

a second, or a duration of 33σ to 25σ . For sound, different observers have chosen different points for measurement. The slowest rate of impressions fusing into a musical sound has been fixed at between 30 and 40 per second; but Helmholtz has shown that the interference of sound-waves perceptible as beats does not escape detection when recurring as rapidly as 132 per second. For non-musical sounds, such as electric clicks, a still higher rate has been found. In touch we distinguish differences of feeling when impressions are rapid enough to fuse but not rapid enough to fuse perfectly. The smoothness of a polished surface is not obtained until the impressions occur 480 to 640 times a second (Valentin). For taste and smell the period, though not accurately determined, is undoubtedly very long. Here the time needed to reach the somewhat concealed sense-organs is considerable, and the chemical processes involved are relatively slow in action. The influence of the mode of activity of the sense-organ upon its period of stimulation is further illustrated in the long inertia period of the probably chemical action of vision compared with the short period of the mechanical senses of hearing and touch. This view is also supported by the fact that the period for the retina is shortened if the eye be directly stimulated electrically. Another mode of experimenting consists in applying a stimulus for the minimum time during which it can be recognized. The time thus measured will be shorter than the other, for it tells us only how long is needed for initiating the process of recognition sufficiently to have it continue to completion (probably after the stimulus ceases). This is indeed a surprisingly short time. Cattell and Sanford independently found that a color or a letter could be recognized when visible for only from 1σ to 5σ , while recently Baxt recognized 6 to 7 letters when exposed for only 5σ . Others have calculated that the maximum effect of an impression is not reached until from 50σ to 150σ , but these determinations seem to involve some mental process of recognition. Whether or not some such process of recognition is involved is not quite clear. Unless specially prevented, the recognition will take place on the basis of the after-image, a few thousandths of a second being sufficient to initiate the process. By following the impression by a strong flash of light, and thus nullifying the after-image, Baxt found a longer time needed to recognize a more complicated impression. Within 10σ to 15σ , one letter; within 24σ , three letters; within 34σ , four letters, could be recognized. This only partially excludes the effect of the after-image, so that perhaps the results with complicated impressions are minimum "recognition times," and those with simple impressions "inertia times." Another method, that of Exner, is similar to the method of fusion. It consists in finding how closely two impressions, stimulating slightly different portions of the sense-organ, may follow one another and yet be recognized as successive. Optical impressions were so recognized when falling at an interval of 44σ on two points of the retina near the centre .011 millimetres apart, a longer time being necessary if the points are away from the centre of the retina. It seems probable that this process is more complicated than the one we are attempting to study. While the data thus at our disposal do not allow us to fix accurately the time of sensory inertia, the estimate provisionally accepted in the text cannot be far from the truth, being rather over than under estimated. The methods of measuring the rate of nervous impulses (*b*) and (*c*) have already been described. The inertia of the muscle and the time of its contraction are determined upon the same apparatus by observing how much after the shock is given the curve leaves the base-line.

Reflex, Automatic, and Voluntary Re-actions.

The term "re-action" as here used is not intended to include all responses to stimuli. The above instanced forms of re-actions present various grades of naturalness, utility, and habituation; that is, the association between motion and stimulus has by practice become more or less close and easy. Copying, for example, may become so entirely automatic

that it runs on of itself without the need of renewed volitional effort. The actions recognized as reflex take place in spite of all volition. The re-actions here considered are limited to those requiring some degree of voluntary effort for their execution, though this may be almost indefinitely reduced by practice. The reflex act takes very much less time for its execution than the voluntary: the time for winking has been determined by Exner to be something over 50σ . In other words, it takes about three times as long to signal by a voluntary closure of the eye-lid that an impression has been received as to perform the same act reflexly when the eye is threatened. The utility of this quick action for the protection of the eye is evident; and other useful re-actions, such as those of flight and escape in timid animals, seem to be of a similar nature. The quick movements of defence when attacked; of regaining one's balance when slipping, are so immediately useful and so well inculcated in the organism as often to surprise us by their quickness. Most of these actions can also be performed voluntarily, but neither so well nor so quickly; it is therefore difficult to subject them to experiment. As already indicated, in the ordinary re-action there is little naturalness in the connection of stimulus and movement, the same type of movement being used for all. The experienced re-actor becomes accustomed to signal by the finger movement that the operation required of him has been accomplished, but hardly associates this movement with any particular stimulus.

It is perhaps well to add that the great saving of time in actions that have become automatic (such as is seen in the experienced piano player or post-office clerk as compared with the beginner), is in great part due to the increased facility of doing several things at once and not serially, a factor that enters only in a small degree into the simple re-action. The processes we should be most interested in measuring are those most closely approaching the operations of daily thought, so that the inference from experiment to practice shall be as direct as possible. This, however, it is difficult to do, because every-day mental processes do not present the simplicity of conditions required by experiment. Accordingly the method has been to study the simplest re-actions, and then take into account the circumstances in which our usual mental operations differ from them.

[To be continued.] JOSEPH JASTROW.

LEGISLATION ON FOOD ADULTERATION.

THE adulteration of alimentary substances has been practised from the most ancient times, and numerous laws and regulations have been adopted in various countries to check and prohibit such sophistications.¹

France has taken the lead in protecting consumers of food from adulterations, and in 1802 the Conseil de Salubrité was established in Paris. In England as well as in France, Germany, and other Continental countries, laws against the adulteration of individual articles, such as tea, coffee, beer, and wine have been passed since the middle ages. The first general act was not passed in England till 1860, and this was amended in 1872. However, they were found unsatisfactory, and the Sale of Food and Drugs Act was passed in 1875, and further amended in 1879 in the endeavor to obtain

¹ For copies of European laws on food adulteration see Report of the Commissioner of Internal Revenue for 1888 and for 1889; and for a summary of their leading features see Science, xiv., p. 308.

a workable law. This latter law is now in force, though the third and fourth sections of the act, relating to the mixing, coloring, staining, or powdering of any article of food so as to injure health, or in the case of drugs so as to injure their quality, are practically of no value and unenforced, because the fifth section provides that guilty knowledge is essential to the proof of the offence, and no prosecution, unless supported by very exceptional circumstances, would be successful under these sections. Sections 6 to 9 are the ones that are found workable, and provide that no person shall sell foods or drugs, with certain exceptions, to the prejudice of the purchaser; shall not abstract any constituents of food, and that compound foods or drugs must be in accordance with the demands of purchase, though with these sections again a large loop-hole for the escape of offenders is provided in section 8, which states that a legible descriptive notice that the article sold is a mixture exonerates the seller.

The amendment act passed in 1879 defined the meaning and effect of section 6, under which conflicting decisions had been given in England and Scotland. In fact, in the latter country the act had been inoperative since the decision by a majority of the judges of the High Court of Justiciary in Scotland that an official purchaser under section 13 of the act, buying samples for analysis and not for consumption, or at his own expense, could not be prejudiced by the purchase, and consequently that no offence would be committed under section 6. The court also held that the words "nature, substance, and quality," in section 6, could not be disjointed, and the article sold must be different in all three respects from the article demanded, and that as the statute was intended to strike only at foreign admixtures, the very nature of the substance must be altered, or the offence contemplated could not be committed (*Davidson v. McLeod*, Cowper's Reports, Vol. III., p. 538).

In the United States, on June 26, 1848, an act was passed by Congress to secure the purity of imported drugs, and is still in force. Its efficacy is directed principally towards Peruvian bark and opium.

The tea adulteration law was passed by Congress March 2, 1883, and on Aug. 2, 1886, the oleomargarine law was passed, defining butter and butter substitutes.

A law "to prevent the manufacture or sale of adulterated food or drugs in the District of Columbia," was passed by Congress in October, 1888. This law is modelled on the Sale of Food and Drugs Act, 1875, of Great Britain, sections 2, 3, 4, 5, 6, 7, 8, 9, 12, 17, 24, 25, and 27 (see Annual Report Commissioner Internal Revenue, 1888, p. cxv), with certain necessary provisions of the English act omitted, especially those in regard to its mode of enforcement, the collection, identification, and payment for analysis of samples, etc. The law does not provide that the Commissioner of Internal Revenue shall enforce its provisions in procuring samples of food or drugs, that matter being delegated to "any purchaser," "any health officer, inspector of nuisances, or any food inspector," only requiring that the analysis shall be under his control "under such rules and regulations as may be prescribed by the Secretary of the Treasury." The officers specified in the act are not under the control of the Commissioner of Internal Revenue nor of the Secretary of the Treasury.

Our different State laws on the subject are most of them

drawn up in a "follow-the-leader" style, under the popular but erroneous impression that any substance used as an adulterant of or a substitute for a food product is necessarily injurious to health, with the consequence that these laws are, with very few exceptions, merely dead letters.¹ In 1877 several of the State boards of health united, viz., those of New York, New Jersey, Massachusetts, and Michigan, and at their instance laws formulated on the English law were passed, and annual reports are now made by these boards on the results of the examinations of their chemists on the adulterations of foods and drugs practised in their several States. In the former State the law has proved a failure, because in an action brought to obtain "an injunction against the sale of certain Ping Suey teas it was held by the court, in refusing to grant the same, that, although the teas in question had been clearly shown to be adulterated with gypsum, Prussian blue, sand, etc., it was likewise necessary to prove that the effect of these admixtures was such as to constitute a serious danger to public health,"² In Massachusetts, however, the law has been enforced with vigor by the State Board of Health, and the yearly reports show a diminution in the percentage of adulteration of the samples submitted to analysis.

Owing to these faulty definitions and inadequate means of enforcement our State laws are inoperative, and until we have a national law to regulate the sale of adulterated articles of food, whereby the co-operation of State and national authorities could be secured in the enforcement of its provisions in regard to this class of fraud, the food sophisticater will pursue the even tenor of his way undisturbed. A national law would not apply to adulterated articles of food manufactured and sold in the State or Territory where produced, unless it should take the form of a revenue measure, imposing a tax upon the manufacturers of and dealers in such commodities.

On turning to some of the European Continental legislation on this subject we find that every dealer is held responsible for the quality of his merchandise, whether of foreign or domestic origin, and every food material must be sold under its true name; artificial products imitating a natural product must be properly labelled in a conspicuous and legible manner; all unwholesome foods are confiscated and destroyed without compensation to the owner; and adulterations generally are considered acts of fraud. Suitable police supervision and control are provided for the enforcement of these statutes; and, although these laws are somewhat of a paternal nature, they are much more effective than any we have.

The average American repudiates the idea of a paternal government supervision over his affairs, or any thing tainted with the idea. He may be willing to support, even to clamor for, a legislative measure to regulate the production or sale of a food product, provided it advances his particular business interests. He would, however, regard with apathy any general law that would guarantee to the public the liberty of purchasing pure food, with a reasonable certainty that they were not imposed upon in their purchases, if it was incumbent on him to take the necessary steps to execute its provisions by bringing samples for analysis, etc.

¹ For list of State laws on food adulteration see Report of the Commissioner of Internal Revenue, 1888, p. cxi.

² Battershall, Food Adulteration and its Detection, p. 8 (New York, 1887).

Let us consider what should be some of the leading provisions and definitions of such a proposed national law.

Definitions.

The word "food" should be defined as including every eatable, beverage, commodity, material or ingredient for food whatsoever, intended for consumption; and an article of food shall be deemed to be "adulterated"—

(1) If any substance has been added thereto which does not exist in the normal article or is only found there in an appreciably lower proportion;

(2) If any substance has been subtracted therefrom which is normally present in the article and which is not found in the abnormal article, or only there found in an appreciably lower proportion;

(3) If any substance has been substituted wholly or in part for the article;

(4) If it be an imitation, or sold under the name of another article; and

(5) If it consists wholly or in part, whether manufactured or not, of an animal or vegetable substance that is diseased, decomposed, putrid, or rotten: provided, that the addition to foods of any substance that increases their value; or the subtraction from foods of any inferior constituent, without deteriorating the resulting article; or the substitution of a superior for an inferior article, where there is no intention to defraud or to deceive, shall not be considered adulterations within the meaning of the act.

When substances known to be injurious to health (as those specified in the fifth definition above, and the mineral and organic salts and compounds enumerated below) are present in food, the manufacturer or dealer in whose possession or ownership such adulterated foods are found shall be liable to the confiscation and destruction by the proper officers of such adulterated articles without compensation for the goods, and want of knowledge in the possession of the manufacturer or dealer that the same was adulterated shall be no excuse. He shall also be liable to more or less heavy penalties, at the discretion of the court. If, on account of dealing in or consumption of articles spoiled in manufacture or transportation, or in those injurious to health, a death or even a severe sickness is caused by the same, the penalty shall be increased to imprisonment at hard labor for a term of years.

The following substances are known to be injurious to health when present in foods:¹ salts of antimony, arsenic, barium (except the sulphate), bismuth, cadmium, chromium, cobalt, copper, iron (the chloride and sulphate, though most iron salts are harmless), lead, magnesium, nickel, zinc, and some of the potassium and sodium salts; oxalic acid, picric acid, cocculus indicus (Indian berry, Levant nut), picrotoxine, gamboge, aniline, aloes, eosine, fuchsine and its immediate derivatives; coloring matters containing nitrous vapors, as naphthol yellow, victoria yellow; coloring matters prepared with di-azo compounds.

The following substances are known to produce more or less toxic effects, and whose presence in food is therefore harmful, and whose use is forbidden, under severe penalties,

in most foreign countries having laws on the subject: salicylic acid and its salts, boracic acid and borax, glycerine, alum, beta-naphthol.

The following is a list of harmless coloring matters: Black,—Chinese black. Blues,—Berlin blue, indigo, litmus, Prussian blue, saffron blue, ultramarine. Brown,—caramel. Greens,—chlorophyl, as spinach juice, mixtures of yellow colors with blue. A mixture of Prussian blue, Berlin blue, and Persian berries gives a green rivalling in brilliancy Schweinfurt's green. Reds,—annatto, Brazil lac, carmine, carmine lac, cochineal, orseil, the juice of beets and red berries, such as cherries and currants, etc. Yellows,—Avignon berries, curcuma, fustel, marigold, Persian berries, quercitron, safflower, saffron, turmeric. Chalk, and the ochres.

The adulteration of food, as specified in the first four definitions, being aimed at the pocket and not at the health of the consumer, the taxes, fines, or penalties, as the case may be, provided for their violation should be such as to make dealing in them, unless clearly and distinctly labelled and branded, unprofitable. By thus compelling all manufacturers and dealers to wrap, label, and brand in a conspicuous manner all articles of food intended for consumption adulterated within the meaning of the first four definitions, the purchaser could readily recognize that such articles were of an inferior quality, and therefore should not be as expensive as the pure article. For instance, a mixture of beef stearine and cotton-seed oil has been placed on the market to compete with lard, having been sold as "refined or compound lard." These ingredients are as wholesome as the best kettle-rendered leaf lard, but being less costly, the mixture should be sold at a cheaper rate. As was said two years ago, "Food adulteration is carried on by manufacturers in the interest of pecuniary profit and gain, and they take pains to keep themselves well posted on the subject of cheap and harmless substitutes." "The public is cheated but not poisoned." (Annual Report Commissioner Internal Revenue, 1888, p. clxxxvi.)

All adulterated goods, when sold as such, should be so branded, with the word "Adulterated," or the words "This is a mixture," in letters printed in broad-faced type at least one inch square and affixed in a secure and conspicuous place, either by a label to the vessel containing the goods or on the goods themselves; and likewise such goods should be wrapped in paper or other covering with said words printed on both sides of the wrapper. Provision should be made for the character of the packing and quality of the vessel, either metal or glass, in which food products are put up. Acid foods will attack and dissolve the solder with which tin packages are closed, and such foods should be put up in glass or acid-proof vessels. The drawing of liquids like beer, vinegar, etc., intended for food, through lead or copper pipes should be prohibited, and iron or block-tin pipes only allowed.

Provision should be made in regard to the way-bills, bills of lading, etc., of railroad and transportation companies indicating distinctly the character of goods shipped.

The manufacture or sale of substances intended for the adulterations of articles of food, but which are themselves unadulterated, should be considered as the manufacture and sale of adulterated foods.

¹ From the regulations prescribed by the Secretary of the Treasury concerning analysis of foods and drugs in the District of Columbia under control of the Commissioner of Internal Revenue. Series 7, No. 15, U. S. Int. Rev. 1888, p. 16.

However perfect the definitions or severe the penalties for violations of the law may be, still, unless the means for enforcing its provisions are furnished, no good would come of it. The establishing and maintaining the force necessary for the due supervision and control, under a national law, of such adulterated foods should be suitably provided for, and the rules and regulations for their guidance should be vested in some responsible bureau officer, with the approval of the Secretary of the Department.

This force should be divided into two classes: (1) The inspectors, who would be assigned to certain districts, and should visit all manufactories of food products, including slaughter-houses and dairies, and the places of all dealers where articles of food intended for consumption are sold, displayed, or stored, procuring, by purchase or otherwise, samples for inspection or analysis. They should have the necessary police authority to detain, seize, or destroy adulterated articles of food wherever found, as now vested in most municipal sanitary police officers. (2) The analysts, under the control of a chief, would be required to make the necessary chemical and physical examinations of the samples of food collected by the inspectors, or submitted, under suitable regulations, by other parties. The duly verified certificate of an analyst, stating that the examination of the sample submitted shows it to be adulterated within the meaning of the act, shall be received as evidence of the fact in any proceedings taken against any person for violation of the law. The defendant, however, shall have the right to require the attendance of the analyst for the purpose of cross-examination.

Standards of strength, quality, or purity of different foods shall be fixed from time to time and prescribed by the Secretary of the Department for the guidance of the analysts.

Where samples of food products are received from the public at large they should be accompanied with an affidavit stating the facts in the case, and a small fee for the analysis of the same should be paid in advance.

The inspection of meat, fish, vegetables, fruit, and especially milk, should be done daily in any large city, and properly belongs to the health department of such city.

If such a law should take the form of a revenue measure many provisions of existing laws in regard to special taxes, stamps, brands, returns, notices, etc., could be made to apply, and very little increase in the force of the Internal Revenue Bureau would be needed.

If the manufacturers of adulterated goods paid special taxes at the rate of one dollar per month, wholesale dealers fifty cents per month, and retail dealers twenty cents for the same time, and a tax of one mill per pound were collected on every article of food adulterated within the meaning of the act, the revenue thus derived would not much more than cover the expense of enforcing such a law.

EDGAR RICHARDS.

NOTES AND NEWS.

AN ingenious contrivance has been recently adopted at the Hippodrome in Paris, with a view to producing scenic effects in the central oval space, without the spectators opposite being seen at the same time. *Nature* describes the contrivance as an elliptical screen of fine steel netting, which is let down in comparative darkness, so as to be about twelve feet in front of the benches. This is painted on the inner side with a representation of the Place du Vieux Marché at Rouen (the piece being "Jeanne d'Arc"), and,

as it is strongly illuminated, at a given moment, from the centre, the light outside being low, a spectator at any point has an excellent view of the scene, while seeing nothing of the crowd beyond.

—James W. Queen, who founded the well-known house of James W. Queen & Co. of Philadelphia, died on July 12. He had been retired from business many years, so that his death will have no effect on the Philadelphia firm.

—In his recent thesis on the influence of the sea-shore on leaves M. Pierre Lesage shows by conclusive evidence, says *Nature*, that a marine habitat leads to a thickening of the leaves. The palisade-cells are more numerous and larger than in the leaves of the same plants grown inland. Apparently the sea-salt is the cause of this alteration, as plants cultivated in artificially salted soil yield thicker leaves. The observations of M. Lesage bear on some ninety species of plants which are in their natural state found near the sea (in Brittany) as well as inland.

—Professor Thomas F. Hunt, Assistant Agriculturist of the Illinois Experiment Station, reports a comparative feeding test between corn fodder and corn silage, the results of which are slightly in favor of the dry cured fodder. While the results of the experiments are somewhat contradictory, those which bear evidence of the greatest thoroughness agree in indicating that there is practically no difference between the feeding values of a given quantity of corn cured as ensilage and an equivalent quantity cured as dry fodder, provided equally good husbandry has been practised in both cases. Whether corn may be cured and preserved more economically by the one process or the other depends largely upon local circumstances and seasonal peculiarities.

—Commenting on an article on the influence of the moon on weather, by Dr. G. Meyer, *Nature* says, that, although such investigations have hitherto given a negative result, the author thought that with the materials furnished by synoptic charts he might eliminate local influences, and he gives tables extending over a number of years, which seem to show the influence of the moon in lowering the height of the barometer in the months of September to January, at the time of full moon, and in raising it during the first quarter. The Deutsche Seewarte, which communicates the article, points out that a similar result has been independently arrived at by Captain Seemann, one of the assistants of the institution. The same effect or any other is not perceptible in other months.

—The following facts, quoted by *Nature* from its French namesake *La Nature*, relate to exceptional seasons in past centuries. They were collected by M. Villard, of Valence, for France especially, and for Europe generally. In 1282 the winter was so mild that corn-flowers were sold in Paris in February. New wine was also drunk at Liège on Aug. 24. In 1408 the winter was so severe that nearly all the Paris bridges were carried away by the ice. Ink froze in the pen, although a fire was in the room. [A similar fact is quoted by Dove as occurring at Sebastopol on Dec. 13, 1855.] All the sea between Norway and Denmark was frozen. The summers of 1473 and 1474 were disastrously hot. In the winter of 1544-45 wine was frozen in barrels all over France. It was cut with hatchets and sold by the pound. In 1572-73 nearly all the rivers were frozen. The Rhone was traversed by carriages at various places. In 1585 the winter was very mild; corn was in ear at Easter, but the third week in May was extremely cold.

—The Belgian Legation at Mexico has recently reported to the Belgian Government on the subject of "guimbobo," known also as "angu," which is found in the State of Vera Cruz, a plant which should be included in the category of all the varieties of Mexican textiles. An American specialist has been appointed to examine and report upon the fibre-producing qualities of this plant. This gentleman has discovered that the guimbobo produces not only a fibre of very superior quality, but that it can be easily and cheaply cultivated; moreover, the fruit of the plant constitutes a nutritious food. According to the *Journal of the Society of Arts*, it appears from experiments that have already been made that the guimbobo differs essentially from the ramie, cotton, and hemp, as in the guimbobo the covering of the plant surrounds the fibre, and is not mixed up and interlaced with it;