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ORIGINAL RESEARCH

Nu-Way Snaps and Snap Leads: an Important Connection in the History of Behavior Analysis

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Abstract Beginning in the early 1950s, the snap lead became an integral and ubiquitous component of the programming of electromechanical modules used in behavioral experiments. It was composed of a Nu-Way snap connector on either end of a colored electrical wire. Snap leads were used to connect the modules to one another, thereby creating the programs that controlled contingencies, arranged reinforcers, and recorded behavior in laboratory experiments. These snap leads populated operant conditioning laboratories from their inception until the turn of the twenty-first century. They allowed quick and flexible programming because of the ease with which they could be connected, stacked, and removed. Thus, the snap lead was integral to the research activity that constituted the experimental analysis of behavior for more than five decades. This review traces the history of the snap lead from the origins of the snap connector in Birmingham, England, in the late eighteenth century, through the use of snaps connected to wires during the Second World War, to its adoption in operant laboratories, and finally to its demise in the digital age.

Keywords Nu-Way snap · Snap lead · Newey Brothers · Snap fastener · Snap connector · Relay rack · Electromechanical modules

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Along with the operant conditioning chamber and the cumulative recorder, relay racks filled with electromechanical programming modules are iconic devices in the history of the experimental analysis of behavior. Many photographs of operant conditioning laboratories in the 1950s and 1960s show these relay racks populated with electromechanical modules connected together by spaghetti-like arrays of wires and metal connectors called "snap leads" (Catania 2002, Figs. 4 and 5; Goldiamond and Dyrud 1968; Gollub 2002, Figs. 2, 4, and 5).

Before the advent of computers for experimental control and behavior recording, programming schedules of reinforcement, presenting stimuli, and creating different measures of behavior in the laboratory were accomplished by connecting relays and other electromechanical devices together (e.g., Ferster 1953; Ferster and Skinner 1957). Originally, relays and then the modules were simply laid out on a table and soldered together with lengths of wire. A problem with this arrangement was its inflexibility: Once a program was hardwired, the only way to change it was to unsolder the wires and resolder them into the new configuration (cf. Dinsmoor 1966). This inflexibility was the impetus for searching for faster and more flexible ways of arranging and changing the programs used to control the contingencies of reinforcement and punishment.

The solution is shown in Fig. 1. It was the snap lead, a wire with a Nu-Way snap connector at either end that could be “snapped” and stacked onto metal studs or each other on each programming module (calling the connector a *snap* may be onomatopoeic because the connector makes a “snap” sound when it is connected in place). The snap lead was constructed by soldering a snap connector to either end of a length of wire and covering the connection with a piece of insulation (called heat-shrink tubing or shrinkable “spaghetti” tubing) or even with electrical tape, to prevent unwanted connections to other, adjacent snaps (see Dinsmoor 1963). Although different electrical-connection solutions were at hand, the snap lead became the “hallmark of operant laboratories throughout the country” (Dinsmoor 1990, p. 140). It is not an overstatement to observe that snap leads played a critical role in enabling the research that became the foundation of contemporary behavior analysis.

One reason for this was that using snap leads perfectly matched the empirical-inductive method as Skinner applied it to the study of operant behavior beginning in the early 1930s. Skinner, in the Baconian tradition, put aside theory construction and theory-driven hypothesis testing in favor of data collection followed by analysis and integration. The method was predicated on following where the data led (Skinner 1956, p. 223). Because, as we will discuss below, the snap lead allowed rapid changes of conditions, its tactical use more readily complemented the strategic underpinnings of the inductive method than did the more cumbersome hardwired programming of experiments that was its predecessor in operant conditioning laboratories. How the snap and

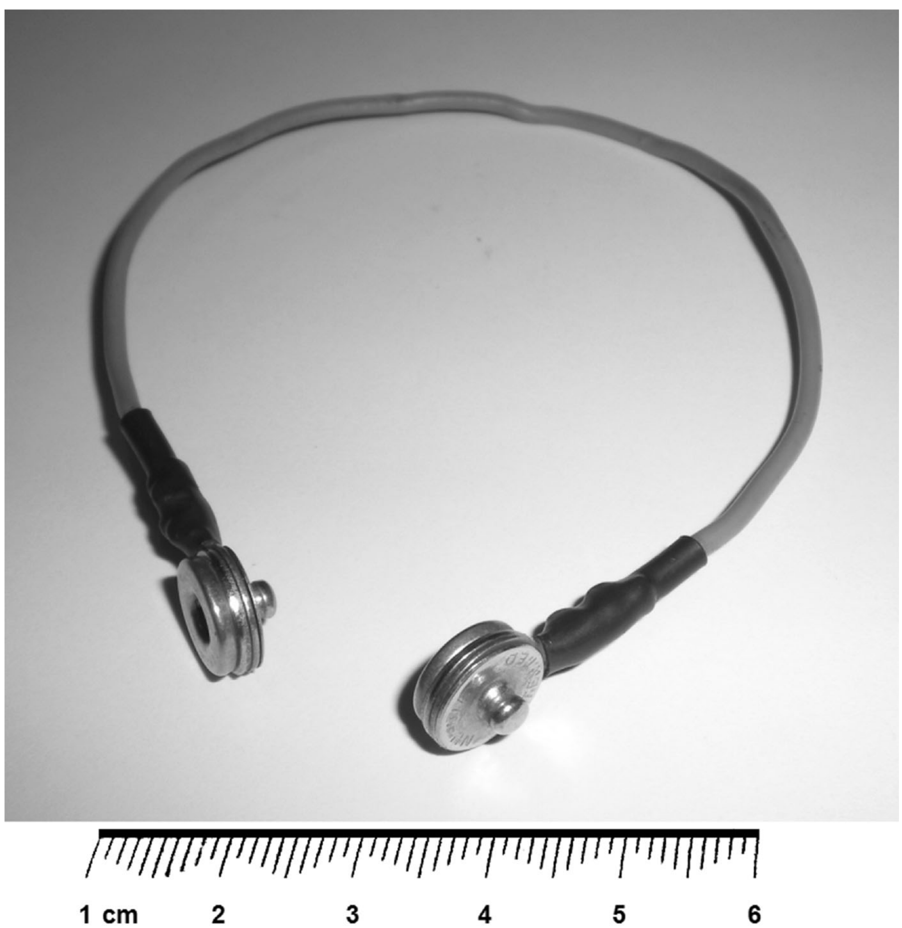

Fig. 1 A snap lead is composed of a wire with Hatheway Manufacturing Company fabricated Nu-Way snap connectors at each end. The snap connectors are engraved with the legend “NU-WAY PATENTED.” A ruler was added for scale

snap lead came to these laboratories and how it changed the experimental analysis of behavior are the subjects of this review.

The Newey Family Connection

The story of the snap lead begins in the eighteenth century in Birmingham, England, one of the crucibles of the English Industrial Revolution. Among the new manufacturers attracted to Birmingham's bustling and profitable environment was James Newey, a "gilt toy" maker (Wrightson 1818) who created the Newey Company in 1798. "Toys" referred at the time not to children's playthings but to devices like buttons, belt buckles, and hooks.

By the mid-nineteenth century, James George Newey and his son, William Millars Newey (Census Returns of England and Wales 1861; Provisional Protections 1858), were working on "[i]mprovements in fastenings, especially for or applicable to wearing apparel and purposes where a spring connexion or adjustment is desirable" (Provisional Protections 1858, p. 286). It is likely that the company acquired the moniker "Newey Brothers" when William and his younger brother, James George, controlled the company. During the following decades, several companies, including Newey Brothers, popularized the use of snap fasteners for clothing. The Neweys, however, did not invent them.

Although devices similar to snap fasteners have been used since ancient times, another British button manufacturer, Benjamin Sanders, invented the modern snap fastener (Marcel 1994; Upton 2002). During the first decades of the nineteenth century, he developed the snap fastener using a button with two shells that were pressed on top of two layers of clothing. The exact year of the invention, however, is unknown (see Marcel 1994). It was the Newey company, however, that popularized snap fasteners in the twentieth century, based on their improvement in the fastener's design.

By the early twentieth century, James Clement's son, James George Newey (named after his parental grandfather), owned the company. In 1922, he filed a patent for an improved clothing snap fastener that included two S-shaped springs that kept the stud in place (UK Intellectual Property Office, No. 201,430). This design has been used in most snap fasteners ever since. This device is shown in Fig. 2a in a 1920s/1930s advertisement emphasizing the latter springs (and noting that Newey Brothers' hooks and eyes were used in Queen Mary's 1911 coronation robe). Based on this new design, Newey Brothers manufactured snap fasteners of different sizes for different purposes. Figure 2b shows a snap fastener for carpets that included a screw-tipped stud. The stud was inserted into the floor such that it went through the carpet. The carpet then was snapped into place by the round snap fastener. These latter two items bear a striking similarity to the snap connectors and studs found in operant conditioning laboratories for good reason.

James George Newey was working with electric equipment in the 1920s, patenting a condenser (UK Intellectual Property Office, Patent No. 246,362) and improved devices for the electroplating process used to finish hooks and clips (US Patent No. 1,744,792; UK Intellectual Property Office, Patent No. 279,616). Even though he thus may have been primed for using his company's snap fasteners for making electrical connections, it is likely that James d'Argaville Clark suggested the idea to him.

The Connectors of James d'Argaville Clark

Clark, a Scottish born (1901) electrical engineer (University of London Historical Record 1836–1926), in 1924 filed a patent for an electrical connector consisting of a snap connector with a stud on one side and a socket on the other. Two or more connectors could be stacked together by connecting or "snapping" the stud of one connector into the socket of another connector (UK Intellectual Property Office, Patent No. GB244,136). Drawings for the application for the patent, which was issued in 1925, are shown in the upper left section of Fig. 3. Two views of the snap connector are marked "Fig. 1" and "Fig. 2." A different arrangement to secure the wire or lead to the connector is shown in the drawing marked "Fig. 3". A few months later, Clark filed a new patent describing a stud that was affixed to a surface. A snap connector could be attached to the stud (UK Intellectual Property Office, Patent No. GB244,388). The upper right drawings in Fig. 3 show the studs that could be affixed to a surface. Clark described how colored covers (e.g., the typical red and black) could be used for identifying connections, but these appear to have been used rarely.

Fig. 2 Advertisements for Newey's snap fasteners (**a**). The *left* and *middle images* are two segments of the same advertisement from the early 1920s (from the British Library Board ([c] British Library Board PP.1103). The *right image* shows a snap connector. This image is dated April 1933 (from Grace's Guide [http://www.gracesguide.co.uk/]). The *bottom pictures* (**b**) show Newey's snap fasteners for mats and carpets. The stud (shown on the *right*) was screwed into the floor, and the snap fasteners (shown on the left) were sewn into the carpet. Thus, the carpet could be kept in place by snapping the fasteners and the fixed studs. The *lettering* and the *color*s used in the package are similar to those in others from the early 1950s

Clark[1] may have connected with the Neweys because the Newey Brothers' snap fasteners were paramount in the industry or because he and Albert Newey studied engineering at the same time at the University of London. In either case, it would seem that anyone seeking to expand the use of snap fasteners would have benefited from an association with the Neweys.

In 1925, James George Newey and Clark filed a patent in Canada for an electrical connector based on the snap connector containing S-shaped springs. It was issued in 1926 (Canadian Intellectual Property Office, CA 259,051). The bottom drawings in Fig. 3, from the patent, show that the connector could be snapped on studs of different shapes. The drawing marked "Fig. 7" shows a stud with a machine-screw base attached to a surface using nuts, the standard arrangement in operant conditioning apparatus years later. When the new snap connector, shown Fig. 4a, was manufactured, it bore the label "Newey England" as did some previous snap fasteners.

Newey snap connectors were advertised in both England and the USA, where growing numbers of radio enthusiasts were a perfect target population. Articles in *Popular Radio* (What's New 1926) and *Wireless Radio*

[1] After working with the electrical connectors, Clark's career took an entirely different direction. He experimented with cellulose, pulps, and paper. A few years later, he moved to the USA and obtained a PhD from the Institute of Paper Chemistry in Appleton, Wisconsin (Doering 1967). He filed patents for instruments and procedures that made him a notable figure in the pulp and paper industry. He became a Professor of pulp and paper science at Oregon State University, a research associate at the Western Washington State College, and a consultant for the pulp and paper industry. He received an award for his contributions to the paper industry in 1963 ("The Daily" 1980). Doering mentioned that he redesigned the metal-saving can opener for the US military and invented several devices, from a food-spoilage indicator to a 3,000-t paper press

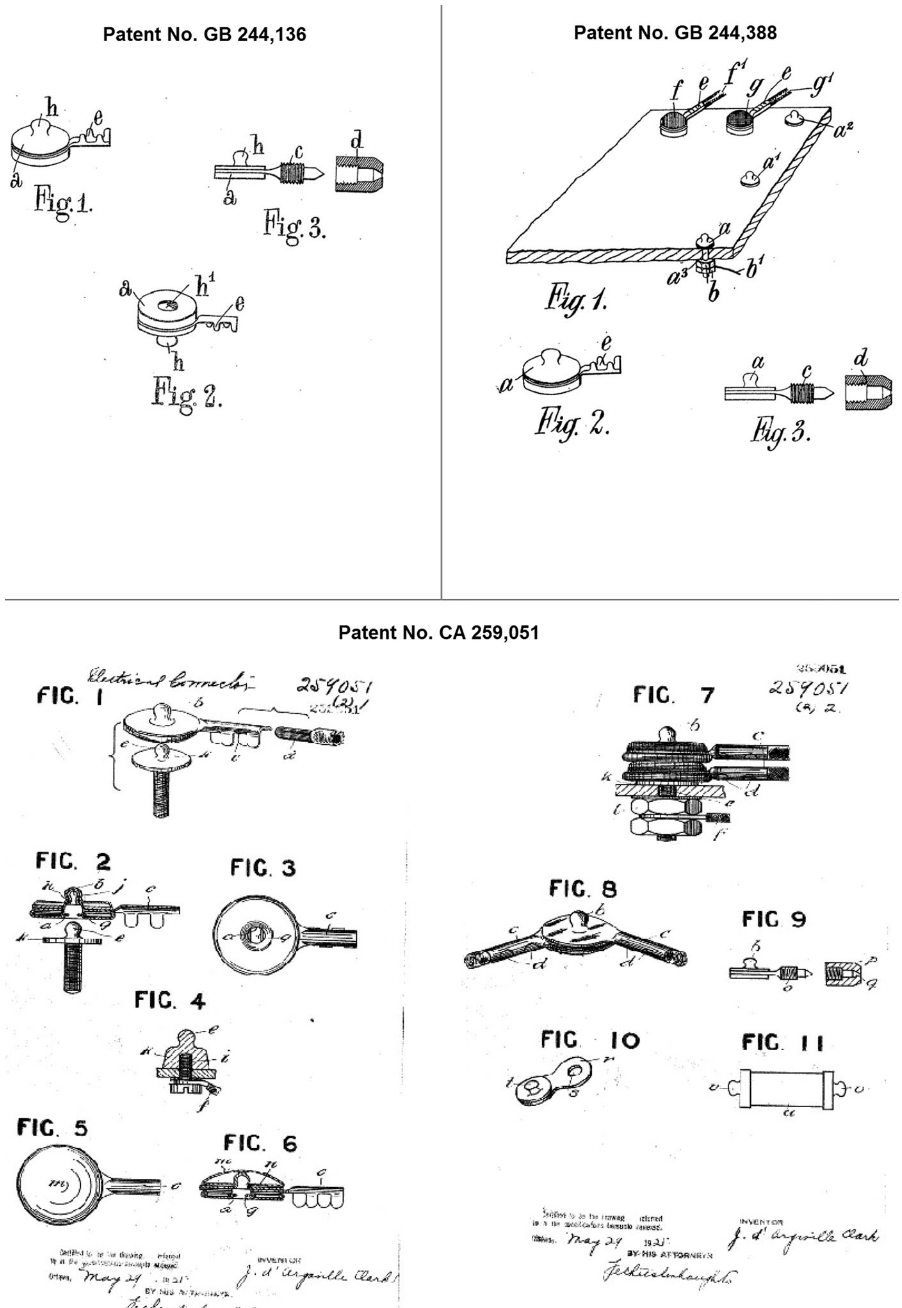

Fig. 3 The *upper left drawing* from patent GB 244,136 and the *upper right drawing* from patent GB 244,388 of the UK Intellectual Property Office. Both patents were issued to James d'Argaville Clark in 1925. The drawings show a snap electrical connector that could be stacked and snapped on a stud. The *bottom drawings* from patent CA 259,051 of the Canadian Intellectual Property Office issued in 1926, describing a snap connector for electrical connections. The patent was filed by James George Newey and James d'Argaville Clark

(The Newey 1925) lauded the advantages of snap connectors. Other articles in *Popular Mechanics* in 1927 and 1928 described an ingenious use on battery terminals for homemade radios and telegraphs. As shown in Fig. 5, a stud could be attached to each battery terminal, and the snap connectors could be connected

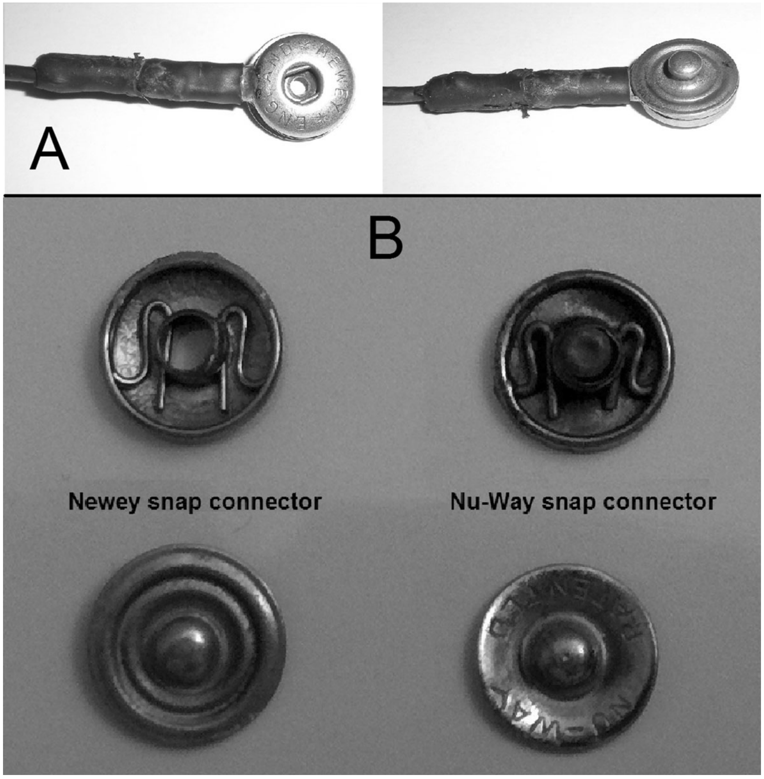

Fig. 4 Newey's snap leads (**a**). The snap connector is engraved with the legend Newey England. The *bottom drawing* (**b**) shows the characteristic Newey's S-shaped springs inside the Newey snap connector and the Nu-Way snap connector

and removed easily from the battery without soldering. In the bottom drawing of Fig. 5, snap connectors attached to each end of a wire, which will be called a *snap lead* hereafter, are connecting two battery terminals. The origin of the term snap lead is unknown, but a 1948 advertisement for an electronics set, the Electro Tech Set, describes the connectors included in that kit as snap leads (in Popular Mechanics, April, 1948, p. 76).

Snap connectors were first distributed in the USA by The Hatheway Manufacturing Co. in Bridgeport, Connecticut. This company started in 1889 producing chains and metal sheets and later buckles and fasteners. By the 1920s, it created a Radio Division that manufactured and distributed, among radio-related components, snap connectors. Theses snap connectors were slightly different from their British counterparts, as can be seen by comparing the ones shown in Figs. 1 (the Hatheway model) and 4a. The label was etched on the reverse side of the snap. Figure 4b shows the two S-shaped springs inside both models. In the US advertisements for snap connectors, the Hatheway Manufacturing Co. renamed the Newey snap connectors "Nu-Way snap terminals" (What's new in radio 1926). The term "Nu-Way" was commonly used during the first decades of the twentieth century to imply innovation and appeared on the labels of products as diverse as barrels, suspenders, courses, tools, glasses frames, and even wieners[2]. Conveniently, it also may have corresponded to the northern England pronunciation of "Newey."

The US Army Connection

Because of their utility as aids in teaching the basics of electricity, snap connectors found their way into use by the US Army. As described in an army training manual from World War II (US Army Air Forces 1945a), snap leads were used in technical training courses for making quick connections between electrical devices. The courses were part of the training of soldiers designated as Basic Electricians, who often received additional training as radio, telephone, telegraph, and storage battery electricians, and were assigned to both Signal Corps

[2] The evidence for this statement was found in advertisement during the first two decades of the twentieth century. As an example, the famous Nu-Way Wieners were established in Macon Georgia in 1916 (Lawler 2004).

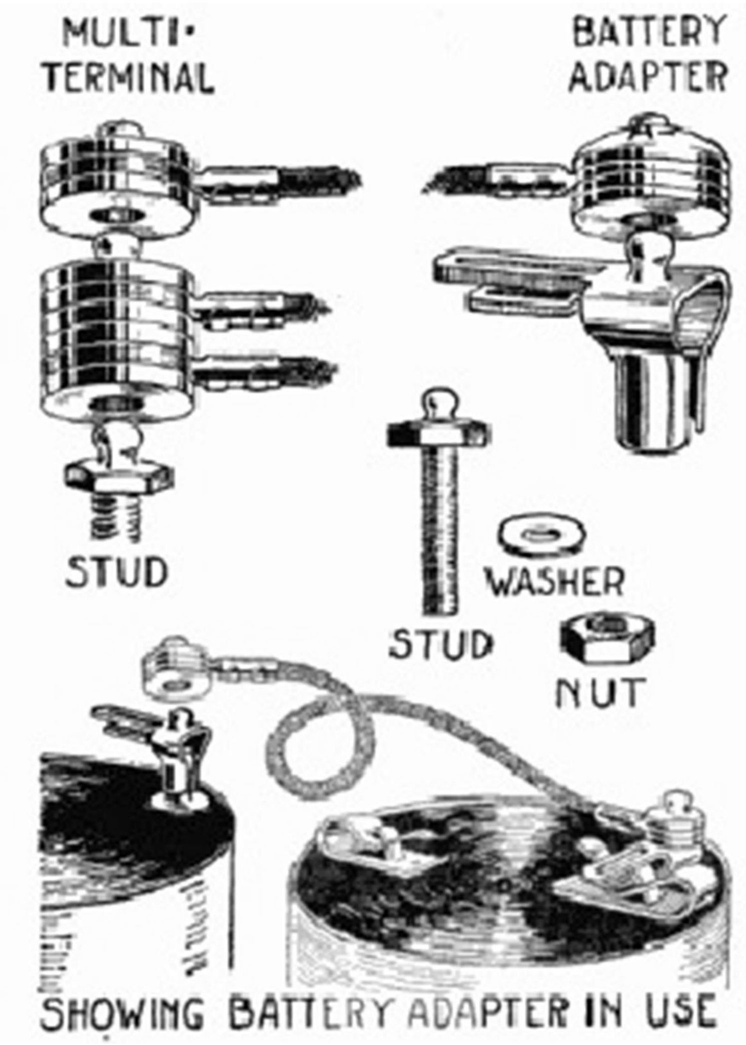

Fig. 5 Drawing showing an application of the snap terminal to connect telegraphs or radios to batteries. A stud was attached to the battery terminal, and the snap connector could be snapped to the battery. More than one snap connector could be attached to the battery at the same time (drawing by Frank L. Brittin, from Popular Mechanics, January 1928, p. 130). In the *bottom drawing*, a snap lead is connecting the terminals of two batteries

and Air Corps signal communication units (War Department 1942). Figure 6a shows a photograph from a Signal Corps electricity course taught at Fort Monmouth, NJ. Figure 6b shows two members of the Army Air Corps at the Air Base in Tyndall, FL, using a panel with an array of what appear to be snap leads.

Another technical manual (US Army Air Forces 1945b) described the use of snap leads to connect instruments like voltmeters, ohmmeters, and ammeters on panels via snap studs for training purposes. Figure 6c provides two photographs included in this manual showing the front and rear views of a panel used in military courses with the instruments connected via snap leads. The snap connectors were identified with the stock number 8800–876200 class 08B and the snap studs with the number 8800–797600 class 08B of the Army Air Forces inventory.

By the late 1940s, the use of snap leads spread to electricity courses outside the military. One example was the Rafferty Limited Production Company's Electro Tech Set, mentioned above, which was used in courses teaching basic electricity. The set included manuals, breadboards, and snap leads. Another example was using snap leads in panels for demonstrations of calculations of the Ohm and Kirchhoff laws in introductory physics courses (Blisard and Greenbaum 1953).

According to Skinner (1979, p. 306; 1983, p. 13), Norman Guttman brought snap leads to the laboratory at Indiana University around 1946:

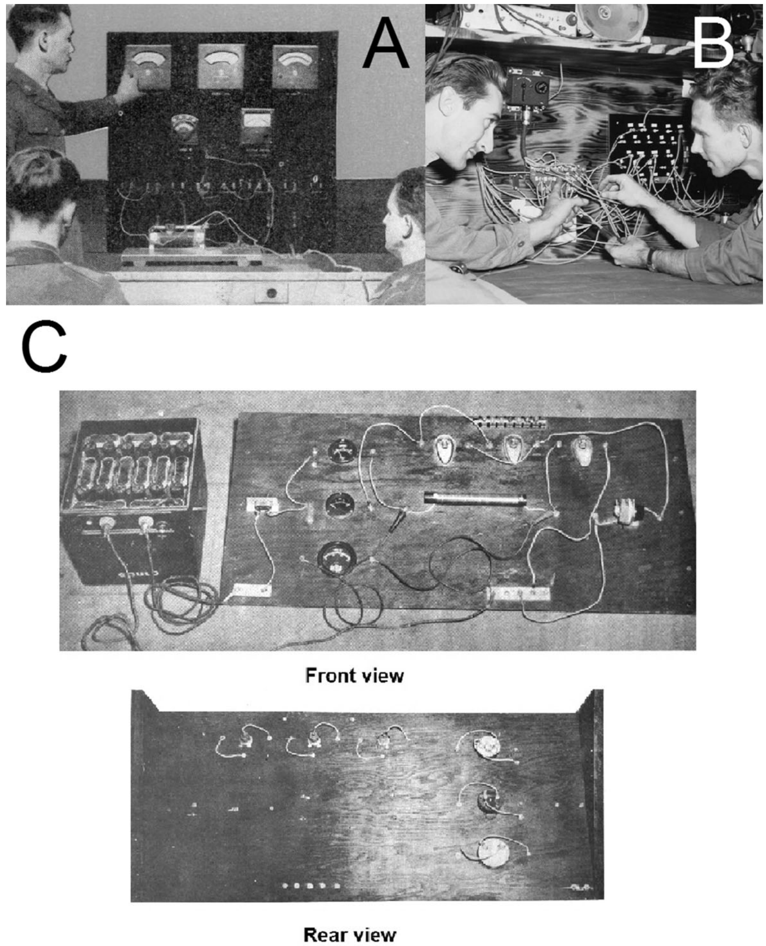

Fig. 6 *Upper left photograph* (**a**): a course on basic electricity at Fort Monmouth, NJ (from Popular Mechanics, February 1940, p. 232). Snap leads can be seen connecting the instruments in the vertical panel. *Right upper photograph* (**b**): two airmen working on a panel with snap leads at Tyndall Air Force Base, FL, circa 1942 (photograph thanks to Richard Burton). *Bottom photographs* (**c**): front and rear views of a panel for demonstration purposes in the Elementary Electrical courses for the Signal Corps and the Air Corps signal communication units during World War II. Nu-Way snap leads were used to connect the instruments in the panels (US Army Air Forces 1945b)

> We took a giant step forward in the design of operant equipment when Norman Guttman turned up as a graduate student. In his military training he had discovered the snap lead–with which one put together various electric circuits on instructional breadboards. With them we could quickly assemble and reassemble complex contingencies of reinforcement (pp. 305–306).

Preceding the above quote, Skinner noted that war shortages resulted in his having limited electrical components to control experiments. Running fewer chambers may have increased the demand for flexible use of the programming and recording equipment, making circumstances ripe for a new way of making the needed connections. Snap leads were the solution.

Skinner's (1979) description above matches information in the *World War II Army Enlistment Records* (1938-1946) showing that Guttman was drafted into the Army in 1944. He reported for duty at Fort Snelling, MN. The caption of a photograph in a local newspaper article (Peach Gathers 1944) showing Guttman in uniform suggests that, at some point, he was assigned to the 15th Signal Training Regiment in Fort Monmouth, NJ. The Army Signal Corps was, of course, responsible for battlefield communications, which required devices that likely might use snap leads for making electrical connections, and, as noted above, certainly in training people to use these devices.

Guttman was an undergraduate senior at the University of Minnesota when he started working with Skinner in 1941 as an assistant (see Skinner 1979, p. 367). He obtained a BA degree in 1942 and was hired as a teaching assistant in 1943 at the University of Minnesota. He worked on Project Pigeon and was with Skinner, Keller and Marian Breland, and W. K. Estes on the "day of great illumination" in 1943 when Skinner discovered hand shaping (Peterson 2004). He joined the military the following year. In 1946, according to records in the Office of the Registrar at Indiana University, he enrolled there as a graduate student. He obtained his Ph.D. in 1951 from Indiana after Skinner departed from Harvard. Because of that departure, Guttman's Ph.D. advisor was W. K. Estes.

Connecting to Operant Conditioning

Despite the important role that Skinner assigned to the snap lead for programming the experiment control equipment when he was at Indiana University, he may not have used snap leads regularly at Indiana. In Dinsmoor's (1987) recollection of a 1947 visit to Indiana University for the first Conference on the Experimental Analysis of Behavior, he noted that snap leads were not in use in Skinner's lab there. Furthermore, snap leads are not mentioned when Guttman and Estes (1949) described equipment that they used at Indiana for operant conditioning experiments.

Following his arrival at Harvard in 1948, Skinner (1983, p. 13) noted, "I had brought some equipment from Indiana–a cumulative recorder resembling one of our improvisations for Project Pigeon… I began to use the snap leads that Norman Guttman had learned about during the war." On the same page, he mentioned the use of snap leads for the first time in a direct application when he described his new relay rack to Burton Wolin, a former student of Indiana:

> My new apparatus has surpassed all expectations. Each relay is mounted on a panel which clips into place, and which carries a functional wiring diagram in the shape of studs to which leads can be snapped. I can throw together an apparatus of complexity comparable with my old matching apparatus in an hour or two (p. 13).

Once C. B. Ferster arrived at Skinner's lab, the snap lead seems to have begun its diffusion into operant conditioning. Although Ferster did not mention snap leads in his description of the free-operant method (Ferster 1953) nor in his recollections of working in the Pigeon Lab at Harvard in the early 1950s (Ferster 1970/2002), in the latter, he showed a photograph (Fig. 1) of a horizontal relay rack used in some of the research described in Ferster and Skinner (1957). Dangling from the rack are two snap leads. Consistent with this detail, Dinsmoor (1990) mentioned becoming acquainted with snap leads when he visited Ferster at Harvard. Although he did not note the date of the visit, Dinsmoor did say that it was before his 1951 departure for Indiana University. Thus, snap leads appear to have begun to be used commonly in the Harvard Pigeon Lab sometime between 1950 and 1951.

Ferster and Skinner (1957, pp. 22–23) subsequently described the use of snap leads as important for building flexible programming circuits, emphasizing how quickly and easily experimental conditions could be changed by using them. Gollub (personal communication, March 30, 2010) recalled his first encounter with snap leads at Harvard:

> When I arrived in 1955 they were the standard device for making electrical connections, incorporated not only in the panels we built but in the two companies already selling such equipment, Grason-Stadler and Foringer. Once their value in programming was recognized, snap leads spread quickly.

Brady (1987) noted that by the mid-1950s, when Harlow visited the laboratory at the Walter Reed, he (Brady) and Sidman had a "confusing array of racks and assorted snap leads" (p. 458). Orlando et al. (1960) describe in detail the facilities at the University of Washington for conducting operant experiments and mentioned the use of snap leads. Dinsmoor (1961), at Indiana University, described the use of snap leads and suggested that instead of using labels to identify the studs, a placement code, similar to the one used in relays, could be used to locate the snap studs on the panels comprising the experimental control modules. Godcharles and Stebbins (1962) described and showed a picture of a relay rack with snap lead connections in the operant laboratory at Hamilton College. In noting the development of the operant laboratory at Alabama in the early 1960s (the Southeastern Behavior Analysis Center or SEBAC), Siegel (1995, p. 7) noted that "the era of the snap lead and the relay rack was underway." Soon, almost every operant conditioning laboratory was using snap leads to connect both homemade programming modules and those commercially manufactured by companies founded by people like Gerbrands, Grason, Stadler, Powell, and Foringer.

A programming module (often called a "panel" in laboratory jargon) with studs to connect to the snap leads was first advertised in the second issue of the Journal of the Experimental Analysis of Behavior (JEAB) in 1958. On the panels were mounted such components as timers, relays, and counters that easily could be connected to one another by Clark's invention complemented by the Newey's ingenious solution for keeping one's clothing together and carpets in place.

Snap leads were available from commercial manufacturers of operant conditioning equipment, but they also could be fabricated in a few minutes in the laboratory. Nu-Way snaps were available in 100-count packages from electronics distributors such as Allied Electronics in Chicago from at least the 1960s and probably earlier. A piece of wire cut to the desired length was stripped of insulation on either end and an inch or so of insulating rubber, or the so-called "shrinkable spaghetti tubing" (insulating rubber that would shrink to a tight fit around the snap lead when heated) was placed on the wire above the stripped insulation. The bare wire then was soldered to the snap (see the snaps in Fig. 1), the insulating material slid over the solder joint (and heated if shrinkable tubing was used), and the snap lead was ready for use.

Snap leads were used in circuits that required both 120 V AC and 24 V DC. The AC voltage was needed to operate timers, feeders, and some bulbs (e.g., 7.5-W Christmas tree bulbs). Modifying the relay racks without turning off the equipment could be a dangerous activity. Catania (personal communication, April 23, 2011) recalled working on the relay racks with one hand behind him "so you wouldn't get current passing through your chest." L. Gollub (personal communication, March 30, 2010) also noted how lab members learned to be very careful with the racks and some even worked with one hand in the pocket at all times to avoid accidental contact with snap leads. Maybe some learned by the rule, but others did so by means of the direct contingency that, according to Gollub, "was a small inkling of how powerful a stimulus electricity could be."

Perhaps inspired by these incidents, two technical notes in JEAB suggested covering the hazardous connectors with plastic covers to reduce the risk of electric shock (Hoffman 1962; Taber and Marshall 1964). This idea was reminiscent of Clark's covers, which, as previously noted, were described in one of his patents. These new covers, however, reduced the functionality of the snap leads or were impractical to connect to the stud. Over time, the solution to the problem of using high-voltage alternating current became replacing 120 V AC programming modules with 24 V DC ones, thereby minimizing the dangers of touching snap leads' transferring current between the modules.

For all of their utility, a downside of snap leads was that, even though the connection was fairly taut, they came off with disconcerting ease when someone bumped into a rack or hit them as they swept their arms out in gesture or turning (see Sidowski and Smith 1966, p. 66). Once removed, it could take some time to discover from whence the dangling lead came. Although Sidman denied ever saying it (Sidman, personal communication, October, 2006, Cambridge Center for Behavioral Studies Annual Meeting of the Trustees, Amelia Island, FL), the second author of this review once heard him introduced at a colloquium at the University of Alabama by Norman Ellis as a man who had once argued that "free will is a loose snap lead." Indeed, when a snap lead was loose, it was as if the relay rack had a mind of its own!

The snap leads reigned supreme in operant laboratories for the better part of five decades, becoming an important feature of behavior analytic culture. L. Gollub (personal communication, March 30, 2010) remembered seeing people wearing snap bracelets and necklaces. At least one graduate student wore a tiara of snap leads at her wedding (K. A. Lattal, personal communication, October 25, 2013). Also, many creative uses for snap leads in research were described. For example, the upper right photograph in Fig. 7 shows how Azrin et al. (1971) used snap leads and studs to attach a wet sensor to pants for toilet training in children with learning disabilities. Another version of the same device, also including snap leads, was sold by the BRS/LVE electronics company (pants alert 552–09) and advertised in the Journal of Applied Behavior Analysis in 1976 (see back pages of numbers 2, 3, and 4). Yehle (1968) used snap leads to secure a cup attached to a rabbits' head (upper left of Fig. 7) to record movement associated with breathing and the nictitating membrane. Other uses were as submergible electrodes to record activity in mud puppies (*Necturus maculosi*) (Goodman and Weinberger 1971), for attaching electrodes to quails (Lydic and Anson 1974), and as electrodes to record brain activity in monkeys (Macchitelli and Montanarelli 1965). In the latter paper, the Nu-Way stud was screwed directly into the skull of the monkey (see the lower portion of Fig. 7).

The use of snap leads in behavior analysis laboratories was sometimes supplemented, but never replaced, by small bayonet-type plug connectors ("banana plugs") used to program solid-state programming equipment (see e.g.,

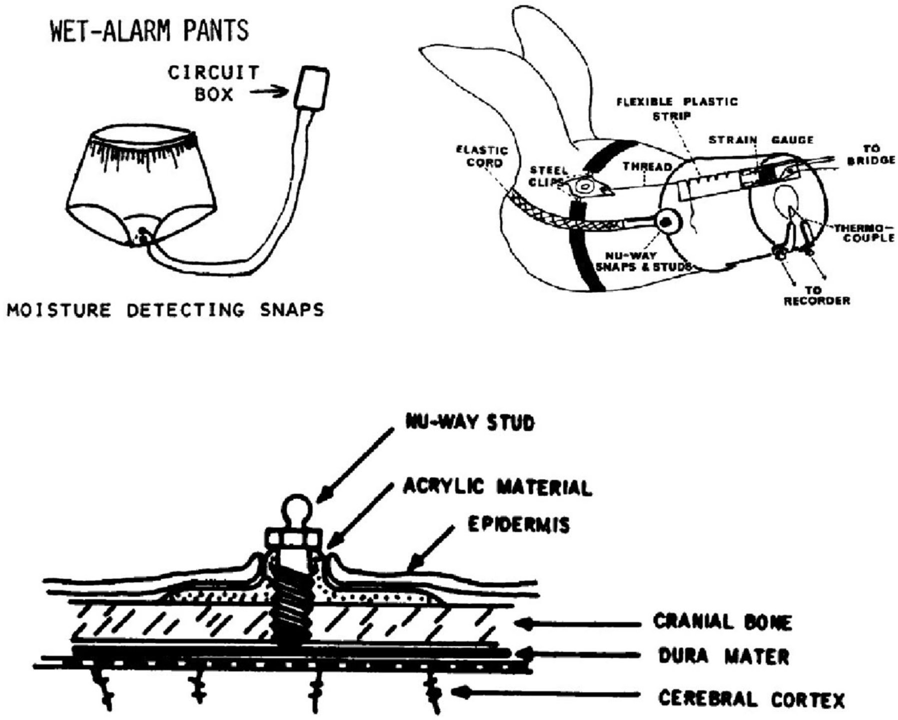

Fig. 7 Three applications of the Nu-Way snap leads. The *upper left image* shows an application for toilet training (from Azrin et al. 1971), the *upper right image* shows the use of snap leads to connect a device to record the movement of the nictitating membrane in rabbits (from Yehle 1968), and the *bottom image* shows a Nu-Way stud for use as electrodes inserted in the skull of a monkey (from Macchitelli and Montanarelli 1965) (images reprinted with permission from Wiley)

Weiner 1963). Brookshire (1967) described how to attach a Nu-Way stud on a banana plug to make snap leads compatible with equipment that included plug connectors. With the availability of digital computers in behavior analytic research beginning in the 1960s (Blough 1966; Uber and Weiss 1966; Weiss and Laties 1965; Weiss et al. 1966; see also Gollub 1991) and becoming common by the 1980s, the era of the snap lead's dominance as a means of programming operant experiments began drawing to an end. Nonetheless, in some laboratories even today, snap leads still can be found in a curious marriage of new and old technologies, connecting operant chamber control panels on relay racks to computer interfaces (see e.g., Crossman and Williams 1978). Furthermore, the Nu-Way snap leads and studs are still used in kits designed as aids in courses of electricity and electronics sold commercially by Hampden Engineering.

Broader Connections for the Snap Lead

The snap lead, composed of a Nu-Way snap connector and an insulated wire, was a small device imported from outside the discipline (and thus an example of exogenous technology; Lattal 2008) that had a singular impact on how experiments were programmed and conducted. Although snap leads are most closely associated with apparatus supporting Skinner's operant conditioning, snap leads probably found their way into use in laboratories where research was guided by other important theoretical points of view of the times. They were to be undoubtedly found in the experimental control devices of followers of the Hull-Spence tradition and devotees of Estes's mathematical learning theory (Hilgard and Bower 1975), as well as in laboratories devoted to such diverse psychological specialties as comparative psychology, psychophysics, and physiological psychology. These uses by many scientists confirm both the general utility of the snap lead and that it did not inevitably lead to Skinner's inductive approach. As noted in the introduction, however, snap leads were uniquely compatible with the frequent changes and flexible experimental designs engendered by Skinner's experimental analysis of behavior.

The flexibility that the snap lead introduced into experimentation fulfilled Skinner's (1956) prophetic observations about the inductive method in science. Summarizing a hallmark of the experimental analysis of behavior, he noted that "when you run onto something interesting, drop everything else and study it" (Skinner 1956, p. 223). This "first principle not formally recognized by scientific methodologists" (Skinner 1956, p. 223) underlies a major theme of both his work and that of others (e.g., Cannon 1945): the role of serendipity in research. As subsequent generations of operant conditioners elaborated and expanded on Skinner's methods and findings, snap leads sometimes came loose from programming modules in the middle of an experiment. When they did, behavior changed, often in unexpected ways. When investigators followed Skinner's first principle, these happy, snap-lead driven, accidents (cf. Watson 1907) sometimes led to new insights about the controlling variables of behavior.

Snap leads were not the only means by which flexibility could have been built into the control of behavioral experiments. A few laboratories may have continued to use either hard-wiring or U-shaped electrical connectors that had to be attached by a screw to the module, and the use of banana plugs was described above. Despite these other methods, the Nu-Way snap connector became dominant. It did not only because it was the only solution to achieving flexibility in programming, but also because it met several important features: it was inexpensive, readily available, and simple to fabricate into snap leads. The Nu-Way snap and the snap lead neither created nor defined the inductive method, but their use surely made its practice easier.

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