when it ended, and (c) judgment of the intensity of the actions that comprised the movement.

Although commonly used reliability indices were applicable to evaluate intercoder agreement for the second and third aspects of facial measurement, they were not applicable to the first aspect of facial measurement. The difficulty occurs because FACS does not limit the coder to a small number of alternatives in identifying the elemental muscular units that might have acted to produce a movement. Instead a coder may decide that anywhere from 1 to 44 elemental actions were involved in any movement. An index of reliability was obtained by calculating ratios of agreement (Wexler, 1972). For each of the 28 startle reactions, the number of elemental units on which the 2 coders agreed was multiplied by 2 and was then divided by the total number of elemental units scored by the 2 coders. Perfect agreement would yield a ratio of 1.0. The mean agreement ratio across all 28 samples was .837. In identifying just those actions that were found to most often characterize startle reactions (see Table 1), the two coders agreed more than 90% of the time.

In the macromeasurement of latency, the 2 coders agreed 47.7% of the time about the 100-ms block in which an elemental unit began. Agreement within one adjacent time block was obtained 98.2% of the time. The agreement about the more precise microtiming measurements (in 20-ms blocks), was about the same as found in other studies using FACS (Ekman & Friesen, 1978). The mean discrepancy between the 2 coders in locating the onset of an action ranged from 14 to 28 ms, depending on the particular elemental unit. As in other studies with FACS, there was a greater discrepancy in locating the end of an action, ranging from 22 to 116 ms.

The intensity of each of the action units that had been identified in each of the four experimental conditions was then scored by Ekman and Friesen jointly. To evaluate the reliability of their scoring of intensity, a research assistant also made intensity ratings on all of the elemental units shown by the normal subjects in the unanticipated and anticipated conditions. Spearman rank order correlations between the intensity ratings made by the research assistant and those of Ekman and Friesen were calculated separately for each of the elemental units that were shown by half or more of the subjects. All of these ρ were .90 or higher. The κ coefficient comparing the intensity ratings of the research assistant and Ekman and Friesen across all actions was .83.

Results

Two of the finer distinctions made in FACS scoring were disregarded in the data analyses. Although FACS distinguishes the activity of either the inner or outer portions of the orbicularis oculi muscle, which orbits the eye, these two very similar action units were combined into a single muscles-around-the-eye score. How long the eye remained closed was also disregarded, collapsing the distinction between a blink and longer eye closures to obtain a eyes-closed score.

Unanticipated Startle

The scores on one normal subject in this condition were dropped because he reported noticing when the gun was about to be fired.

Table 2
Micromeasurement (in 20-Millisecond Blocks) of the Timing of the Unanticipated Startle (N = 6)

Action	Latency	Period: Onset	Period: Apex	Period: Offset	Total duration
Muscles around the eye	84.00	72.00	44.00	72.00	188.00
Horizontal lip stretch	104.00	72.00	36.00	88.00	196.00
Neck muscle activity	100.00	83.33	103.00	133.33	320.00
Eyes closed	73.33	53.33	123.33	103.33	280.00
Head movements	100.00	113.33	200.00	180.00	493.33
Trunk movements	120.00	110.00	673.33	210.00	993.33

Because no differences between normals and hyperstartlers were observed either in the specific actions that occurred or in their latencies, the results for normal subjects and for hyperstartlers were combined in this condition.

Without exception, all actions that were shown by more than half of the subjects began within 200 ms after the gun was fired. Table 1 shows that four actions were present for virtually all of the subjects—eye closure, neck muscle activity, head movement, and trunk movement. Two other actions—activity of the muscles around the eye and horizontal lip stretch—were shown by most subjects. The next most frequent facial action, the lowering of the brows produced by the corrugator muscle, was shown by only 11 of the 27 subjects.

Recall that the macromeasurement of latency was obtained by specifying the 100-ms time block in which an action was first observed to occur. In order to obtain the absolute latency figures reported in Table 1, any action that began within the first 100 ms was assigned a latency score of 50, and any action that started in the second block was assigned a score of 150, and the mean was calculated using these latency estimates. Although the differences in the latencies reported in Table 1 might appear to be so slight as to be unreliable, the sequence of actions duplicates exactly Landis and Hunt's report, which was done more than 40 years ago. The absolute values shown in Table 1 are also very close to those reported by Landis and Hunt.

The more precise, micromeasurement of the timing of facial actions in 20-ms units was performed on a subsample of 6 subjects for only the actions listed in Table 1—those that were shown by the majority of the subjects and that began within the first 200 ms. There is a minor discrepancy between the latencies reported in Tables 1 and 2. Table 1 probably contains the better estimates, even though they are less precisely measured, because they are based on a larger sample, and they are in agreement with the values reported by Landis and Hunt. The discrepancies in latency between the two forms of measurement are very small. The actions with the shortest latency (eye closure) and longest latency (trunk) were the same with both types of time measurement. Table 2 also shows that the head and trunk movements had the longest onset period and the longest offset period.

As noted by Landis and Hunt, shortly after the offset of the startle reaction another facial expression typically occurs. Although we did not measure this secondary reaction, we noted that it usually occurred within 500 ms after the startle offset. Smiling was the most frequent secondary reaction, although the smiles did not appear to be those of enjoyment but rather of embarrassment. Fear and sad expressions were also seen but much less frequently.

Anticipated Startle

Only the actions identified as comprising the startle response in the unanticipated condition (listed in Table 1) were examined in the anticipated condition. Behavior in the anticipated and unanticipated conditions were compared for the normals and the hyperstartlers separately in regard to the *frequency*, the *latency*, and the *intensity* of each action.

With respect to frequency, the number of subjects who showed the actions that characterized the unanticipated startle (Table 1) decreased in the anticipated condition, but the decrease was pronounced for only some of the

Table 3
Mean Intensity of Facial Actions Beginning in the First 200 Milliseconds in the Unanticipated Startle and Anticipated Startle Conditions

Group	Unanticipated startle	Anticipated startle	t	p
Normal subjects (n = 16)	14.76	7.12	5.81	.001
Hyperstartlers (n = 11)	16.36	15.64	.55	—

actions and only among the normal not the hyperstartler subjects. Horizontal lip stretch decreased markedly, by more than 50%, among the normal subjects in the anticipated condition [McNemar test, $\chi^2(1, N = 17) = 6.12, p = .05$]. Similarly, trunk activity decreased markedly among the normal subjects in the anticipated startle condition [McNemar test, $\chi^2(1, N = 17) = 5.14, p = .05$]. Among the hyperstartlers these actions occurred just as often in the anticipated as in the unanticipated conditions.

With respect to latency, neither normals nor hyperstartlers showed any significant difference between their unanticipated and anticipated startles.

With respect to intensity, all actions were less intense in the anticipated condition for normal subjects, although intensity decreased for only some of the hyperstartlers. A single intensity score was obtained for each subject by summing the intensities of each of the actions listed in Table 1. Table 3 shows the mean of these intensity summary scores for each group of subjects, in the unanticipated and anticipated conditions. The decrease in intensity of facial actions in the anticipated condition was significant for the normals but not for the hyperstartlers. This decrease in the intensity of facial action when the startle was anticipated was found for 15 out of 16 normal subjects. The behavior of the hyperstartlers was much more variable; 5 decreased, 5 increased, and 1 did not change. These differences between normals and hyperstartlers will be discussed in a separate report (Simons et al., 1985).

Inhibited Startle

Behavior in this condition was examined for only 14 of the normal subjects; 3 other normal subjects and the hyperstartlers did not participate in this or in the simulated startle condition. Behavior in the inhibited startle condition was compared with behavior shown in the anticipated startle condition, because in both circumstances the subjects knew exactly when the pistol was to be fired. Despite attempts to inhibit responses to the gunshot, there were no significant differences in either the frequency with which an action was shown or in the latency of facial actions. Although the difference was slight, intensity was weaker in the inhibited, than in the anticipated conditions (mean intensity anticipated = 1.9, inhibited = 1.59, $t = 2.2$, $df = 13$, $p = .05$).

Simulated Startle

Behavior in the simulated condition was compared with the unanticipated startle because subjects attempted to produce the appearance of the unanticipated startle rather than that of the less intense startle that had been shown in the anticipated condition. Although all the analyses reported so far considered only those actions that began within 200 ms after the pistol shot, this analysis included any action evident in the first 600 ms that was shown by one third or more of the subjects, because a less rapid and more varied response was expected when startle was simulated. Table 4 shows that almost half of the subjects did a brow raise—an action that is part of a surprise expression—which never appeared in either the unanticipated or anticipated startle conditions (McNemar test, $\chi^2 = 4.16$, $df = 1$, $p = .05$). Most subjects neglected to include tightening the muscle around the eye in their simulation (McNemar test, $\chi^2 = 4.08$, $df = 1$, $p = .05$). Table 4 also shows that the latency was much longer for every action in the simulated condition. This difference was tested by comparing the latency of the first action to be shown in each condition. As Table 4 suggests

Table 4
Actions Evident in the Simulated Startle and Unanticipated Startle Reactions (N = 13)

	Simulated startle		Real startle	
Action	Subjects	Latency (ms)	Subjects	Latency (ms)
Brow raise	6	366.67	0	0
Muscles around eye	4	400.00	10	70.00
Horizontal lip stretch	6	316.67	11	59.09
Neck muscle activity	11	289.36	13	80.77
Eyes closed	9	272.22	13	50.00
Head movements	10	310.00	13	96.15
Trunk movements	12	316.67	12	116.67

this latency score was much longer in the simulated than in the unanticipated condition ($t = 6.96$, $df = 13$, $p = .001$).

To determine whether untrained observers could discriminate between real or simulated startles, both were shown to groups of college students. Two videotapes were prepared with each subject appearing only once on each. On each videotape, seven real and seven simulated startles were edited in a random order. Pilot data showed that the latency difference alone (much longer for simulated than real) allowed near perfect discrimination. To find out whether observers could detect the simulated startle just from the expression itself, the videotape was edited to eliminate latency clues. Forty-eight students saw one tape; 50 saw the other. Both were asked to judge whether each startle was real or simulated. Across both groups of observers the total accuracy was 60% (binomial test, $p = .01$). Very few students did much better than this slight level of accurate discrimination. Only 11 of the 98 students were accurate on 70% or more of the startles they judged. Brow raising in the simulated condition, which was never found in the real startle, may have been a clue that the performance was false, because none of the six simulations that included a brow raise was judged to be real by a majority of the students.

Discussion

All but one of the actions that we found to characterize the unanticipated startle reaction (Table 1) were also reported by Landis and Hunt. They missed the action of the orbicularis oculi muscle, which tightens the eyelids and may draw the skin surrounding the eye inwards. Landis and Hunt must have seen the appearance changes produced by this muscle even though they failed to measure it, because the appearance changes produced by orbicularis oculi are included in their line-drawing illustration of the startle. This action was shown by 71% of our subjects in the unanticipated condition.

Landis and Hunt reported that eye closure had the shortest latency, followed by lip stretching, then head and neck movement at about the same time, and finally trunk movement. By scoring in 100-ms units and in 20-ms units, we replicated this temporal sequence with the addition that the action of the muscle around the eye occurred at about the same time as the lip stretching. Eye closure, which involves very small muscles, had not only the shortest latency, but the shortest onset period. The movements of the trunk, which require the involvement of very large muscles, had not only the longest latency, but the longest onset period as well.

Landis and Hunt proposed calling startle a "pattern" because of the uniformity in both the component actions and latencies. "The fact that few such patterns have been found in the realm of emotion increases the value of this one" (Landis & Hunt, 1939, p. 12). Its value as a model of emotion depends on whether the features of the startle are general to other emotions or unique to it. Let us now consider the findings in these terms.

Discontinuity in Expression

Some of those who view startle as an emotion (Plutchik, 1962, 1980; Tomkins, 1962; Woodworth & Schlosberg, 1954) see it as the extreme version of surprise. Although each cited Landis and Hunt's description of the ap-

Table 5
Differences Between Surprise and Startle Expressions

Facial feature	Appearance	Muscular basis
Eyebrows		
Surprise	Raised	Frontalis
Startle	Lowered	Orbicularis oculi, pars lateralis
Eyes		
Surprise	Upper lid raised, eyes widened	Levator palebralis, superioris
Startle	Eyes closed, lids tightened	Orbicularis oculi, pars medialis
Lips		
Surprise	Dropped open jaw, lips relaxed	Relaxation of masseter
Startle	Horizontally stretched	Risorius or platysma, or both
Neck		
Surprise	No activity	
Startle	Tightened, taut	Platysma, sternocleidomastoid, trapezius

pearance of the startle, none commented on the discontinuity in appearance between the startle and surprise. Table 5 contrasts the findings on the appearance of the startle with Ekman and Friesen's (1975, 1978) description of the surprise expression. (The surprise description is based on what they found observers in different cultures would judge as surprise. It includes all the features noted by other researchers who have observed or theorized about the appearance of surprise.)

No emotion theorist has suggested that a radical discontinuity in appearance, like that between startle and surprise, characterizes any emotion. Just the opposite has usually been assumed or asserted: The appearance of the expression of an emotion is said to become stronger, due to increased muscular contraction, as the emotion is felt more strongly. A totally different set of muscular actions has never been described for any emotion when it is felt most strongly. Thus rage resembles anger, as terror resembles fear, revulsion resembles disgust, extreme joy resembles moderate happiness, and extreme distress resembles moderate distress.

There are only two studies (Ekman, Friesen, & Ancoli, 1980; Ekman, 1984) that examined how facial appearance differs with variations in the strength of the feeling reported. Both studies found moderate to high correlations between the intensity of the muscular expression and the intensity of the subjective experience of the emotion. And, neither study found a discontinuity in expression between extreme and moderate expressions of an emotion such as the discontinuity we found between startle and surprise.

Easy and Reliable Elicitation

Landis and Hunt recommended the startle response to the scientist wishing to study emotion in the laboratory because it is not only uniform in appearance but easily elicited, appearing reliably in every subject, and indeed this was the case in our study as well. Although no claim can be made that the universe of elicitors has been adequately sampled for any emotion, in more than 50 years of research no elicitor has been found for any emotion that functions like the gunshot does for the startle. No elicitors have been reported that invariably produce the same initial observable emotional reaction in every subject. The closest approximation are some films that show animals engaging in cute behavior (Ekman et al., 1980). These films elicit only zygomatic major muscle smiles, but not in everyone. Although the gunshot never failed to produce at least part of the startle facial expression, we have observed that about 15% of the subjects who watch the film of cute animals show no visible facial expression. Attempts to elicit negative emotions produce even more variability in the initial facial expression of emotion. We have observed that a film of a limb amputation can elicit expressions of fear, surprise, disgust, distress, embarrassment, pain, anger, or blends of these emotions as the initial response. Films of other scenes, stress interviews, or pain stimuli are no more successful in eliciting a single initial facial expression of emotion across all subjects.

This lack of uniformity across persons in the initial emotional response to most events is consistent with those theories of emotion that emphasize the role of appraisal. How an individual appraises an event—the meaning given to the event not the event itself—is said to determine the type of emotional response. Certainly appraisal, which appears to play a minor role in the startle, plays a major role in the generation of emotions. In our view (Ekman, 1977, 1984), appraisal can sometimes operate automatically, with minimal, very brief, cognitive activity preceding the emotional response. Even then, the emotional response may not always be uniform across all people. Differences may occur because of variations in expectations, memories, or in the habits that link one emotion to another. In any case, the events that are most likely to elicit a uniform emotional response, such as the death of a child, can not be readily studied in a laboratory.

Attempts to elicit emotion in a laboratory are often contaminated, if not overwhelmed, by the social psychology of the situation. For example, observable facial expressions often change when the subject knows others are observing, and this has been found to vary with culture. Japanese more than American students masked negative emotional expressions in response to stress films if an authority figure was present (Ekman, 1973; Friesen, 1972). And, American students showed different facial expressions in response to pain when they knew they were being observed (Kleck et al., 1976). Although no one has compared startles when subjects are alone (unaware of being observed) with startles that occur in the presence of others, anecdotal observations suggests that they would not differ much as long as the subjects did not know exactly when the pistol shot would occur.

Difficulty in elicitation is probably the rule for emotion. Elicitors of emotion probably typically call forth different initial facial expressions across subjects and different emotional expressions over even a short period of time for any given subject. In the laboratory, emotion elicitors are especially influenced by the social context.

Fixed Timing: Latency and Duration

The startle reaction has a fixed, very brief latency, well within the range of what has been reported for most reflexes (Davis, Gendelman, Tishler, & Gendelman, 1982). Latency did not change with anticipation, nor with the attempt to inhibit the startle response. The response always begins within 100 ms of the eliciting stimulus. Although the latency of other emotional expressions has yet to be systematically measured under a variety of conditions, what work has been done does not suggest, nor has anyone theorized, that latency is fixed nor so brief.

The startle is also unique in the brevity of the entire response. The pattern usually disappears in less than one second, which is, again, well within the range reported for most reflexes (Davis et al., 1982). Surprise is the only emotion that also always has a brief duration, although it is not as short. Even though there has not been study of the duration of all other emotions, what evidence there is shows that the duration of an expression varies and is related to the intensity of emotional feeling (Ekman et al., 1981).

Our findings raise some question about whether signal value was important in the origin of the startle expression. Although theorists disagree about the importance of signaling in the evolution of the facial expressions of emotion, all agree it played some role (Allport, 1924; Andrew, 1963; Bell, 1847; Darwin, 1872/1965; Eibl-Eibesfeldt, 1970; Ekman, 1977; Izard, 1971; Lersch, 1971/1932; Tomkins, 1962; van Hooff, 1972). Signaling may not have played a similar role in the evolution of the startle expression because it is so hard for others to see. It is not only very brief (the facial elements disappear within ½ s), but the startle expression is usually obscured by the emotional reaction to being startled, which often follows closely after it and lasts much longer. The vocalization that often occurs with startle, may, of course have signal value.

Not Suppressable

Landis and Hunt mentioned that the startle pattern could not be totally suppressed but did not report systematically studying attempts to inhibit it. We found no difference between inhibited and anticipated startle reactions in either the muscular components or latency and only a very small diminution in intensity. Our own attempts to inhibit the startle expression were no more successful than those of the experimental subjects. Our subjective experience was that the startle expression always burst forth before we would interfere with it. Despite knowing exactly when the pistol shot would occur, the expression was over before we could begin our attempt to inhibit it.

Again, there has not been thorough study of this aspect of expression for the other emotions. What evidence there is suggests that it is at least sometimes possible to suppress deliberately the expression of emotion. In the one study (Ekman & Friesen, 1974) in which extremely strong emotion was elicited (with surgical films) and exacting measurement was performed (with FACS), some subjects were able to inhibit their expressions totally.

Unconvincing Simulations

Deliberately produced startles failed to show the very brief latency that characterizes a genuine startle. It seems as if voluntary direction of the facial musculature can not produce the immediate response that is a hallmark of the startle. Because emotional expressions do not have such a brief latency, the clue that their expression is false, the product of deliberate intention, is not so obvious.

Almost half of the subjects raised their brow as if in surprise when simulating the startle. We believe that if the subjects had not been actually startled just minutes before, many more would have activated the wrong muscle movements. Again, there are no comparable data on other emotions. Although there have been many studies of posing emotions, none precisely measured both the posed and genuine expressions.

Anticipation Diminishes Startle

Surprise is probably the only emotion in which anticipation has a uniform effect. Knowing precisely what unexpected event will happen and when it will occur eliminates surprise. Such anticipation diminished the intensity of the startle reaction for 15 of the 16 normal subjects but did not eliminate the startle response. No emotional theorist has suggested that anticipation would have a uniform influence on the experience or expression of fear, anger, disgust, or distress; but there has been no systematic study of this issue. Anecdotal information suggests that anticipation can heighten or diminish emotional experience and expression, depending on the specifics of the emotional elicitor, the social context, and personal characteristics.

Is Startle An Emotion?

The answer matters in terms of the current controversy about whether cognitive appraisal must always precede emotion. No one doubts that startles are brought on without prior appraisal, in an automatic fashion, much like a reflex. Physiologists agree in considering startle a reflex not an emotion (Davis et al., 1982; Graham, 1975). A decision to consider startle an emotion would support Tomkins' and Zajonc's and contradict Lazarus's claim about whether or not cognitive appraisal is a prerequisite for emotion.

The evidence from our study of the startle is mixed. In two respects startle resembles emotions: (a) Uniformity in facial appearance, apart from intensity variations or attempts to control the expression, is a characteristic probably shared with happiness, surprise, and fear; (b) brief latency and duration is a characteristic shared with surprise, although startle is briefer than surprise.

However, startle differs from the emotions, including surprise, in four ways: (a) Startle is very easy to elicit; (b) it is shown reliably as the initial response by every subject; (c) the startle response can not be totally inhibited; and (d) no one seems able to simulate it with the correct latency. If startle is considered the extreme state of surprise, as claimed by those who say it is an emotion, then it would differ from emotions in a sixth way, appearing radically different from the supposed less extreme surprise expressions. One important type of evidence is still missing—the subjective experience of how it feels to be startled. Anecdotal evidence suggests that being startled feels very different from being surprised, much more different in kind than the difference in feelings between terror and fear, or between rage and anger.

S. S. Tomkins (personal communication, February, 1982) does not regard our findings as a challenge to his claim that the startle is an emotion. He argues that the differences we documented would be found with other emotions if stimuli as strong as the blank pistol shot were used. There are some data to counter Tomkins' reasoning on two features unique to the startle.

1. *There is continuity in emotional expression from moderate to extreme states:* Unlike the difference between the startle and surprise expressions, the expression of disgust when someone nearly vomits involves most of the same muscle movements activated in an expression of more moderate disgust (Ekman et al., 1980). Similarly, measurements of the facial expressions in news photographs of severe emotional situations (e.g. response to torture, death of a baby), did not find discontinuity in expression (Ekman, 1984).

2. *Even with very strong stimuli, no single emotional expression is initially shown across all subjects:* The data for this assertion comes both from Ekman's (1984) study and from Landis's (1924) findings when he used the extreme provocation of twisting off the head of a laboratory rat. There have been no studies relevant to Tomkins' claim that expressions can not be completely inhibited or simulated when the provoking stimuli are very strong.

The balance of evidence suggests that startle differs sufficiently from what is known to characterize emotions that it should probably not be considered an emotion. We make that judgment independently of the argument about whether appraisal is a precondition for emotion, because our position on that matter is that emotion can be aroused either with or without prior appraisal (Ekman, 1977, 1984). Our judgment must, however, be tentative. There is not sufficient information about each of the emotions to know how much each emotion differs from each other emotion. Although the startle does not appear to be a good model for the study of emotions, no other single emotion may prove to be so. If other emotions are examined in as much detail and in as many respects as the startle, each may be found, as Tomkins (1962) has suggested, to be unique in many respects. At present, far more is known about startle than about any of the emotions. Hopefully it will not long remain so.

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