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Frustration Theory—Many Years Later

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The role of frustration in learning theory, in the invigoration of behavior and in the development of learned persistence and discrimination learning, is conceptualized. This and other phenomena are facets of the larger explanatory domain of what has come to be known as *frustration theory*, a theory that has guided the author's own research—from behavioral to developmental to psychobiological—until the present time and has had some influence on the research of other investigators. This is a commentary on the 1st of several published theoretical papers on frustration theory.

> This paper is based on the proposition that an adequate theory of instrumental behavior must involve three types of goal event: (*a*) *Rewarding events*—usually the presence of stimuli which evoke a consummatory reaction appropriate to some condition of deprivation; (*b*) *Punishing events*—noxious stimulation at the termination of a behavior sequence; and (*c*) *Frustrative events*—the absence of or delay of a rewarding event in a situation where it had been present previously. ("The Role of Frustrative Nonreward in Noncontinuous Reward Situations," Amsel, 1958, p. 102)

My 1958 article, "The Role of Frustrative Nonreward in Noncontinuous Reward Situations" (Amsel, 1958), was the first of my theoretical articles on frustration; an earlier paper, submitted to the *Psychological Review*, had been rejected because the reviewer said there was "no point trying to patch up Hull's theory." The rejected article was an extension of a paper I had presented at a meeting of the Southern Society for Philosophy and Psychology (SSPP) in 1951 in which I proposed that a third factor, frustrative inhibition resulting from anticipatory frustration (r_F), be added to reactive and conditioned inhibition, the two factors in Hull's (1943) theory of inhibition. The argument was that this would bring Hull's theory more into line with its Pavlovian antecedents and with Kenneth Spence's (1936) influential theory of discrimination learning, which included an inhibitory factor that was based on nonreinforcement. My point was that nonreinforcement played no role in Hull's theory of inhibition and that the proposed third factor would play such a role. Figure 1 is adapted from a slide I used in the 1951 SSPP presentation. In the SSPP paper, I illustrated this point with particular reference to the phenomenon of successive negative incentive contrast, a suppressive effect of reduced reinforcement. (In addition to his admonition not to bother patching up Hull, the referee of the paper I submitted to the *Review* also wrote that it "had only two or three ideas in it." In a losing cause, I wrote back to the editor, plaintively, that I thought one idea per paper was enough, provided it was a good one. I still think so.)

In the 1951 paper I was obviously very much influenced by the concept of *frustration drive*, which was very much "in the air" just earlier in my graduate years at Iowa. In fact, in the same year I presented my paper at SSPP, an article appeared in the *Psychological Bulletin* that defined frustration drive (I later called it *primary frustration*) in terms of conflicting tendencies to approach and avoid (Brown & Farber, 1951). My own definition of primary frustration was, I thought, simpler. All it involved was nonreward in the presence of anticipated reward (Hull's r_G–s_G).

Even before submitting the rejected *Review* paper, I had concluded that to argue for a factor such as conditioned anticipatory frustration, it was necessary first to identify unconditioned or primary frustration, the requisite Pavlovian unconditioned response (UCR) to the unconditioned stimulus (UCS) of nonreinforcement. To get an indirect measure of the UCR, primary frustration, I set up an apparatus in the basement of Newcomb College, Tulane University. It involved pine boards, hardware-cloth mesh, homemade reward pellets, and a stopwatch. Later called the *double runway*, it consisted of two runways in series: a start box, a first alley and a first goal box, and a second alley and a second goal box. It was used in a large number of experiments, first in our laboratory (Amsel & Roussel, 1952) and later elsewhere, to study what came to be known as the *frustration effect* (FE). We took this effect to be an indicant of primary (unconditioned) frustration.

An outline of the basic idea that was developed in the 1958 *Bulletin* article and extended in subsequent ones (e.g., Amsel 1962, 1967, 1972) jumped out at me while I conducted a pilot experiment (probably in the summer of 1953) as I watched rats running in an alley for food under a schedule of intermittent partial reinforcement (PRF). In such schedules, studied earlier by L. G. Humphreys and B. F. Skinner, reward is given or withheld quasi-randomly for the same response. Humphreys had shown in several experiments that on such schedules the learned responses were more resistant to extinction than under continuous reinforcement (CRF) schedules. As I watched them in the alley, I saw that compared with animals on a CRF schedule, the behavior of PRF-exposed rats went through the four distinct stages of what became the frustration theory of the partial reinforcement extinction effect (PREE): At first, these animals approached vigorously even though reward was given only on half the trials, and nonrewards appeared to have little effect. In a second stage, they reacted emotionally when reward was withheld; they urinated and defecated and were more likely to bite my hand when removed from the frustrating goal box. In a third stage, I saw other emotional, conflictlike behavior, with retracing and urination in the runway. And in the fourth stage, the outward manifestations of conflict disappeared, and the

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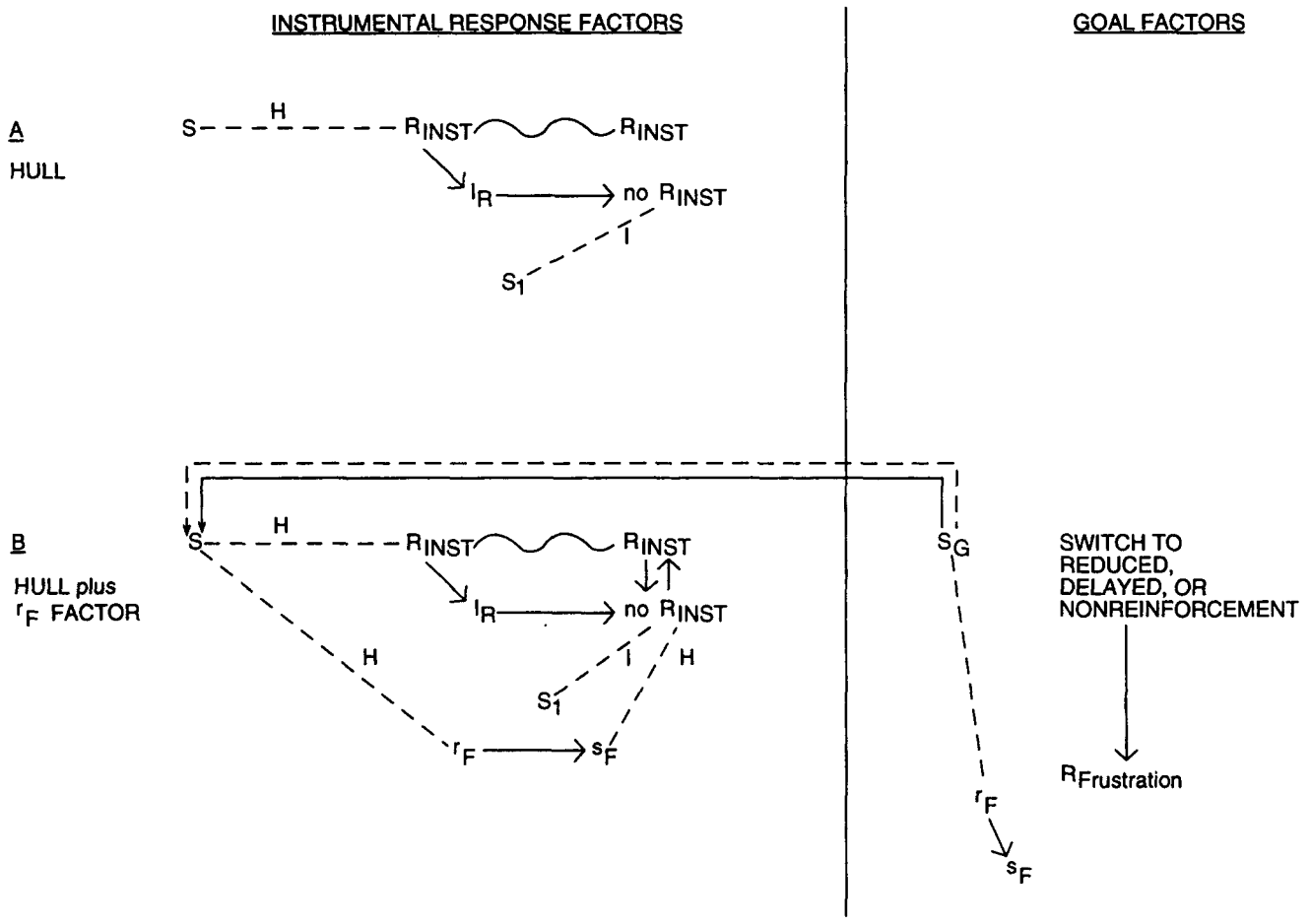

Figure 1. A. Diagram of Hull's (1943) two-factor theory of inhibition. B. Diagram showing the proposed addition of a third factor, anticipatory frustration (r_F–s_F), to Hull's two-factor theory [of inhibition, I_R and S^{I_R}]. Solid lines with arrows = unlearned connections; dashed lines = learned associations; wavy lines = continued responding; solid and dashed return lines from S_G to S = stimulus generalization and higher order conditioning, the mechanisms through which the conditioning of r_F to S_G (the CS [conditioned stimulus]) at the goal (on the basis of reduced, delayed, or nonreinforcement as the US [unconditioned stimulus], and $R_{Frustration}$ as the UR [unconditioned response]), moves forward in time so that r_F is evoked by S in the instrumental sequence. S_1 = version of S conditioned to not responding ($S_1^{I_R}$). (H = habit strength, S = stimulus, R_{INST} = instrumental response, I_R = reactive inhibition, S_G = goal stimulus, r_F = anticipatory frustration, s_F = stimulus from anticipatory frustration. Figure and caption from "What I Learned About Frustration at Iowa" [p. 155] by A. Amsel, 1991, in J. H. Cantor (Ed.), *Psychology at Iowa: Centennial Essays*, Hillsdale, NJ: Erlbaum. Copyright 1991 by L. Erlbaum Associates. Adapted by permission.)

rat returned to vigorous and consistent approach. The frustration theory of the PREE was (and with minor modifications is) these four distinct stages, and the nub of its explanation of the PREE is that overcoming the emotional conflict of the third stage and getting to the fourth depends on a mechanism of instrumental counterconditioning, of approaching rather than avoiding the goal in the presence of anticipated frustration (r_F–s_F). These animals were now more resistant to extinction—more persistent.

An outline of this theory of the PREE had been suggested a year or two earlier in an article with Wilma Wilson and Elizabeth Weiss (Wilson, Weiss, & Amsel, 1955), which tested, and rejected, the hypothesis of the PREE offered by Virginia Sheffield (1949). The Hull-Sheffield hypothesis, as it was called, held that increased persistence after partial reinforcement training (the PREE) depended on trial spacing: that the effect was present after massed but not after spaced trials in acquisition, and that it depended on intertrial intervals of seconds and not minutes. (The Hull-Sheffield hypothesis was later formalized by Capaldi, 1966, but without reference to trial spacing. Capaldi's position was that each of the stimuli arising from reinforcement and nonreinforcement [S^R and S^N] were relatively permanent until replaced by the other.)

The 1958 *Bulletin* article formalized the theory and extended

it to discrimination learning. It begins with the idea that Hull's *fractional anticipatory goal response* (r_G–s_G) is a general term encompassing a class of goal anticipations: specifically, fractional anticipatory reward (r_R–s_R), fractional anticipatory frustration (r_F–s_F), and fractional anticipatory pain or fear (r_P–s_P). (Later, Mowrer, 1960, added the concept of anticipatory relief, [r_{Rel}–s_{Rel}], so that r_{Rel} could relate to r_P as r_R [Mowrer's "hope"] related to r_F.) The main ingredients of the 1958 article, however, were the four stages I had observed 5 years earlier while training animals under a schedule of partial reinforcement. As I have indicated, the theory of the PREE was based on the concept of instrumental counterconditioning. It held that increased resistance to extinction, continued approach in extinction to the inconsistently rewarding goal, depended on counterconditioning of the approach response to the feedback cues from anticipatory frustration (r_F–s_F). The article also showed that in go–no-go discrimination learning, another instance of the operation of noncontinuous reinforcement, the hypothetical mechanisms were the same as in the PREE in the first three of the four stages; it was only in the fourth stage that they differed, because in the fourth stage, as the discrimination was formed, approach was conditioned to r_R–s_R and avoidance to r_F–s_F. In short, the theory in the 1958 *Bulletin* article provided an integration of the primary frustration effect, the PREE, and the role of frustration in discrimination learning. One of its predictions was that in the course of discrimination learning, the emotional effects of primary frustration (the FE) would appear before and disappear after the discrimination was formed. This was later confirmed (Amsel, 1962; Amsel & Ward, 1965).

My guess is that this article has been cited frequently because *frustration theory,* as it came to be called, was easy to understand and because its explanatory scope continued to expand after its publication. A brief and incomplete survey of this scope (a more complete survey is in Amsel, 1992) includes the integration of a number of behavioral phenomena, including the PREE, discrimination learning, and prediscrimination effects; phenomena such as simultaneous positive and successive negative contrast, the overtraining–extinction effect, variable magnitude and partial delay of reinforcement (and later their specific order of first appearance in infant development [e.g., Amsel, 1986; Amsel & Stanton, 1980]); Pavlovian induction and local behavioral contrast (Amsel, 1971); the formation of behavioral rituals under schedules of discontinuously negatively correlated reinforcement and their relation to regression (e.g., Rashotte & Amsel, 1968); emotionality in PRF acquisition and CRF extinction (but not in CRF acquisition or PRF extinction); the emission of odors of frustration by adult rats and their suppressive effects on the behavior of conspecifics (e.g., McHose & Ludvigson, 1966); the emission of ultrasonic calls in extinction by infant rats (Amsel, Radek, Graham, & Letz, 1977); and suggested neuroanatomical, neurophysiological, and pharmacological correlates (e.g., Amsel, 1992; Glazer, 1972, 1974; Gray, 1970, 1982; Henke, 1973, 1977). The theory has also addressed phenomena in humans, such as normal and psychopathic persistence, aggression, regression, and helplessness (e.g., Levis, 1976; Nation & Massad, 1978; Nation & Woods, 1980). A mathematical treatment in the context of the Rescorla-Wagner (1972) model has been provided by Daly and Daly (1982), and Daly (1991) has recently provided a mathematical analysis of the ontogeny of reward-schedule effects in rats from infant to weanling age.

Our own research has recently taken on a more developmental psychobiological emphasis. We have been examining some of the behavioral manifestations of frustration in relation to the development and integrity of the limbic system, particularly the hippocampal formation and the amygdala. This work depends on the aforementioned order of appearance in ontogeny of the reward-schedule effects organized by frustration theory. The emphasis in this work is on the parallel development of these effects and of the brain systems to which they appear to be related in prenatal and early postnatal stages in the laboratory rat, a period equivalent to the third trimester of human pregnancy. The questions that can begin to be asked are, How do specific interventions in these systems (lesions, exposure to alcohol in utero and postnatally, early postnatal exposure to X-irradiation) affect the emergence of the frustration-related behavioral effects from which dispositional learning and memory are inferred? Conversely, do the kinds of training that are required for the earliest manifestation of these effects on learning and memory induce neuronal and synaptic placticity? Do they induce acceleration or retardation in some of the structural landmarks of brain development—neurogenesis and neuronal morphology, neurotransmitter release, synapse formation —and how do these changes in turn relate to accelerated or retarded appearance of the later behavioral effects?

Thirty-four years after the first published theoretical article on frustration theory and 40 years after the first experimental paper, a book on frustration theory has appeared, almost coincident with the publication of the present commentary. The main purpose of the book, *Frustration Theory: An Analysis of Dispositional Learning and Memory* (Amsel, 1992), is to provide an account of the work the theory has influenced and a survey of its explanatory scope.

Everyone can make his or her own evaluation of the worthwhileness of this long-term enterprise, which has been the main continuing focus of at least one academic, scientific career; however, evaluation aside, the 1958 *Bulletin* article was the cradle out of which the enterprise developed. This much can be asserted with some certainty.

References

Amsel, A. (1951, April). *A three-factor theory of inhibition: An addition to Hull's two-factor theory.* Paper presented at the Southern Society for Philosophy and Psychology Meetings, Roanoke, VA.

Amsel, A. (1958). The role of frustrative nonreward in noncontinuous reward situations. *Psychological Bulletin, 55,* 102–119.

Amsel, A. (1962). Frustrative nonreward in partial reinforcement and discrimination learning: Some recent history and a theoretical extension. *Psychological Review, 69,* 306–328.

Amsel, A. (1967). Partial reinforcement effects on vigor and persistence: Advances in frustration theory derived from a variety of within-subjects experiments. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 1, pp. 1–65). San Diego, CA: Academic Press.

Amsel, A. (1971). Positive induction, behavioral contrast, and generalization of inhibition in discrimination learning. In H. H. Kendler & J. T. Spence (Eds.), *Essays in neobehaviorism* (pp. 127–236). New York: Appleton-Century-Crofts.

Amsel, A. (1972). Behavior at habituation, counterconditioning, and a general theory of persistence. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning: II. Current research and theory* (pp. 409–426). New York: Appleton-Century-Crofts.

Amsel, A. (1986). Daniel Berlyne Memorial Lecture. Developmental psychobiology and behaviour theory: Reciprocating influences. *Canadian Journal of Psychology, 40,* 311–342.

Amsel, A. (1991). What I learned about frustration at Iowa. In J. H. Cantor (Ed.), *Psychology at Iowa: Centennial essays* (pp. 151–167). Hillsdale, NJ: Erlbaum.

Amsel, A. (1992). *Frustration theory: An analysis of dispositional learning and memory.* Cambridge, England: Cambridge University Press.

Amsel, A., Radek, C., Graham, M., & Letz, R. (1977). Ultrasound emission in infant rats as an indicant of arousal during appetitive learning and extinction. *Science, 197,* 786–788.

Amsel, A., & Roussel, J. (1952). Motivational properties of frustration: I. Effect on a running response of the addition of frustration to the motivational complex. *Journal of Experimental Psychology, 43,* 261–266.

Amsel, A., & Stanton, M. E. (1980). Ontogeny and phylogeny of paradoxical reward effects. In J. S. Rosenblatt, R. A. Hinde, C. Beer, & M. Busnel (Eds.), *Advances in the study of behavior* (pp. 227–274). San Diego, CA: Academic Press.

Amsel, A., & Ward, J. S. (1965). Frustration and persistence: Resistance to discrimination following prior experience with the discriminanda. *Psychological Monographs, 79* (4, Whole No. 597).

Brown, J. S., & Farber, I. E. (1951). Emotions conceptualized as intervening variables—With suggestions toward a theory of frustration. *Psychological Bulletin, 48,* 465–495.

Capaldi, E. J. (1966). Partial reinforcement: A hypothesis of sequential effects. *Psychological Review, 73,* 459–477.

Daly, H. B. (1991). Changes in learning about aversive nonreward accounts for ontogeny of paradoxical appetitive reward effects in the rat pup: A mathematical model (DMOD) integrates results. *Psychological Bulletin, 109,* 325–339.

Daly, H. B., & Daly, J. T. (1982). A mathematical model of reward and aversive nonreward: Its application in over 30 appetitive learning situations. *Journal of Experimental Psychology: General, 111,* 441–480.

Glazer, H. I. (1972). Physostigmine and resistance to extinction. *Psychopharmacologia, 26,* 387–394.

Glazer, H. I. (1974). Instrumental conditioning of hippocampal theta and subsequent response persistence. *Journal of Comparative and Physiological Psychology, 86,* 267–273.

Gray, J. A. (1970). Sodium amobarbital, the hippocampal theta rhythm, and the partial reinforcement extinction effect. *Psychological Review, 77,* 465–480.

Gray, J. A. (1982). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system.* London: Oxford University Press.

Henke, P. G. (1973). Effects of reinforcement omission on rats with lesions in the amygdala. *Journal of Comparative and Physiological Psychology, 84,* 187–193.

Henke, P. G. (1977). Dissociation of the frustration effect and the partial reinforcement extinction effect after limbic lesions in rats. *Journal of Comparative and Physiological Psychology, 91,* 1032–1038.

Hull, C. L. (1943). *Principles of behavior.* New York: Appleton-Century-Crofts.

Levis, D. J. (1976). Learned helplessness: A reply and an alternative S-R interpretation. *Journal of Experimental Psychology: General, 105,* 47–65.

McHose, J. H., & Ludvigson, H. W. (1966). Differential conditioning with nondifferential reinforcement. *Psychonomic Science, 6,* 485–486.

Mowrer, O. H. (1960). *Learning theory and behavior.* New York: Wiley.

Nation, J. R., & Massad, P. (1978). Persistence training: A partial reinforcement procedure for reversing learned helplessness and depression. *Journal of Experimental Psychology: General, 107,* 436–451.

Nation, J. R., & Woods, D. J. (1980). Persistence: The role of partial reinforcement in psychotherapy. *Journal of Experimental Psychology: General, 109,* 175–207.

Rashotte, M. E., & Amsel, A. (1968). Transfer of slow-response rituals to extinction of a continuously rewarded response. *Journal of Comparative and Physiological Psychology, 66,* 432–443.

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning: II. Current theory and research* (pp. 64–99). New York: Appleton-Century-Crofts.

Sheffield, V. F. (1949). Extinction as a function of partial reinforcement and distribution of practice. *Journal of Experimental Psychology, 39,* 511–526.

Spence, K. W. (1936). The nature of discrimination learning in animals. *Psychological Review, 43,* 427–449.

Wilson, W., Weiss, E. J., & Amsel, A. (1955). Two tests of the Sheffield hypothesis concerning resistance to extinction, partial reinforcement, and distribution of practice. *Journal of Experimental Psychology, 50,* 51–60.

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