Stimulus Generalization of Conditioned Taste Aversion in Rats

**Rick Richardson, Cathy Williams, and David C. Riccio**

*Kent State University, Kent, Ohio 44242*

- Relatively little information is available regarding the intradimensional stimulus generalization of conditioned taste aversion (CTA). Experiment 1 employed a between-groups generalization test to examine the extent to which conditioned flavor aversion to one sucrose solution generalized to other concentrations of sucrose in adult rats. Evidence of a gradient of aversion was obtained. Because generalization gradients in other tasks have been found to flatten over a retention interval, Experiment 2 investigated the effects of delayed testing (2, 7, or 21 days) upon the slope of the generalization gradient. The generalization gradient flattened at the longer intervals, suggesting that subjects forgot the specific attributes of the conditioning concentration and avoided generalized stimuli as if they were the original CS. Experiment 3 used a long delay between taste and toxicosis to degrade the associative contingency and found no evidence that the generalization gradients found in the first two experiments could be explained in terms of enhanced neophobia due to poisoning. These findings provide further evidence (cf. A. W. Logue, 1979, *Psychological Bulletin*, 86, 276–296; M. Domjan, 1980, in J. S. Rosenblatt, R. A. Hinde, C. Beer, & M. Busnel (Eds.), *Advances in the study of behavior*, Vol. 11, New York: Academic Press) that CTA shares a number of similarities with other learning processes. Further, they illustrate that stimulus forgetting can be detected in a paradigm considered relatively immune to retention loss.

- Although a voluminous literature on conditioned taste aversion (CTA) now exists (see Riley & Clarke, 1977), relatively little attention has been given to the phenomenon of intradimensional stimulus generalization in CTA. Thus, while several studies (e.g., Domjan, 1975; Parker & Revusky, 1982) have shown that toxicosis associated with one flavor (e.g., saccharin) will lead to avoidance of other flavors as well (e.g., casein), few experiments have examined the generalization of CTA along the CS continuum. This dearth of information stands in marked contrast to the extensive research

---

1 This research was supported in part by NIMH Grant MH437535 to D.C.R. The assistance of Stan Molenda in conducting Experiment 3 is gratefully acknowledged. Portions of these data were presented at Midwestern Psychological Association, Chicago, May 1983.

Requests for reprints should be sent to Rick Richardson or David Riccio, Department of Psychology, Kent State University, Kent, OH 44242.
on stimulus generalization in other paradigms (e.g., Hall, 1976; Mackintosh, 1973; Thomas, 1981). In one of the relatively few studies examining generalization of CTA, Nowlis (1974) found weak evidence of a generalization gradient. However, the results of Nowlis' experiment were best explained by a stimulus intensity dynamism effect; that is, as the intensity of the test stimulus increased, avoidance behavior also increased. Evidence of a stimulus dynamism effect has also been obtained when visual cues, rather than flavor, were paired with toxin. Extending an earlier study demonstrating that quail formed an aversion to the color of a substance more readily than its taste (Wilcoxin, Dragoin, & Kral, 1971), Czaplicki, Borrebach, and Wilcoxin (1976) found that quail showed stronger aversion to new but more intense stimuli along the visual CS dimension at testing.

On the other hand, in an unpublished study, Logue (1978) has reported a generalization gradient in rats receiving lithium chloride (LiCl) injections after exposure to saccharin. In two experiments using different concentrations of saccharin as the CS and a within-subjects procedure to assess aversion to various test concentrations, Logue obtained roughly U-shaped gradients in which lick responses were fewest to the original training flavor. Subjects tended to show more responding (i.e., less CTA) as the test concentrations diverged from the CS. Also, Tapper and Halpern (1968) presented evidence that rats show inter- and intrachemical generalization gradients. However, because only solutions weaker than the concentration used in conditioning were examined in establishing the intrachemical generalization gradient, it is unclear whether the reduced aversion reflected generalization decrement or the lower end of a dynamism gradient.

Given the ambiguous and limited nature of these findings, the overall aim of the present study was to examine further the extent to which a conditioned flavor aversion to a particular sucrose solution generalized to other sucrose solutions of different concentrations. Because CTA is considered by some to represent a unique form of learning (Rozin & Kalat, 1971; Seligman, 1970; but cf. Domjan, 1980) whether stimulus generalization occurs is of interest because it bears on the relationship of taste aversion learning to other associative paradigms. In addition, the empirical findings may help clarify one aspect of the presumably adaptive function of CTA. It is not necessarily obvious a priori whether it would be advantageous for an organism like the rat to favor precision or generality in learned food aversions. That is, from a psychobiological perspective, it is not self-evident that the rat should possess a highly precise learning ability, such that it avoids only the particular taste that was related to illness. In designing the omnivore one could certainly argue that the learning mechanism should allow the animal to renounce a range of similar tastes as well.
EXPERIMENT 1

Method

Subjects. Thirty-four adult (76–208 days of age) male rats purchased from the Holtzman Company served as subjects. The animals had been used in previous experiments on retrograde amnesia involving footshock, hypothermia, and/or electroconvulsive shock, but had not been exposed to flavored solutions, water deprivation, or injections of any kind. All subjects were individually housed in standard wire-mesh cages and maintained on a 15/9-h light/dark schedule. Food was available ad lib, but water was removed 24 h prior to conditioning and testing sessions.

Procedure. Conditioning consisted of a 10-min exposure to a 10% (w/v) sucrose solution (in a 100-ml graduated cylinder; Wahman Co.) followed immediately by an intraperitoneal injection of a 3 M LiCl solution (1 ml/kg of body wt). Water bottles were returned 3–4 h after conditioning. On the day following conditioning, all animals were water deprived again. Twenty-four hours later, a 10-min, two-bottle preference test was administered to all subjects. A between-groups design was used to assess generalized taste aversion. For all animals, one graduated cylinder contained tap water and the other contained a sucrose solution. The cylinder containing sucrose was always placed on the cage first and always on the left side of the cage. The sucrose solution was either a 2.5, 10 (the conditioning concentration), or a 32% (w/v) concentration; thus, there were three independent groups tested (2.5% vs water, 10% vs water, and 32% vs water). Intakes were measured to the nearest 1.0 ml. Subjects were randomly assigned to one of the sucrose concentrations at the preference test. Sucrose preference ratios were obtained by dividing sucrose intake by total liquid intake. Ratios near .00 are indicative of a sucrose aversion, whereas ratios near 1.0 are indicative of a sucrose preference.

Results

A Kruskal–Wallis ANOVA on intake of sucrose during the conditioning trial demonstrated that the three groups of subjects formed at testing did not initially differ in their consumption of 10% sucrose ($H = 2.86, p > .10$). With regard to average intake (medians reported), subjects tested with 2.5% sucrose consumed 16.5 ml of the 10% sucrose solution at conditioning, subjects tested with 10% sucrose consumed 16 ml, and subjects tested with 32% sucrose consumed 15 ml. Subjects given 10% sucrose at test had a median sucrose preference ratio of .06, whereas subjects given 2.5 and 32% sucrose had preference ratios of .13 and .11, respectively. Subsequent analysis of these data, with a Kruskal–Wallis ANOVA, indicated a significant treatment effect ($H = 10.13, p < .01$). Pairwise comparisons with the Mann–Whitney $U$
test demonstrated that subjects receiving the 10% solution at testing had a greater aversion than subjects exposed to the other sucrose concentrations (10 vs 2.5%, \( U = 22.5, p < .02 \); 10 vs 32%, \( U = 20, p < .02 \)). Also, the aversion to the two generalized concentrations did not differ (i.e., aversion to 2.5 and 32% solutions were equivalent). This pattern reflects a generalization gradient of conditioned taste aversion along the sucrose concentration continuum.

The overall pattern of results obtained in this experiment cannot be due to subjects having learned to suppress drinking per se. At conditioning, all subjects received LiCl immediately after drinking a 10% sucrose solution. Any suppression of drinking behavior produced by this procedure would be constant across all groups and could not, in itself, explain the differential preference ratios found in this experiment. Furthermore, the median total liquid intakes (sucrose and water) in this experiment were 16.5, 15, and 19 ml for those subjects tested with 2.5, 10, and 32% sucrose, respectively. Clearly, the present data cannot readily be accounted for in terms of a Pavlovian conditioning arrangement such as the conditioned emotional response phenomenon in which environmental cues paired with illness subsequently suppress the drinking response.

**EXPERIMENT 2**

The results of the first experiment clearly demonstrate that a generalization gradient can be obtained in the taste aversion paradigm. In the following experiment we sought to determine if the generalization gradients in CTA change as a function of the retention interval. It is typically found (Perkins and Weyant, 1958; Thomas and Riccio, 1979; Thomas, 1981) that as the retention interval lengths, subjects show a flattening of the generalization gradient; i.e., they tend to respond to generalized test stimuli as if they were the original conditioned stimulus. For example, Thomas and Riccio (1979), using the Kamin blocking procedure (Kamin, 1968) and a tone–light compound, were able to obtain blocking with the previously conditioned tone CS, but not with two similar tones, at a short retention interval. However, at a long retention interval, all three tones were able to block conditioning to the added stimulus (light). This indicates that the subjects did not forget the CS-US (tone–shock) pairings, but did forget the exact qualities of the CS as the retention interval increased. In a more traditional operant generalization paradigm, Thomas (1981) has shown that the differential rate in responding to the S+ and to generalized test stimuli diminishes with increasing delays of testing: essentially, amount of responding increases to generalized test stimuli while remaining constant to the S+. If the generalization gradient in CTA follows a similar pattern, subjects should show an aversion limited primarily to the conditioned concentration after a short retention interval, but extending to all three concentrations after a long retention interval.
Method

Subject. One hundred four adult (84–92 days of age) male rats purchased from the Holtzman Company served as subjects. Subject characteristics and housing procedures were the same as in Experiment 1.

Procedure. All procedures were the same as in Experiment 1 with the exception that subjects were tested either 2, 7, or 21 days after conditioning. Thus, there were three independent groups of subjects (2.5% vs H₂O, 10% vs H₂O, 32% vs H₂O) tested at each of these three intervals. Subjects were assigned randomly to retention interval and test concentration conditions. In all cases, subjects were 24 h water deprived at the time of testing.

Results

Initial intakes. Separate Kruskal–Wallis ANOVAs on the initial intakes of the nine groups of subjects (grouped according to subsequent retention interval and test concentration) indicated that subjects did not differ in initial intakes of the to-be-conditioned concentration (10%) of sucrose ($H = 3.16, p > .20$). Additional Kruskal–Wallis ANOVAs made on groups tested at the same interval or with the same test concentration, across the three intervals, were all also nonsignificant (all $H$'s $< 1.44$; $p$'s $> .20$).

Test preferences. As Fig. 1 indicates, a very clear generalization gradient was again found for subjects tested after a 2-day retention interval ($H = 11.77, p < .01$). Subsequent comparisons, using the Mann–Whitney $U$ test, demonstrated that in the three groups of adult rats tested after a 2-day interval, those given the conditioned concentration (10%) at testing had the strongest aversion (2.5 vs 10%, $U = 16.5, p < .02$; 10 vs 32%,

![Fig. 1. Median sucrose preference ratios at each of three test concentrations in adult rats 2, 7, or 21 days after a 10% sucrose–LiCl pairing.](image-url)
Furthermore, the preference ratios of subjects tested with the two generalized concentrations did not differ (2.5 vs 32%, \( U = 69, p > .10 \)).

As can also be seen in Fig. 1, this clear generalization gradient flattened with a delayed test. Separate Kruskal–Wallis ANOVAs on the preference ratios of subjects tested at the 7-day interval and the 21-day interval were both nonsignificant (\( H = 2.62 \) and \( H = 5.20 \), respectively, \( p > .05 \)). Thus, with a delayed test, subjects came to treat the novel test concentrations (2.5 and 32%) as if they were the poisoned concentration (10%). Subjects did not forget the conditioned response (avoidance of sucrose) but displayed similar strong avoidance responding to the additional taste stimuli.

Additional analyses which compared subjects exposed to the same test concentration at the three retention intervals (i.e., 2.5% at 2-, 7-, and 21-day retention intervals) were also performed. A Kruskal–Wallis ANOVA comparing subjects given the conditioned concentration (10%) at test was not significant (\( H = .59, p > .10 \)). Thus, the conditioned taste aversion did not increase or decrease as a function of the retention interval. Because of a floor effect, it may have been impossible for the aversion to increase, but this analysis at least indicates that the baseline aversion was stable across the retention intervals employed. A separate Kruskal–Wallis ANOVA comparing rats given the 2.5% concentration was significant, however (\( H = 12.32, p < .01 \)). Subsequent pairwise comparisons, with the Mann–Whitney \( U \) test, demonstrated that subjects tested with the 2.5% concentration had significantly stronger aversions after the 7- and 21-day interval than after the 2-day interval (2-day vs 7-day, \( U = 10.5, p < .002 \); 2-day vs 21-day, \( U = 22, p < .02 \)). Subjects tested at the two long intervals did not differ from one another (7-day vs 21-day, \( U = 58.5, p > .10 \)). Exactly the same pattern of results was obtained for animals tested with the 32% concentration. A Kruskal–Wallis ANOVA comparing these groups was significant (\( H = 8.99, p < .02 \)). Subsequent pairwise comparisons demonstrated that subjects tested at the two long intervals did not differ from one another, but both differed from subjects tested at the short interval (2-day vs 7-day, \( U = 27.5, p < .02 \); 2-day vs 21-day, \( U = 35.5, p < .05 \); 7-day vs 21-day, \( U = 45, p > .10 \)).

As in Experiment 1, the aversion does not reflect a general suppression of fluid intake. This conclusion is supported by both the differential pattern of suppression at the 2-day interval and the overall level of fluid consumption across all test intervals. (Median total intake at testing ranged from 10.5 to 15.5 ml.)

Discussion

The data from this experiment are consistent with those of Experiment 1 and provide an interesting extension of information on the retention
of CTA. Not only was the basic generalization gradient obtained in Experiment 1 replicated, but this gradient was found to flatten significantly, i.e., to change from differential to nondifferential responding to test stimuli, with a delay between training and testing. The lack of differential responding to the three sucrose concentrations at the longer intervals strongly suggests that subjects forgot the specific attributes of the CS as a function of the delay of testing, although the conditioned avoidance response itself was well retained. Thus, this finding, along with that obtained by Thomas and Riccio (1979) with the CER paradigm, illustrates that retention of the stimulus characteristics that control aversively motivated responding may be lost more rapidly than the learned response. Paradoxically then, response strength when summed across stimuli increases after a retention interval and, as the McAllisters (McAllister & McAllister, 1963, 1967) have noted, can be mistakenly interpreted as "incubation."

EXPERIMENT 3

In our judgment, there is ample evidence that CTA is based upon associative processes as opposed to performance artifacts such as pseudoconditioning or, more specifically, neophobia (see, for example, Garcia, 1978; Revusky, 1978; Smith, 1978). However, it could be argued that exposure to a toxin might modify subjects’ later responsivity to novel (generalized) taste stimuli, either directly or as a neophobic response. Thus, although the view that subjects forget specific CS attributes provides a highly plausible interpretation of the flattening of the generalization gradient, the design of Experiment 2 did not rule out possible effects of noncontingent illness. Since exposure to a toxin can enhance neophobic responses, an alternative explanation would be that the flattening of the gradient reflects a time-dependent increase in neophobia rather than a loss of stimulus control. More specifically, the argument might be as follows: Rats generally consume small amounts of a novel substance (i.e., display neophobia) and it has been shown (Domjan, 1975) that this neophobic response can be increased by poisoning subjects prior to their exposure to the novel substance. As the 2.5 and 32% sucrose solutions are novel solutions, subjects tested to these concentrations may exhibit some neophobic tendency. As all animals received a LiCl injection in Experiment 2 on the day of training, in conjunction with the CS, perhaps the decreased consumption of the 2.5 and 32% solutions after the long retention intervals is due to an enhancement of neophobia which increased over time. While we know of no evidence that neophobia to novel substances increases with long intervals following poisoning, Experiment 3 was conducted to determine what role, if any, enhancement of neophobia had in the flattening of generalization gradients obtained in Experiment 2.
The appropriate control conditions to address this issue are debatable. Pairing a novel taste with illness maintains the amount of exposure to a CS and the UCS, as well as their associative relationship, but runs the serious danger that any aversion to the flavor will also generalize to the test stimuli. Such an outcome could hardly be viewed as a control for nonassociative effects, of course. Presenting water as a neutral "tasteless" CS prior to toxin injection probably precludes conditioning and generalization of CTA, but introduces other problems: (a) sucrose experience is not comparable to that in the experimental groups and (b) the CS differs from that in Experiments 1 and 2 by being familiar rather than novel. An alternative approach, which we chose, is to provide CS and UCS exposures equivalent to those in the preceding experiments, but to degrade the associative connection by introducing a long delay interval. Thus, subjects in Experiment 3 were comparable to animals undergoing CTA training with respect both to consumption of 10% sucrose solution and to experience with LiCl-induced illness when tested with one of the three sucrose concentrations, but differed in the associative relation between 10% sucrose and illness.

Method

Subjects. Eighty-three adult male rats (75-113 days of age) purchased from the Holtzman Company served as subjects. Subject characteristics and housing procedures were the same as in Experiment 1. Subjects were randomly assigned to their respective treatment condition.

Procedures. All subjects were water deprived 24 h prior to a 10-min exposure to a 10% sucrose solution. Approximately 4 h after this exposure water bottles were returned to all animals. On the day following the sucrose exposure 60 subjects were weighed and given an injection (ip) of LiCl (3 M, 1 ml/kg). The additional 23 subjects were weighed and given an injection of physiological saline (0.9%, 1 ml/kg). Immediately following the injection, water bottles were removed from all subjects receiving saline and from 25 of the subjects receiving LiCl. Twenty-four hours after the injection (2 days after the sucrose exposure) all of these 48 subjects were given a 10-min two-bottle preference test with water versus either 2.5, 10, or 32% sucrose solutions. Thus, the following six groups (n's ranging from 7 to 9) were tested 2 days after their initial exposure to the 10% sucrose solution: 2.5%-LiCl, 10%-LiCl, 32%-LiCl, 2.5%-Sal, 10%-Sal, and 32%-Sal. (The first symbol refers to the test concentration of sucrose and the second to the substance the subject was injected with 24 h prior to test.) Those animals injected with saline provide an estimate of the subjects' normal consumption of the sucrose concentrations employed in this experiment. As there was a 24-h interval separating the initial sucrose exposure and the LiCl injection, no taste aversion to the 10% sucrose should have been formed in those subjects.
injected with LiCl. However, any enhancement of the neophobic response by an exposure to poison should be indicated by these animals. A lower sucrose preference ratio by those subjects injected with LiCl (relative to those subjects injected with saline) would indicate that mere exposure to poisoning and the resulting illness enhanced neophobia.

The remaining 35 subjects injected with LiCl were tested 6 days later (7 days after the initial exposure to sucrose), as the gradient in Experiment 2 was as flat at this interval as at the 3-week test. Animals were 24 h water deprived at the time of testing and were tested with either a 2.5, 10, or 32% sucrose solution versus tap water. These subjects provide an assessment of whether any enhancement of neophobia produced by exposure to a toxin changes over time. If exposure to toxin leads to enhanced neophobia which increases during a retention interval, then these subjects would be expected to have even lower sucrose preference ratios than counterpart rats tested 1 day after poisoning.

Results

Initial intakes. A Kruskal–Wallis ANOVA comparing all nine groups on initial intakes of the 10% sucrose solution was not significant ($H = 5.16, p > .10$).

Test preferences. Separate Kruskal–Wallis ANOVAs comparing the six groups tested 2 days after their initial exposure to sucrose ($H = .60$), the three groups tested 1 day after the LiCl injection ($H = .21$), the three groups tested 1 day after the saline injection ($H = .21$), and the three groups tested 6 days after the LiCl injection ($H = .17$) were all nonsignificant (all $p$'s > .10). None of the groups tested 2 days after their initial exposure to sucrose differed in their sucrose preference ratios. If exposure to a toxin enhanced neophobia, then those subjects injected with LiCl should have consumed less sucrose at test than subjects injected with saline, but this was not the case. As can be seen in Table 1, all subjects had strong preference for the sucrose solutions. Apparently, with this procedure, exposure to a toxin does not enhance neophobia.

To determine if exposure to poison enhanced neophobia with a delay between poisoning and testing, pairwise comparisons of those subjects injected with LiCl and tested 1 or 6 days later (for example, 2.5% LiCl with 1-day interval vs 2.5% LiCl with 6-day interval) were made. As none of these comparisons was found to be significant (all $U$'s $\geq 57$, all $p$'s > .10) it appears that introducing a delay between LiCl injection and the test session does not increase neophobia.

Discussion

Under the conditions employed here, there is no evidence for toxin-induced enhancement of neophobia, whether testing was conducted at either a brief or a long delay interval after poisoning. As the procedures
Median Sucrose Preference Ratios in Experiment 3

<table>
<thead>
<tr>
<th>Sucrose solution (%) at test</th>
<th>Interval between injection and test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saline—</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
</tr>
<tr>
<td>2.5</td>
<td>.83</td>
</tr>
<tr>
<td>10</td>
<td>.78</td>
</tr>
<tr>
<td>32</td>
<td>.86</td>
</tr>
</tbody>
</table>

(except for the taste-poisoning interval) were identical to those in Experiment 2, these “negative” results are useful in evaluating the CTA generalization gradients. There seems little doubt that both the generalized avoidance of sucrose concentrations and the increase in this avoidance with test delay are based upon associative process rather than performance artifacts from illness.

GENERAL DISCUSSION

The present findings clearly demonstrate stimulus control over conditioned taste aversion, at least in adult rats. At the 2-day test interval, subjects showed avoidance to all three test concentrations of sucrose, but substantially less aversion to the generalized stimuli. The generalization gradient is not attributable to decreased sucrose preference for the novel stimuli since data from controls (Experiment 3) indicate that the 2.5 and 32% are still strongly preferred over water, even after a noncontingent poisoning. Moreover, a decrease in baseline preference of those solutions would only work against obtaining a gradient, as the change would be reflected in a smaller, rather than larger, sucrose-intake ratio.

Of major interest is the finding that the generalization gradients flattened as a function of delayed testing. That is, subjects came to respond to the generalized stimuli as if they were the originally conditioned concentration. Thus, while CTA itself was well retained over a several-week interval (as has often been noted, e.g., Campbell & Alberts, 1979; Guanowsky, Misanin, & Riccio, 1983; Steinert, Infurna, & Spear, 1980), the present data indicate that a substantial shift occurs in stimulus control of the response. Our interpretation follows that offered for other instances.

It should be noted that, despite repeated efforts, our attempts to assess generalization of CTA in weanling rats to date have proved uninformative. An initial study yielded a stimulus generalization gradient generally parallel to that of adults, but in five subsequent replication experiments the gradients were substantially flat. Lack of differential responding at the short test interval also precluded investigation of the retention of stimulus attributes in immature rats.
of the flattening of a generalization gradient over time. Subjects retain the response but forget the specific attributes of the conditioned stimulus. In the present case, subjects presumably no longer remember the exact features of the taste cues paired with illness and therefore avoid related tastes as if they were the CS.

These data cast an interesting light on the long-term retention of CTA and the presumed “permanence” of memory in this paradigm. While our findings are consistent with others in showing no loss in aversion over a 21-day retention interval, at the same time they indicate substantial forgetting of the stimulus attributes after only a 7-day interval. Admittedly, this is not the type of memory usually considered in the retention of CTA, but the outcome points to the fact that some aspects of the taste–illness episode do indeed show retention loss.

From an adaptive standpoint, rats appear to have evolved with a mechanism which can produce strong suppression of intake of food associated with illness, but more moderate suppression of edibles that have a slightly different taste. Presumably, this response pattern could produce some discriminative “fine tuning” by permitting organisms to discover which foods are not accompanied by illness. However, in the absence of this discriminative opportunity, and with a lengthy interval after the illness episode, forgetting of specific characteristics of the stimulus results in the conservative strategy of increased avoidance of related tastes (cf. Hendersen, 1983).

Although it has been proposed that the associative processes underlying CTA are different from those underlying other types of learning tasks (e.g., Rozin & Kalat, 1971), there is an increasing amount of evidence that those processes are essentially the same. Logue (1979) cites a number of examples in which CTA learning follows the same principles established for more traditional tasks. The present findings add further support to Logue’s contention. Even with the methodologically inefficient between-groups design, rats showed classic V-shaped generalization gradients. Furthermore, the change in the gradient with delayed testing is remarkably similar to results obtained with traditional conditioned, discriminative, or contextual stimuli (see Riccio & Ebner, 1981; Riccio, Richardson, & Ebner, in press, for reviews). It would appear that CTA is an intriguing but not a unique learning phenomenon.

REFERENCES


