Emotion concepts and learning theory 2: The biological functions of emotional reactions and their elicitation conditions[1] [with revisions[2] from 1991]

The elicitation of emotional reactions

The conditions governing the elicitation of emotional reactions, like the composition of the reactions themselves which we discussed in the last lecture, reflect the biological function of these reactions in the interaction between an organism and its natural environment. Those features of human emotion which are adapted to the special circumstances of human civilisation are few and far between. Hence the value and importance of animal studies in this area of investigation:

The biological function of emotional reactions

The biological function of emotional reactions in general would seem to be, as suggested by Cannon (2), to mobilise the behavioural and physiological resources of the organism to meet a biological *emergencies* of various kinds.

Biological emergencies may be classified into

(a) *opportunities* and

(b) *threats*.

An *opportunity* may be defined as an environmental contingency in which the survival chances for the organism in question and/or for the species will be *improved*, *if* an appropriate response is made. A *threat* may be defined as an environmental contingency in which the survival chances for the organism in question and/or for the species will *diminish, unless* an appropriate response is made.

Opportunities in this sense may then be sub-classified into

(i) *positive opportunities* in which the effect of the response for which an opportunity exists will be to *improve* the survival chances for organism and/or species and

(ii) *negative opportunities* in which the effect of the response for which an opportunity exists is to *avert a threat* to the survival chances.

Threats may be similarly sub-classified into

(i) *positive threats* in which the threat is to what would otherwise be an improvement in the survival chances and

(ii) *negative threats* in which [the threat is] an absolute diminution in the survival chances ~~is threatened~~.

The nature of an organism's emotional response is related not only to the kind of biological emergency involved, whether it is a positive opportunity, a positive threat (i.e.: a threat to a positive opportunity), a negative or absolute threat or a negative opportunity (i.e. an opportunity to avert a negative threat), it is also related to what we may call the 'state of play' with respect to the opportunity or threat in question, in other words, whether the emergency is *imminent, active*, or has already been *realised.*

Emotional reactions to different kinds of emergency

When faced with an			the appropriate emotion is to
imminent	*positive*	*opportunity*	*be excited*
active	*positive*	*opportunity*	*enjoy it*
realised	*positive*	*opportunity*	*be pleased*
imminent	*positive*	*threat*	*be worried*
active	*positive*	*threat*	*be angry*
realised	*positive*	*threat*	*be disappointed*
imminent	*negative*	*threat*	*be afraid*
active	*negative*	*threat*	*be angry*
realised	*negative*	*threat*	*be miserable*
imminent	*negative*	*opportunity*	*be hopeful*
active	*negative*	*opportunity*	*be relieved*
realised	*negative*	*opportunity*	*relax*

[1] Editor: The original title of this lecture was 'The elicitation of emotional reactions and their biological functions'.

[2] Editor: Between square brackets.

It is apparent from the above table

(a) that pleasant emotions are associated with opportunities, unpleasant emotions with threats and

(b) that high arousal emotions are associated with imminent and to a lesser extent with active emergencies and low arousal with realised emergencies.

Other emotions are related to more specific opportunities and threats. Thus:

Sexual arousal (Lust):	imminent positive opportunity for sexual commerce with another organism.
Love and affection:	active positive opportunity to improve the survival chances of another organism (typically the mate or offspring of the organism in question)
Jealousy:	active positive threat to one's own positive opportunity from the behaviour of another organism in taking the opportunity for itself.
Grief:	realised positive threat to the opportunity to give love and affection to another
Shame:	imminent negative threat to self from the justified anger-aggression of another organism provoked by one's own past behaviour
Pity:	active negative threat to another organism, typically one who is submitting or abasing in response to aggression on the part of the organism in question
Disgust:	an active negative threat constituted by the ingestion or other consummatory commerce with a noxious substance
Weariness:	a negative opportunity for the cessation of movement and a positive opportunity to sleep.

Sources of error in the mechanisms of emotional elicitation

Although the principles governing the elicitation of particular emotional reactions by particular stimulus configurations are such as to ensure that in the majority of cases emotional reactions occur when and only when the relevant type of biological emergency occurs, like all biological systems the mechanisms of emotional elicitation are not perfectly efficient, with the result that emotional reactions often occur when there is no objective biological opportunity or threat and less commonly fail to occur when there *is* such an objective emergency. Biological errors in the elicitation of emotional reactions are of two types

(a) *perceptual or cognitive errors* and

(b) *errors of volition or value judgement*.

A *perceptual or cognitive error* is one in which there is a discrepancy between the actual state of affairs in the environment and the emotional reaction that is elicited by the stimuli from the environment due to noise or ambiguity that arises within the organism's information processing system. As described in terms of the mentalist concepts of ordinary language, this is a case where there is a discrepancy between things as they actually are and things as they appear to the subject to be. *An error of volition or value judgement* is one in which certain states of the environment which do not in fact favour or threaten the survival chances of the organism or species in a biological sense are regularly reacted to in a manner which would be appropriate if they did in fact constitute such an opportunity or threat in a biological sense. An error of volition which treats what is actively harmful as if it were a positive opportunity in the biological sense, may be described as an *addiction*. An error of volition which treats what is biologically harmless or even beneficial as if it were a negative threat in the biological sense may be described as a *phobia*.

It should be emphasized in this connection

(a) that there are many human emotional reactions, [such as the enthusiasm for a hobby or pique at some imagined social slight – added in 1991] , which, although not constituting addictions or phobias, in that they are not positively maladaptive in a biological sense, do not have any obvious biological function in promoting the survival of the organism or the species, and

(b) that there are many addictions and phobias, [such as an addiction to cross-dressing or an acrophobia in someone who is not a steeplejack – added in 1991], which can be said to be actively maladaptive only in so far as the social circumstances within a particular human community marginally diminish the survival chances for those individuals who react in these ways.

Emotion and Motivation

The biological functions of emotional reactions are closely related to the biological function of the motivational process, which has the function of securing the sequential organisation of behaviour in such a way that specific positive contingencies likely to increase the survival chances of the individual and the species are brought about, while negative contingencies constituting a threat to survival are avoided. The biological emergencies for which it is a function of the emotion to mobilise the appropriate behaviour are always situations towards or away from which it is the function of the motivational process to organise behaviour. Accordingly, the relation between emotion and motivation may be specified by saying that a *motive* is a dispositional state of the organism whereby stimuli related to the appearance, disappearance or non-occurrence when otherwise expected of a specific environmental contingency has the property of eliciting certain characteristic emotional reactions tending either to increase or decrease the probability of the appearance of the contingency in question.

As we saw in Lecture 13 and again in the previous lecture, in ordinary language there is a conceptual relationship between the motivational concepts of 'wanting' and 'not wanting' and the emotion concepts of 'being pleased, distressed, worried, frightened, angry, miserable and relieved'. Thus to say that someone *wants something* to happen, is to say

(1) that he will be *pleased*, if it appears about to happen,
(2) that he will be *pleased*, if it does happen,
(3) that he will be *worried* or *frightened*, if it appears not to be happening as expected,
(4) that he will either be *angry* or *miserable*, if it does not happen as expected.

Likewise to say that someone *does not want something* to happen, is to say

(1) that he will be *worried* or *frightened*, if it appears about to happen,
(2) that he will be either *angry, miserable* or *depressed*, if it does happen,
(3) that he will be *relieved*, if it appears not to be happening as expected,
(4) that he will be *relieved*, if it does not happen as expected.

Motivation and the conditioning of emotional reaction

If we disregard the case where information about environmental contingencies is received from another person and consider the sequence of events, which would lead an individual to think or believe that something is or is not about to happen, it is not difficult to see that this is essentially the same sequence of events as occurs in a classical conditioning situation as described by Pavlov (9). Repeated presentation of the *CS* followed by the *US*[3] which produces a *CR* is a stimulus configuration which would lead someone presented with the *CS* to think that the *US* was about to happen. If on the other hand *CS* when presented in combination with another stimulus or *CI* is never reinforced, the *CI* will acquire an inhibitory effect with respect to this and other conditioned responses based on the same *US*. It would also be a stimulus which would lead an individual to think that the *US* was *not* going to happen when otherwise expected as a result of the presentation of a *CS*.

[Paragraphs added in 1991]

[These considerations lead into a view of the nature of classical Pavlovian conditioning which is supported by much recent work within the so-called 'associative learning' tradition represented by the seminal paper by Rescorla and Wagner (10). On this view, classical conditioning is not primarily a matter of establishing a new stimulus-response connection. What happens is that, by virtue of repeatedly experiencing the occurrence of the *CS* alone followed immediately or after a brief interval by the onset of the *US*, whereas the *CS* + *CI* combination is not so followed, the organism learns to *expect*, *anticipate* and, where the organism is a verbally competent human, *predict* the *occurrence* of the *US*, when the *CS* is presented alone, and the *non-occurrence* of the *US*, when the *CS* is presented in combination with the *CI*.

[Expectations of this kind are constantly being formed, confirmed, modified and disconfirmed as the organism interacts with a constantly changing environment. Appropriate expectations are formed whenever a stimulus of one kind S_1 is regularly followed by a stimulus of another kind S_2 under one set of

[3] Editor: In the original *UCS* is used instead of *US*.

conditions (S_1 by itself) and is not so followed under another set of conditions (S_1 + another stimulus S_2). In the majority of cases the only detectable manifestation of the existence of an expectation of this kind is in the phenomenon whereby the organism's attention is attracted to and by a stimulus which is *unexpected* relative to the organism's previous experience of the normal sequence of events under the prevailing conditions of stimulation. However, by using as the stimulus *(S_2)* whose occurrence is anticipated a stimulus which elicits a strong emotional reaction from the organism (a *US*), it becomes possible to chart the course of the acquisition and extinction of the expectation as a function of the sequence of stimulus events by measuring one of the autonomic *sequelae* (salivation, G.S.R., etc.) of the emotional reaction elicited by an emotionally significant stimulus. From the standpoint of someone interested in studying the acquisition and extinction of expectations, the point of using an emotionally significant stimulus as the stimulus whose occurrence is expected is simply to make the expectation visible and measurable. From the standpoint of someone interested in studying the elicitation conditions of emotional reactions, on the other hand, this feature of the classical conditioning experiment takes us to the very heart of the matter.]

[Paragraph substantially reconstructed in 1991]

In practice, very little can be learned about the elicitation conditions of *different* emotional reactions from a study of classical conditioning alone. One reason for this is the well known fact that the principles of classical conditioning are the same, regardless of whether the *US* whose occurrence is anticipated is a pleasant or gratifying stimulus such as the injection of food into the mouth as in Pavlov's experiment, or an unpleasant or aversive event such as an electric shock or the injection of acid, rather than food, into the mouth; whereas the emotional reactions elicited in the two cases are very different.

There is, however, a modification of the classical conditioning procedure developed by Jerzy Konorski and Stefan Miller (6) which brings out the difference which is made by changing the valence of the *US* in terms of the nature of an instrumental/operant response which develops within the context of the classical procedure. In these experiments the proprioceptive feedback from an operant response (generated by the passive flexion of one of the animal's forelegs) is used either

(a) as an excitatory conditioned stimulus *(CS)*, or

(b) as an inhibitory conditioned stimulus *(CI)*

in relation to the classically conditioned emotional response. Under these conditions, the valence of the *US*, the pleasantness of the food *versus* the unpleasantness of the acid injected into the mouth manifests itself in the different operant responses that develop on top of the underlying classically conditioned emotional reaction. If the *US* is food and the operant feedback is made excitatory *(CS)*, an operant in the form of an active flexion of the leg is emitted in the presence of the *CS*. If with *US* food, the feedback is made inhibitory *(CI)*, the operant that develops takes the form of an active resistance to leg-flexion. With acid as the *US*, the opposite relationship applies. With the feedback excitatory *(CS)*, the resulting operant is active resistance to passive leg-flexion. With acid as the *US* and the feedback inhibitory *(CI)*, the operant is active leg-flexion.

[Paragraphs added 1991]

[A second reason why classical conditioning on its own fails to tell us very much about the elicitation conditions for different emotional reactions emerges when we consider how we would naturally describe the emotions elicited by the various elements of the classical conditioning contingency in ordinary language. When we do this we find that, over and above the difference in the reported emotion which depends on whether the *US* is pleasant or unpleasant, there is also a difference between the emotion aroused by the *CS* as compared with that aroused by the *US*, and a parallel difference between the emotion aroused by the *CI* as compared with that aroused by the non-occurrence of the *US* which it predicts. Thus, in the case where the *US* is pleasant, the emotion aroused by the *CS* is *anticipatory excitement*, whereas that aroused by the *US* is *pleasure/satisfaction*. Likewise, if the *US* is unpleasant or aversive, the emotion aroused by the *CS* is *fear*, whereas that aroused by the *US* alternates between *anger*, *distress* or *depression*.

[A mirror image of this relationship holds between the emotions aroused by the conditioned inhibitory stimulus *(CI)* and that aroused by the non-occurrence of the *US* which it predicts. Thus, if the *US* is pleasant, the emotion aroused by the *CI* is *anxiety*, whereas that aroused by the non-occurrence of the *US* alternates between *frustration/anger* and *disappointment/depression*. If the *US* is aversive, both the *CI* and the non-occurrence of the *US* elicit *relief* and *relaxation*, the only difference being that, other things being

equal, the relaxation elicited by the non-occurrence of the *US* is more secure and profound than that elicited by the *CI* which predicts it.]

[The reason why these differences fail to appear either in the classical Pavlovian experiment or in the Konorski-Miller derivative (6) which adds in the pleasant-unpleasant dimension of the emotional reaction, along with the emergent operant response, is that neither situation allows scope for the emergence of the differences in the impulsive reactions appropriate to a situation in which an outcome (the occurrence or non-occurrence of the *US*) is anticipated as compared to those appropriate when the anticipated outcome has actually materialised. An experimental technique for displaying, measuring and determining the elicitation conditions for the impulsive attack behaviour characteristic of anger has been developed by Azrin and his associates (1 & 12); but no comparable studies are, to my knowledge, available for the impulsive behaviour typical of other emotional reactions.]

[Paragraph substantially reconstructed in 1991]

Generalising from these considerations, we can summarise the relation between classical conditioning and its associated emotional reactions as follows:

When the *US* is *pleasant* (i.e., when the organism 'likes it' and 'wants it to occur')

(1) the *CS*	elicits	*anticipatory excitement*,
(2) the *US*	"	*pleasure/satisfaction*,
(3) the *CI*	"	*anxiety*,
(4) no *US*	"	*frustration/anger* or *disappointment/depression*.

When the *US* is *unpleasant* (i.e., when the organism 'dislikes it' and 'doesn't want it to occur':

(1) the *CS*	elicits	*fear*,
(2) the *US*	"	*anger, distress* or *depression*,
(3) the *CI*	"	*relief*,
(4) no *US*	"	*relief/relaxation*.

Experimental evidence for the principles of emotional conditioning

Conditioned pleasure

1. Evidence that a *CS* in a classically conditioned pleasure reaction evokes pleasure - the extensive literature on *Secondary Reinforcement.*
2. Evidence that the *US* in a classical conditioned pleasure reaction evokes pleasure - the Konorski-Miller *CR* Type 2 Variety 1 experiment (6) i.e., *positive operant reinforcement*
3. Evidence that a *CI* in a classically conditioned pleasure reaction evokes fear - experiments using *time out from positive reinforcement* as the aversive stimulus for conditioned avoidance learning, e.g. Morse & Herrnstein (8).
4. Evidence that the extinction of a classically conditioned pleasure reaction evokes
   (a) anger - Azrin *et al.* (1), Dollard *et al.* (4),
   (b) depression - the extinction of positively reinforced operant responses.

Conditioned aversion

1. Evidence that a *CS* in a classically conditioned aversive reaction evokes fear - the phenomena of *conditioned suppression* (Estes & Skinner (3)) and *conditioned avoidance.*
2. Evidence that the *US* in a classically conditioned aversive reaction evokes
   (a) *distress* - the emission of escape behaviour in response to shock,
   (b) *anger* - Ulrich & Azrin (12),
   (c) *depression* - the phenomena of *unconditioned suppression* (Estes & Skinner (3)).
3. Evidence that a *CI* in a classically conditioned aversive reaction evokes relief - the phenomenon of conditioned avoidance Konorski & Miller's *CR* type 2 variety 3 experiment (6).
4. Evidence that the extinction of a classically conditioned aversive reaction evokes relief - not explicitly demonstrated, though implicit in a conditioned avoidance situation once the aversive *US* has ceased to occur.

Evidence on the elicitation conditions for anger as measured by impulsive attack behaviour[4]

Unconditioned aversive [stimulation]

Ulrich and Azrin (12) have shown that anger, as measured by ~~aggression~~ [attack behaviour in response to an unconditioned aversive stimulus (electric shock)] occurs only if

(a) the shock is unavoidable; if escape is possible, no attack occurs,

(b) there is a suitable attackable object present.

Extinction of ~~conditioned pleasure~~ [a positively reinforced operant response]

Azrin *et al.* (1) have shown that extinction will ~~produce aggression~~ [generate attack behaviour] only if

(a) the offset of reinforcement is clearly signalled, e.g. by the termination of a c.r.f.,

(b) there is a suitable attackable object present.

Conditioning versus innate releases in the elicitation of emotion

The analysis given above suggests that the problem of how far emotional reactions occur as learned or as unlearned responses is a complex one. Some emotions, such as fear and excitement, occur characteristically as conditioned reactions, but not, under that description, as unconditioned reactions. Other emotions such as anger and depression have no standard occurrence as conditioned responses. Their standard elicitation conditions do however, in both cases include the extinction of responses which have been previously acquired and maintained by positive reinforcement (frustration) and are to this extent dependent for their occurrence on previous learning.

The problem is further complicated by the fact that emotions, such as fear and excitement, which occur characteristically as conditioned responses, also occur in animals, if not in man, as unlearned reactions to stimuli which from a biological standpoint constitute reliable and consistent indicators of threat or opportunity situations for the species concerned. Tinbergen (11) has drawn attention to the innately determined elicitation of fear reactions in young ducks and geese by a bird-like model having the crucial features of a short neck characteristic of birds of prey. It has also been suggested that the frequency of snake and spider phobias in man cannot easily be accounted for in terms of traumatic experiences involving those animals and may reflect a similar unlearned fear reaction in the human species.

By the same token emotions like anger and depression which do not characteristically occur as conditioned responses may under certain circumstances do so. The concept of 'hatred' frequently used in the description of human behaviour presumably implies conditioning of anger to a particular ~~stimulus~~ [class of stimulus events].[5]

A further complication is suggested by the work of Kinsey *et al* (5) on the human sexual response. This appears to show a sex difference, not in the readiness with which the sexual arousal response is elicited, but in its susceptibility to conditioning, the male sexual response being more readily conditioned to stimuli accidentally associated with sexual experience than the female.

It also seems likely that innate response tendencies influence what appear at first sight to be purely social, institutional and hence, one would think, essentially acquired determinants of emotional response. Thus shame as a response to attack behaviour on the part of another member of the same species is obviously related to the 'neck bowing' or abasement response to which Lorenz (7) has drawn attention in a number of animal species.

In humans, however, shame is elicited as a response to impending aggression towards the individual on the part of another person if:

(a) the aggression on the part of the other person is elicited or is likely to be elicited in response to some antecedent behaviour on the part of the individual concerned.

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[4] Editor: In the original this heading reads as 'Evidence on the determination of alternative reactions to unconditioned aversion and the extinction of conditioned pleasure'.

[5] [Footnote added in 1991] There is some reason to think that hatred may depend on a verbal mulling over past 'grievance' events. If so, this would explain why Azrin (personal communication) found no evidence of conditioning of anger in any of the animals whose attack behaviour he studied.

(b) the behaviour which has provoked the aggression is behaviour which the individual concerned accepts as morally wrong.

It is not without significance in this connection that the aggression which is characteristically deflected by abasement in animals is aggression evoked by the infringement by one animal on the territory of the other. On the other hand, where aggression is evoked by aversive stimulation or by the extinction of positively reinforced behaviour (frustration) as in the Ulrich and Azrin (12) and Azrin *et al.* (1) experiments, the reaction of the animal towards which the aggression is directed is to fight back.

Suggested stimuli for specific emotions

EMOTION		*STIMULI*
Excitement		Anticipatory conditioned stimuli in relation to an unconditioned pleasure reaction.
Sexual arousal		Complex conditioned and unconditioned stimuli see Kinsey *et al.* (5).
Anger	(a)	Unavoidable aversive stimulation with attackable object present.
	(b)	Non-reinforcement of a positively reinforced response with an attackable object present.
Fear[/anxiety]		Anticipatory conditioned stimuli in relation to (a) an unconditioned aversive stimulus, (b) time out from positive reinforcement, (c) certain specific innate releasing stimuli.
Distress		Unconditioned aversive stimuli especially pain stimulation.
Pleasure		Various unconditioned stimuli and associated conditioned stimuli.
Love		Lorenz (quoted by Tinbergen (11)) has suggested certain facial proportions characteristic of young mammals as an innate releaser of affection in man. Other factors conditioned and unconditioned must be assumed.
Pity		The abasement response in another member of the same species.
Shame		Aggressive behaviour on the part of another member of the same species evoked by the individual's own antecedent behaviour.
Disgust		Conditioned and unconditioned aversive reactions arising in the process of eating, drinking and other consummatory behaviour, such as sexual response.
Relief		The disappearance of conditioned or unconditioned aversive stimulation.
Weariness		A long period of sustained activity.
Depression	(a)	Unavoidable, unconditioned aversive stimulation with *no* attackable object available.
	(b)	Non-reinforcement of a positively reinforced operant with *no* attackable object available.

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