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John Augustus Larson (1892–1965)

An American physiologist, policeman, and inventor born in Canada to Scandinavian immigrants, Larson studied biology at Boston University and earned a master's degree in 1915. Interestingly, the subject of his MSc dissertation was fingerprint identification. Later, Larson studied at the University of California, Berkeley, where he obtained his PhD in physiology in 1920. In the same year he joined the forces of the Berkeley Police Department, quite likely becoming the first American policeman with a doctoral degree.

Larson knew Marston's experiments with blood pressure used as a method of lie-detection, and developed it further. First, he combined Marston's test based on the examination of blood pressure with measurements of the pulse, and control of respiration with the use of the pneumograph. In this way, he constructed the first polygraph for the detection of deception. It is worth mentioning that August Vollmer, at the time Chief of the Berkeley Police Department, supported Larson in his experiments.

Larson's polygraph (called "sphymomanometer", or shortly "sphyggy") is included on the 2003 List of the 325 Greatest Inventions of All Time of the *Encyclopedia Britannica Almanac* along with the hot air balloon of the Brothers Montgolfier, the Flyer (airplane) of the Wright Brothers, Torricelli's barometer, A. Jeffreis's DNA fingerprinting, Willem Einthoven's electrocardiograph, and many others.

Larson is an unquestioned pioneer of using polygraph in criminal investigations. When the use of polygraph examination spread widely and wildly (notably, with no scientific control) in many fields of life, Larson lost interest in the polygraph and turned to psychiatric practice. He is alleged to have said that he "*At times I'm sorry I ever had any part in its development*". Anyway, a hundred years ago, a new era of criminal investigation began in Berkeley, California. The era of criminal investigation supported with polygraph examination.

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Modification of the Marston Deception Test

In his latest article in this JOURNAL, Marston describes a test whereby deception or the emotional syndrome involved in lying may be detected in an individual. In brief, he studies the changes in the systolic blood pressure which are produced by emotional disturbance (4). According to his description he has obtained 100 per cent accuracy in cases upon which the tests were tried, both in court cases and upon a number of individuals in an army test. Before mentioning his own technique, Marston sums up, or rather criticizes, the hitherto prevalent methods for the determination of the presence of emotional disturbances. For our own purpose it may be well to mention them briefly.

The first and very common psychological test is the so-called "association test." The second is the galvanometric test, and the third is physiological. In his work Marston considered all methods, but later dispensed with all except that of the blood pressure. We agree with Marston that the association test is often cumbersome and difficult to interpret and not very satisfactory for presentation before courts. However, the second method, that in which the galvanometer is used, is not to be so easily disposed of. The great difficulty experienced in the ordinary use of the galvanometer lies primarily in the instrument. It is well known that the ordinary galvanometers give results which are very difficult to interpret properly and show too many variations. If the proper use is made of the string galvanometer, the results are highly satisfactory and important. The most interesting work in relation to the test that is to be described is that of Hyde and Scalapino (3). They studied the effects of music as indicated in the electrocardiogram. Here they found definite changes in the electro-motive force, and in addition, changes in the systolic and diastolic blood pressures. The changes in blood pressure were studied by the use of a modified Erlanger apparatus and a Tycos Sphygmomanometer.

Prior to Marston's time Benussi (1) was the first to show definite results from the lying processes upon respiration. Benussi found a characteristic ratio of inspiration to expiration, symptomatic of "inter-

[1]Ph. D., Member of the Police Force, Berkeley, Cal.

nal excitement" caused by lying and this was found to be stronger in the case of clever liars than in the case of easily detectable ones. In the latter case such excitement may injure and modify the truth of the records if the test is not carefully controlled. The work of Benussi (1) is of especial interest to this investigation since both respiratory and circulatory changes are to be considered.

Marston's articles should be consulted for a description of various tests made by him upon students and offenders (4) His work is of especial interest to us since his so-called deception test consists in the recording of changes in the systolic blood pressure produced by emotional disturbances. It is important to note that Marston found that sustained intellectual work showed no appreciable effects on the blood pressure. Since he found that the diastolic pressure was less readily controlled, this was not utilized. This should answer such objections as that blood pressure might be influenced by the solution of short mathematical problems to the same extent as that caused by the basic emotions such as those involved in lying. But this objection might, however, be put to the use of the plethysmograph in recording effects of emotional disturbances, since here there are so many slight changes involved and these are so variable as to render the interpretation at times impossible. Therefore the plethysmograph, which involves any slight vasomotor change, is not nearly as practical as the direct measurement of the systolic blood pressure.

Marston obtained very definite results in correlating changes in blood pressure with what he termed "the deception process." In his experimental work with students and offenders he obtained as high as 100 per cent accuracy in determining whether or not a suspect was telling the truth. He conducted three investigations in which the blood pressure was used directly as a criterion of guilt, or better, deception. In the first he had students deliberately lie if so inclined, but if they did so he detected it from the pressure curve obtained. Of course there is a possible objection to this investigation, since the lying might seem artificial in most cases, but still the result is of great importance, for if an artificially created condition will cause enough deviation from the curve obtained when telling the truth, how much more will this result be intensified given an act of real deception. Such a condition Marston obtained in his last investigation, in which he actually tried his testing upon persons suspected of misdemeanors. Wherever he used cases in which the results were subsequently checked up by the outcome of the cases, he reported 100 per cent accuracy. In another investigation previous to this one he obtained over 90 per cent accuracy,

working with a group of army men at a training camp. The condition of this experiment was more nearly the same as that of the investigation first mentioned, and again, although the result was not a vital issue to the men concerned, any deception was at once detected.

The only criticism of Marston's technique is in the method utilized. He took the pressure by feeling the pulse. This method is being gradually superseded by the auscultatory method, in which a stethoscope is utilized to get the sound. This method has the advantage over the palpitory method in that there is not such a personal factor involved. Often two physicians of long experience disagree as to the exact reading by the palpitory method, whereas in the auscultatory method the systolic pressure is more accurately detected. However, if the pulse method be used, an apparatus such as the Dudgeons Sphygmograph should be used, for in work of this kind it is desirable to eliminate all personal factors wherever possible, for in making interpretations or readings much depends upon the individual. Marston mentioned this latter method, but did not use it. Another objection is the discontinuous method used by him, for he took readings at certain intervals, say two or three minutes, but during the intervening periods, any fluctuations were lost.

In our work the aim is to eliminate all the variables possible. Thus, if for no other reason than to determine the effect of respiration upon the heart rate, a pneumographic record is taken simultaneously with the blood pressure. In addition to the rythmic rise and fall in blood pressure produced by respiratory changes, there are irregular changes in the pressure curve which appear in certain persons, but these are best detected with the pressure slightly below systolic. The blood pressure is obtained by the use of the Erlanger Sphygmomanometer, which has the great advantage that a continuous record can be taken. A modification of this apparatus will subsequently be made, since different investigators disagree as to the accuracy of this instrument in recording the exact moment of the appearance of the systolic pressure. However, in the present working this would not vitiate the results since they are qualitative and relative, for all the emotions are studied commencing with the same initial pressures, and furthermore, each factor is checked up by a determination of the systolic pressure by a Tycos Sphygmomanometer and stethoscope. In all cases the systolic pressure is the one made use of, since Marston found that the diastolic was so easily affected by external stimula.

In the work of Hyde and Scalapino (3) the effect of music upon the electro-cardiogram and blood pressure was studied by a string gal-

vanometer and a modified Erlanger with a Tycos Sphygmomanometer. But these investigators used both the systolic and diastolic pressures.

In our apparatus, in addition to pneumograph and Erlanger, the time and the exact moment of asking the questions are recorded separately on two drums working together. For the former a Jacquet chronometer or a signal magnet operated by a metronome or some similar device may be used; for the latter an ordinary signal magnet connected in series with a key and a battery can be used. By the use of ordinates crossing all the lines, the heart beats and respirations can be recorded as well as the exact instant that the stimulus question or association word is applied. In addition, by a modification of the Erlanger the pressures can be obtained directly and recorded on a separate line. However, at the present time we obtained the quantitative changes of pressure throughout the entire investigation by means of the Tycos Sphygmomanometer and a stethoscope. These readings are taken on the opposite arm to that to which the cuff of the Erlanger is attached, and while the subject is resting from a tracing made by the Erlanger; and since continued application of the pressure necessary for tracing on the Erlanger often becomes very uncomfortable and painful, the investigation should be divided up into intervals of from three to ten or more minutes, depending upon the comfort of the subject, but this interval should be the same for all of the subjects.

There is still one important variable to be controlled and that is the method in which the questions are applied, for the subject can get many hints from the manner of intonation of the examiner. To obviate this the questions should be delivered in uniform monotone, with no change of inflection, and by one experienced in conducting such examinations. However, this objection can be wholly overcome by having all questions or important association words written and placed on a drum which is made to rotate before the subject, who should face this drum and who should be screened off from the sight of any other drums or the examiner. Their questions can be timed and by the use of a suitable device, such as pegs projecting from the top of the drum which will automatically make and break a circuit and by means of a signal magnet, these instantly can be recorded underneath the pressure readings.

There are other very important factors to be considered which may modify the interpretation of the results. Thus a query is raised that, given two persons, a suspect and an innocent person, and accuse them of committing a serious crime or felony, the reactions of these two persons may be alike. Thus an innocent person accused of mur-

der will naturally experience several emotions, the chief of which will be fear and possibly anger, but fear is the emotion which should dominate when an individual is suddenly confronted with a strong accusation and in an unusual environment, where his entire future is at stake. However, it has been found by trial that any such initial emotions are of short duration and do not affect the interpretation. Another way of controlling any possible initial emotion of the innocent is to control the results obtained by the innocent with those obtained by the suspect or the guilty, and this can be done by subjecting them to the same conditions, and it is *very important* to emphasize that here all the questions *should be the same.* In addition to controlling the innocent person against the suspect, the questions should be so planned that the emotional response of the same individuals should be controlled as fully as possible. This can be done by alternating questions bearing upon the subject at hand, usually of an accusatory nature, with those arousing other emotional response, such as intense interest, anger, etc. In this light it is interesting to note that in one investigation, although all the individuals were given the same questions in the same sequence, there was a marked variation in response shown by subsequent inspection.

In all the so-called controls, even though one individual gives different responses than the other, the curve of blood pressure and respiration shows a marked uniformity throughout. The subjects afterward said that their only feelings were of marked interest and that the only effect of accusation was to arouse a feeling of resentment, but this was not intense enough to influence the curve. In one case an individual was told to lie deliberately (this being a person from whom certain articles were taken, and although the subject lied about every other question this was manifested by a very perceptible pressure change, although the individual said there was no definite motion involved in the lie, such as pleasure or pain, except that there was a feeling that something was being done which should not normally take place.

By way of recapitulation, the essential features of this test will be enumerated. All important changes in blood pressure, heart rate and respiration are recorded by the apparatus described, with special reference to the effect of emotion upon these changes. It is impossible for a subject to prevent any emotional changes from showing on the drum, and any involuntary inhibitions of breathing and movements are recorded as well. If the subject makes any muscular movement, there will be a resultant change in the drum which can be labeled and discounted later.

SUMMARY

In this investigation the effects of the emotional changes upon the circulatory and respiratory systems during an intensive cross-examination are recorded.

The following instruments are made use of:

An Erlanger and Tycos Sphygmomanometer, a pneumograph, and in addition to these, various signaling devices are also employed.

USE OF THE MODIFIED DECEPTION TEST IN A PRACTICAL TEST

It may be interesting to note the results obtained by the above test in a recent investigation. A description of the cross-examination and other results will tend to elucidate some of the variables met with and a way in which these may be overcome.

The problem involved was to find out who, out of one hundred girls living together in a large hall, was responsible for a series of thefts. Several thefts, aggregating about $600.00, had centered in a definite corner of the building, within two or three rooms in fact, and the suspicion narrowed down to three or four of the girls. That is, all of the evidence which the officer investigating the case had accumulated seemed to point to these girls, and yet it was nothing but hearsay evidence. It was thought desirable to make a blood-pressure test, and incidentally it might be noted that in the circumstances surrounding the thefts it was practically impossible for the officer, ordinarily, to go further. But none of the girls could refuse to help us by submitting to any tests that we might use. In fact about twenty-five girls were chosen, all of whom lived in the vicinity of the place where the thefts were committed. The test was purposely made without first ascertaining who might be responsible, so that the interpretation of the record might not be biased. We were prepared, if necessary, to submit every girl to the test, but found the party responsible before going through the second group of subjects.

The test was divided into two series, in the first of which 12 girls were taken, including the three thought by the officer to be responsible. Of the girls whom we examined, three were set aside for further investigation, as this first test was but very short and was what might be termed a spotting examination. These three girls included the one who eventually admitted being responsible. The irregularities in the tracings of the other two were but slight and they were taken in the final test not on account of their showing, but more on account of the circumstantial evidence, as the evidence accumulated by the officer

seemed strong enough nearly to convict one girl in the minds of several. In addition to these three, ten other volunteers, selected at random from different parts of the house were taken. At this point it should be mentioned that all of these girls served as so-called norms and it is very important to note that all were subjected to the same treatment. That is to say, all were given the same preliminary statements as to their being under suspicion of possible complicity in the affairs being investigated, and all the girls who volunteered knew that they were under suspicion until the culprit was found. It was found advisable to shorten the investigation as much as possible, but it should be emphasized that all were questioned the same length of time. The chief reason for shortening the investigation is that if the subject be allowed to rest, irregularities occur in the record through the readjustment and the ascertaining of the systolic pressure anew. Of course, if the case was such as to warrant very extensive examination, the time should be cut up into no longer than five-minute intervals, and as all the norms are treated the same, irregularities due to the interruptions of the test can be discounted. It was therefore deemed advisable to run every girl through a six or seven minute examination, and then the test was stopped. The time need not be so long, for if the questions are properly chosen, a few are better than many. Two methods were utilized in asking the questions. In the first series of tests the questions were alternated. That is, a control question, or one not concerning the subject under investigation, and yet calculated to stimulate various emotions, was alternated with one pertinent to the investigation. In the second series it was thought best to run the irrevelant questions all together and then to pile up those concerned with the job. In this way a cumulative effect can be secured and associations called into play by the crucial words or questions allowed to have their effect, whereas in the former method the interspersing of indifferent questions might tend to vitiate this effect.

After the test was over, each girl was asked to introspect carefully and to tell us her real feeling and to analyze her emotions as far as possible during the test. The chief feelings as stated by all concerned, wherever any emotions were experienced, were those of extreme interest, anger at the thought of possible suspicion, and worry or fear ("nervous feeling"), as during an examination. But it is noteworthy that none of these emotions was intense enough to show upon the records. Both the respiratory curve and that of the blood pressure showed marked uniformity throughout and no difference was found between the effect produced by the irrelevant questions and the "dyna-

mite" questions. The actual variations in mm. of mercury was ascertained by the Tycos Sphygmomanometer, auscultatory method (this being taken on the opposite arm), was not more than from four to six mm. of mercury during the entire examination, the average variation being about 5 mm. of mercury, which was readily accounted for by respiratory effect, as Marston found that there might be a variation of eight mm. However, in the case of the girl who was picked out from all the others, the systolic rose from 118 to 148 mm. of mercury during the seven minutes of investigation.

The importance of having as many norms as possible cannot be over-estimated, for by these we are able to eliminate such variables as the fright of an innocent person at being accused of crimes, as well as the natural anger and indignation at being made an unwilling party to such an investigation.

The following questions were used during the last test:

(1) This test is to determine whether you are in any way responsible for the thefts committed at X. The test will prove whether or not you are telling the truth. The questions are framed with a view to obtain your emotional reaction to them. And in so far as it is possible we would like to have you analyze your feelings at the end of each question and explain to us later just what your feeling was following each of the questions. We solicit your co-operation and beg of you not to divulge the questions here propounded to any other person. You are especially enjoined not to attempt to make any explanation of our feelings or to comment on the questions asked you.
(2) Do you like college?
(3) Are you interested in this test?
(4) How much is 30 x 40?
(5) Are you frightened?
(6) Will you graduate this year?
(7) Do you dance?
(8) Are you interested in mathematics?
(9) Did you steal the money?
(10) The test shows that you stole it. Did you spend it?
(11) Do you know where the stolen money is?
(12) Did you take the money while the rest were at dinner?
(13) Did you take Miss T's ring?
(14) Do you know who took Miss B's money?
(15) Do you know who took Miss S's hose?
(16) Did you at any time lie to shield yourself or others?
(17) Are you accustomed to talk in your sleep when worried?
(18) During the past few nights do you remember having dreamed when you might have talked in your sleep?
(19) Do you wish at this point to change any of your statements regarding the thefts?

All of these questions were asked of every girl and the time consumed during the entire investigation was made nearly the same as possible for all of the subjects. With one exception, the records of all the girls investigated showed a marked uniformity, and except for rhythmic changes due to respiratory effects, and one or two involuntary movements, which were duly noted and indicated on the drum, no differences could be noted between the effects of the indifferent questions and those appertaining to the thefts. However, in one case the record showed very marked effects, both in the respiratory and in the blood-pressure curve, and this record was not completed, as the subject "blew up." In one instance there seemed to be an involuntary holding of the breath and a nearly complete cessation or marked drop in the height of the beats, following which there was a marked increase in rate pressure and amplitude. At the point at which the subject forced us to discontinue the experiment, the pressure rate and force of contraction were steadily increasing. The record of this girl showed very clearly another advantage of the continuous method of recording all changes on the drum. In addition to the ordinary respiratory effects upon blood pressure, and increased rate, force of each beat and rises in pressure, marked irregularities were noted. These were chiefly inhibitions in breathing and apparent slowing or skipping of heart beats. Thus it is to be noted that, although the blood pressure may rise markedly during a cross-examination, yet this may not be by any means the sole determining factor in making the interpretation, for in the record irregularities may appear which are themselves of great significance.

As the Tycos reading was being taken the subject jumped to her feet and ran over to the drums, and while protesting vehemently at the questions asked and stating that the entire performance was an outrage of the worst sort, she kept looking over the record. She then went out of the room and told one girl that she wanted to tear the paper record into pieces, and informed another girl that she wanted to "smash the officer's face." She then went directly to her roommate and asked her if she had told us anything in the last few hours, for she was the only one who could have known the things that we asked her about. Here she was referring to the talking in her sleep, an episode which was merely conjectural. It was found that she had been addicted to talking in her sleep. A few days later she admitted committing the thefts under investigation. Upon studying her personality, she seemed to present all the indications of a psychopath, in all probability of a manic-depressive type.

Through the use of the above apparatus we were enabled to clear

up a puzzling series of thefts and have had success even with experimental subjects, such as patrolmen who volunteered to be questioned. Experimental investigation will be made upon other cases and also the effects of different emotions studied separately. By the use of the apparatus on thousands of cases, interpretations can be made of most, if not all, of the emotional changes found.

NOTE.—In view of a recent article by Langfeld and Marston ("Psychophysical Symptoms of Deception," *Jour of Abnormal Psychology*, XV, 5 and 6, 319 ff.), Dr. Larson has sent us an *Addendum* to the foregoing. We regret that it was received too late to be included in this number. It will be published in our next issue.—(ED.)

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