ment time about 5 min. A number of plates may be exposed and developed simultaneously by using large sheets of paper.

The only necessary precautions are the use of an agar layering medium which does not contain granules of undissolved material which might be mistaken for microcolonies, and the selection of Petri plates with unscratched glass bottoms. Ordinary care should be taken to prevent contamination when the plates are uncovered for photographing. It is felt that this method possesses advantages over the usual marking procedure in saving time, increasing accuracy, and providing a permanent record of each plate.

References

1. LEDERBERG, J., and TATUM, E. L. *J. biol. Chem.*, 1946, **165(1)**, 381.
2. WAGNER, K. A. *Turtox News*, 1948, **26(1)**.

Sentential and Propositional Generalizations of Salivary Conditioning to Verbal Stimuli

Gregory Razran

Department of Psychology, Queens College, and The John Simon Guggenheim Memorial Foundation

While conditioned responses to single words have been established by a few investigators, no one, to the writer's knowledge, has studied the course of true conditioning to whole sentences, or propositions. In the present study, salivary CRs were formed in four adult human subjects to three short sentences—"Poverty is degrading," "Roosevelt will be elected," and "Socialism is desirable"—and the generalization of the conditioning to sentences, with reversed "subjects" and/or "predicates" and/or "copulas," was mapped out.[1] The writer's technique of salivary conditioning has been previously described (*1*). It consists essentially of measuring saliva by weighing increments in dental cotton rolls (Johnson and Johnson, No. 3, 0.5/15 in) inserted under the subjects' tongues for a short period of time, usually for 1 min. Since the cotton-in-the-mouth is by no means a totally inactive stimulus, periods of control salivation must be rotated with experimental periods; and, again, to prevent evaporation, scale-corrosion, and absorption, the rolls are weighed in small cellophane envelopes, and reweighed in the envelopes immediately after their removal from the subjects' mouths. Other characteristics of the technique are: (1) multiple intermittent 1-sec presentations of stimuli-to-be-conditioned, during single continuous eating periods of 2–4 min, so as to provide maximum attention for the stimuli and to make the entire task more "molar" and meaningful; (2) misinforming the subjects about the nature of the experiment, so as to forestall disrupting subjective attitudes; and (3) varying the food—small pretzels, tea, sandwiches, lollipops and peppermint candy—in the different eating periods of the experimental sessions, and scheduling the sessions in the late morning or afternoon, so as to insure adequate psychophysiological motivation.

[1] "Wealth is degrading," "Wealth is uplifting," "Poverty is uplifting," "Wealth is not degrading," "Poverty is not degrading," "Poverty is not uplifting," "Wealth is not uplifting"; "Dewey will be elected," "Dewey will be defeated," "Roosevelt will be defeated," "Dewey will not be elected," "Roosevelt will not be elected," "Roosevelt will not be defeated," "Dewey will not be defeated"; "Capitalism is desirable," "Capitalism is undesirable," "Socialism is undesirable," "Capitalism is not desirable," "Socialism is not desirable," "Socialism is not undesirable," "Capitalism is not undesirable."

TABLE 1

GENERALIZATION OF CONDITIONED SALIVATION TO SENTENCES: "POVERTY IS DEGRADING," "ROOSEVELT WILL BE ELECTED," AND "SOCIALISM IS DESIRABLE"*

Generalization sentences†	Logical formula	Percent of generalization	Mean of percent
We ⊕ Ul ; De ⊕ Df ; Ca ⊕ Ud	S′CP′ ○	59 ; 53 ; 63	58
We × Dg ; De × El ; Ca × Ds	S′C′P ○	49 ; 50 ; 58	52
Po × Ul ; Ro × Df ; So × Ud	SC′P′ ○	44 ; 41 ; 51	45
We ⊕ Dg ; De ⊕ El ; Ca ⊕ Ds	S′CP ●	38 ; 31 ; 39	36
Po × Dg ; Ro × El ; So × Ds	SC′P ●	37 ; 28 ; 34	33
Po ⊕ Ul ; Ro ⊕ Df ; So ⊕ Ud	SCP′ ●	33 ; 36 ; 30	33
We × Ul ; De × Df ; Ca × Ud	S′C′P′ ●	19 ; 28 ; 27	25

* Each entry in the third column is a mean of 64 measurements, 16 for each of the four subjects in the experiment.

† Abbreviations and symbols: We = wealth, Ul = uplifting, De = Dewey, Df = defeated, Ca = capitalism, Ud = undesirable, Dg = degrading, El = elected, Ds = desirable, Po = poverty, Ro = Roosevelt, So = socialism; ⊕ = *is* or *will be*, × = *is not* or *will not be*; S′ = reversed subject, P′ = reversed predicate, C′ = reversed copula; ○ = proposition affirmed, ● = proposition negated.

In this particular experiment, each of the three to-be-conditioned sentences was flashed 30 times, in random order, on a screen for 2 sec—with random intervals of 1 to 2 sec between flashes—during eating periods of 3 min. Ten such eating periods, with random rest periods of ½–1½ min between them, constituted an experimental training session; and after the first two training sessions, came eight training-testing sessions. Each training-testing session consisted of six 3-min eating periods, during which the three sentences were presented, and of six 16-min testing periods, during which the amount of conditioned salivation (1-min experimental minus 1-min control salivation in mg), to the conditioned and to the generalization sentences, was ascertained. Testing periods alternated with eating periods, and in each testing period the CRs of only one conditioned sentence and of its appertaining generalization sentences were determined, so that each sentence—conditioned as well as generalization—was tried twice in each experimental training-testing session and 16 times in the entire experiment. The four subjects were undergraduate college students, and they were divided into two equal subgroups, the procedures for the subgroups differing, however, only in the sequences of testing the CRs.

The results are presented in Table 1. They are given in percent of generalization, that is, the conditioned

salivation to the generalization sentences as percent of the conditioned salivation to the conditioned sentences (the latter ranging from 189 to 531 mg per min). For lack of space, the entries in the first column of the table are abbreviated, while the first entry in the second column under *Logical formula* means that each of the three generalization sentences in the first row of the first column was formed from its respective conditioned sentence by reversing the "subject" (S′), keeping the "copula" (C) unchanged, and reversing the "predicate" (P′) of the conditioned sentence, thus affirming (○) its proposition; and the fourth entry in the second column means that each of the three generalization sentences in the fourth row of the first column was formed from its respective conditioned sentence by reversing the "subject" (S′) but keeping unchanged the "predicate" (P) and the "copula" (C) of the conditioned sentence, thus negating (●) its proposition. As seen from the table, the amount of CR generalization was a function of both (a) the general logical equivalence of the propositions in the generalization sentences to those in the conditioned sentences, and (b) the particular verbal similarity of the two types of sentences. The generalization factor of *propositional equivalence* is seen in the greater CR generalization to the sentences in the first three rows, affirming the propositions of their respective conditioned sentences, than to the sentences in rows four, five, and six, negating these propositions, even though the sentences in the latter rows were sententially twice as similar to the conditioned sentences. On the other hand, the significance of the factor of *sentential similarity* is manifest in the differences between CR generalizations to sentences that were propositionally equivalent yet sententially different, such as each of the sentences in the first three rows and each of the sentences in rows four, five, and six—and it further follows from the fact that the generalization to the sentences in the first rows that were propositionally equivalent yet sententially different from their respective conditioned sentences was not complete, but ranged from 41 to 63 percent. The table also appears to show that sentential similarity is itself a complex function, and is more than mere verbal similarity. Thus, comparing rows two and three, and four and six, we learn that reversing the "predicate" produced a greater loss in CR generalization than reversing the "subject," which fact points to both a grammatical factor of *syntax* and a logical factor of the relative contributions of "*concepts*" and "*individuals*" to total propositions. Finally, the table gives some indication that changing "desirable" to "undesirable" resulted in less of a loss of CR generalization than changing "degrading" to "uplifting" and "elected" to "defeated." This apparently means that even pure verbal similarity between sentences must, in its turn, take account of not only the number of identical words between the sentences, but also the intersentential relatedness of nonidentical and even of contradictory words. In a previous study (*2*), the writer found that CR generalizations to single words proceeded both along semantic and along phonetic and graphic relatednesses—though more along the former than the latter—and that finding has since been corroborated by two other investigations in conditioning the galvanic skin response (*3*). It would seem worth while to try out, similarly, the more complex findings of the present study with other responses and techniques. And these techniques need not necessarily be those of conditioning.

References

1. RAZRAN, G. H. S. *Science*, 1939, **89**, 160–162.
2. RAZRAN, G. H. S. *Science*, 1939, **90**, 89–91.
3. RIESS, B. F. *J. exp. Psychol.*, 1940, **26**, 238–240; 1946, **36**, 143–152.

The Purification of Phenol for Paper Partition Chromatography

O. Janet Draper and Arthur L. Pollard

Department of Bacteriology, University of Tennessee

Since the original work of Consden, *et al.* (*1*) on paper partition chromatography, many workers have sought diligently for a better solvent system than the phenol-water which they used. So far nothing better has been reported even though the phenol-water system is frequently limited in usefulness by the development of extraneous colors, which are particularly harmful when the chromatogram is run in ammonia atmosphere, as it usually is.

In this laboratory, the method has been used for some time to identify amino acids in bacterial culture filtrates. The extraneous colors which were almost always present on the developed chromatogram introduced so much uncertainty that final results could not be presented with any confidence. A project was therefore undertaken to determine the cause of these colors and the possibility of eliminating them. This was finally accomplished and it is thought that the results may be of interest to others.

The colors are probably caused by the catalytic action of heavy metals on phenol. Consden, *et al.* (*1*) believed them to be caused by copper in the paper but it has been determined here that the principal source is from impure phenol and from the distilled water used to dilute it. Present practice is to distill all phenol before use. If in the form of crystals, it is liquefied with 12% water first. It is put into the distilling flask and 0.1% aluminum turnings and 0.05% $NaHCO_3$ are added. Distillation is carried on at atmospheric pressure until the azeotrope is off and then under about 25 mm from a water pump until approximately 20 ml of the almost black residue is left. A 14 mm × 70 cm Pyrex air-cooled tube is used as a condenser.

Before use the water content is adjusted to 25% using triple distilled water which is tested for heavy metals. The water content of the mixture is determined as follows: into a 15-ml centrifuge cone put 10 ml of the phenol-water solution and 500 mg of NaCl; stopper and shake the tube; allow to stand 20 minutes to form the phase boundary. This should be at 1.4 ml when the water content is 25%. The water content may vary from 24 to 28% without a detectable difference in Rf values. It should not, however, be at saturation since if a water