REMEMBERING
JIM HOLLAND

Operants

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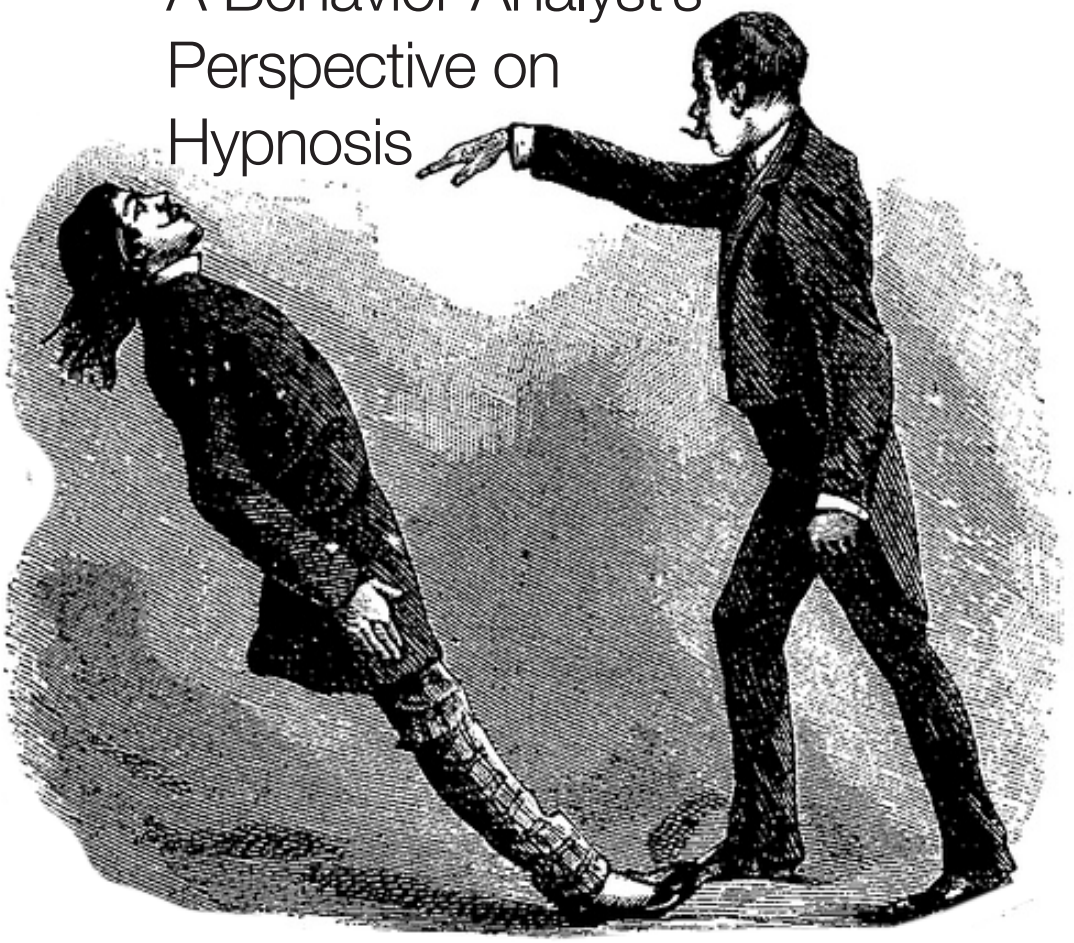
A Behavior Analyst's Perspective on Hypnosis



ARTIFICIAL INTELLIGENCE:
HUMAN-COMPUTER INTERACTION

Recently I visited the American Air Force Academy. I was surprised to find several operant chambers for an elective course in behavioral science. Students taking the course taught their rats to run through an impressive obstacle course. In the United States, many university labs for students are closing because of the high costs of animal care. So I was pleased to find a lab where I didn't expect one.

Do you run a lab, or have access to one as a student? If so, whether your animals are rats, pigeons, cockroaches, fish, or any other species, please let *Operants* know. We would be interested in your experiences.

Julie S. Vargas, Ph.D.
President, B. F. Skinner Foundation

Chinese Simplified Translated by Coco Liu

最近我访问了美国空军学院。我很惊讶地发现几个操作室（“斯金纳箱子”）的行为科学选修课。参加课程的学生教他们的老鼠跑，并穿越障碍课程。在美国，许多大学的学生实验室都因为动物护理成本高而关闭。所以我很高兴在我没想到的地方找到实验室。

你是否有在实验室，或者作为学生参与实验室活动？如果是这样，请告诉 OPERANTS 让我们知道你的动物是老鼠，鸽子，蟑螂，鱼还是其他物种。我们会对你的经验感兴趣。

Chinese Traditional Translated by Coco Liu

最近我訪問了美國空軍學院。我很驚訝地發現幾個操作室（“斯金納箱子”）的行為科學選修課。參加課程的學生教他們的老鼠跑，並穿越障礙課程。在美國，許多大學的學生實驗室都因為動物護理成本高而關閉。所以我很高興在我沒想到的地方找到實驗室。

你是否有在實驗室，或者作為學生參與實驗室活動？如果是這樣，請告訴 OPERANTS 讓我們知道你的動物是老鼠，鴿子，蟑螂，魚還是其他物種。我們會對你的經驗感興趣。

Czech Translated by Helena Vadurova

Nedávno jsem navštívila Vojenskou leteckou akademii Spojených států amerických. Byla jsem překvapena, když jsem tam našla několik boxů pro operantní podmiňování (“Skinnerových skříněk”), které byly využívány ve volitelném kurzu Behaviorální věda. Studenti tohoto kurzu učili krysy proběhnout velmi složitou trasu. Ve Spojených státech je ukončován provoz mnoha univerzitních laboratoří pro studenty, protože péče o zvířata je velmi nákladná. Byla jsem tedy potěšena, že jsem se setkala s laboratoří na místě, kde jsem to nečekala.

Provozujete laboratoř nebo máte do nějaké jako student přístup? Pokud je to tak, je jedno, zda máte krysy, holuby, šváby, ryby nebo jiné druhy zvířat, prosím, dejte nám v Operants vědět. Zajímají nás vaše zkušenosti.

French Translated by MarieCeline Clemenceau

Récemment, j’ai visité l’American Air Force Academy. J’ai été surprise de trouver plusieurs chambres opérantes («boîtes de Skinner») pour un cours optionnel en science du comportement. Les étudiants qui suivent le cours ont appris à leurs rats à traverser un parcours d’obstacles impressionnant. Aux États-Unis, de nombreux laboratoires universitaires pour les étudiants ferment à cause des coûts élevés des soins aux animaux. J’étais donc heureuse de trouver un laboratoire là où je ne m’attendais pas à en voir un.

Dirigez-vous un laboratoire ou y avez-vous un accès en tant qu’étudiant? Si c’est le cas, que vos animaux soient des rats, des pigeons, des blattes, des poissons ou toute autre espèce, veuillez en informer Operants. Nous serions intéressés par vos expériences.

Hebrew Translated by Shiri Ayvazo

לאחרונה ביקרתי באקדמיה של חיל האוויר האמריקני. הופתעתי לגלות מספר תאים אופרנטיים (״תיבות סקינר״) לקורס בחירה במדעי ההתנהגות. סטודנטים שלוקחים את הקורס מלמדים את החולדות שלהם לעבור דרך מסלול מכשולים מרשים. בארצות הברית, מעבדות סטודנטים באוניברסיטאות רבות נסגרות עקב העלות הגבוהה של אחזקת החיות. כך שהייתי מרוצה למצוא מעבדה היכן שלא ציפיתי לה.

האם לכם יש מעבדה או שהייתה לכם גישה למעבדה כסטודנטים? אם כן, אם החיות שלכם הם חולדות, יונים, מקקים, דגים או כל זן אחר, אנא יידעו את אופרנטס (Operants). אנו מעוניינים בהתנסויות שלכם.

Hellenic (Greek) Translated by Katerina Dounavi

Πρόσφατα επισκέφθηκα την Ακαδημία Αεροπορίας. Έκπληκτη βρήκα διάφορους πειραματικούς θαλάμους (“Θάλαμοι του Skinner”) για ένα μάθημα επιλογής στην επιστήμη της συμπεριφοράς. Οι φοιτητές που παρακολουθούν το μάθημα δίδαξαν στους αρουραίους τους να διασχίζουν μια εντυπωσιακή σειρά εμποδίων. Στις Ηνωμένες Πολιτείες, πολλά πανεπιστημιακά εργαστήρια για φοιτητές κλείνουν λόγω του υψηλού κόστους της φροντίδας των ζώων. Οπότε ήταν χαρά μου να βρω ένα εργαστήριο εκεί που δεν το περίμενα.

Μήπως διευθύνετε ένα εργαστήριο ή έχετε πρόσβαση σε αυτό ως φοιτητής; Εάν ναι, ανεξάρτητα από το εάν τα ζώα σας είναι αρουραίοι, περιστέρια, κατσαρίδες, ψάρια ή οποιοδήποτε άλλο είδος, παρακαλώ ενημερώστε την Operants. Θα μας ενδιέφερε η εμπειρία σας.

Icelandic Translated by Kristjan Gudmundsson

Ég heimsótti nýverið háskóla bandaríska flughersins. Það kom mér á óvart að sjá þar nokkur virknibúr (“Skinner búr”) til notkunar í valkúrs í atferlisvísindum. Nemendur í þeim kúrs kenna rottum að hlaupa í gegnum nokkuð erfiða hindrunarbraut. Í Bandaríkjunum eru margir háskólar að loka tilraunastofum fyrir nemendum vegna kostnaðar sem fylgir dýrunum. Þess vegna varð ég svo ánægð að finna tilraunastofu þar sem ég bjóst einmitt ekki við henni.

Rekur þú tilraunastofu, eða hefur þú aðgang að slíkri sem nemandi? Ef svo er, hvort sem að dýrin eru rottur, dúfur, kakkalakkar, fiskar eða hvaða önnur dýrategund sem er, endilega láttu Operants vita af því. Okkur leikur forvitni á að vita um reynslu þína.

Italian Translated by Anna Luzi

Recentemente ho visitato l’American Air Force Academy e sono rimasta sorpresa dell’utilizzo di numerose “Skinner Boxes” durante un corso avanzato in scienze comportamentali. Gli studenti che hanno frequentato il corso hanno insegnato ai loro topi a superare un complicato percorso a ostacoli. Negli Stati Uniti, molti laboratori universitari per studenti stanno chiudendo a causa dei costi elevati richiesti dalla manutenzione degli animali. Per questo sono stata contenta di trovare un laboratorio dove non me lo aspettavo.

Gestisci un laboratorio oppure vi puoi accedere in qualità di studente? Se è così, di qualunque specie siano i tuoi animali, ovvero ratti, piccioni, scarafaggi o pesci ti preghiamo di metterti in contatto con Operants. Saremmo interessati a conoscere i tuoi esperimenti.

Japanese Translated by Naoki Yamagishi

最近、私はアメリカ空軍士官学校を訪れました。そこで行動科学の選択課程用のいくつかのオペラント実験箱（スキナーボックス）を見つけて驚きました。その課程では、学生はラットに障害物のある印象的なコースを走ることを教えました。アメリカ合衆国では、動物飼育にコストがかかるため多くの大学で学生のための実験室を閉鎖しました。そのため私は思いがけないところに実験室を見つけてうれしく感じました。

あなたは実験室を運営しているか、あるいは学生として実験室を使うことができるでしょうか？もしそうであれば、飼育されている動物がラット、ハト、ゴキブリ、魚、あるいは他のどんな種であれ、雑誌Operantsにお知らせください。私たちはあなたの体験した事柄に興味をもっています。

Korean Translated by Theresa Yunhee Shin

최근 저는 미공군사관학교에 방문하였습니다. 거기서 저는 행동과학에서 선택과목으로 보던 몇 개의 Operant chambers(“스키너상자들”)를 발견하고는 놀랐습니다. 수업을 듣는 학생들이 인상적인 장애물 코스를 통과해 달리도록 그들의 쥐를 가르치고 있었습니다. 미국에서는 동물관리를 하는데 고비용이 들기 때문에 학생들을 위한 많은 대학의 실험실들을 폐쇄하고 있습니다. 그래서 저는 예상하지 못했던 실험실을 발견하고는 즐거워졌습니다.

실험실을 운영하거나, 학생신분으로 실험해본 적 있나요? 만약 그렇다면, 당신의 동물들이 쥐였는지, 비둘기였는지, 바퀴벌레였는지, 물고기였는지 혹은 어떤 다른 종류였는지 Operants에게 알려주세요. 우리는 당신의 경험에 대해 흥미로와 할 것입니다.

Norwegian Translated by Karoline Giæver Helgesen

Jeg besøkte nylig akademiet til det amerikanske luftforsvaret, American Air Force Academy. Der ble jeg overrasket over å finne flere operantkamre («Skinnerbokser») brukt i forbindelse med et valgfag i atferdsvitenskap. Studenter som deltok på kurset lærte rottene å løpe gjennom en imponerende hinderløype. I USA legger man ned mange av universitetslabene som er tilgjengelig for studenter på grunn av de høye kostnadene knyttet til dyrehold. Jeg ble derfor glad over å finne en lab der jeg ikke forventet å finne en.

Driver du en lab, eller har du tilgang til en som student? Om så, og uavhengig av om dine dyr er rotter, duer, kakerlakker, fisk eller andre arter, vær snill å la Operants høre om den. Vi er interessert i erfaringene deres.

Portuguese Translated by Monalisa Leão

Recentemente eu visitei a Academia da Força Aérea Americana. Fiquei surpresa ao encontrar várias câmaras operantes (“Caixas de Skinner”) para um curso eletivo em ciência comportamental. Os alunos que participaram do curso ensinaram seus ratos a percorrer um percurso de obstáculos impressionante. Nos Estados Unidos, muitos laboratórios universitários para estudantes estão fechando devido aos altos custos dos cuidados com os animais. Então, tive o prazer de encontrar um laboratório onde eu não esperava.

Você tem um laboratório ou tem acesso a um como estudante? Em caso afirmativo, se os seus animais são ratos, pombos, baratas, peixes ou qualquer outra espécie, por favor, informe ao Operants. Nós estaríamos interessados em suas experiências.

Romanian Translated by Luciana Hăloiu Richardson

Recent am vizitat Academia Fortelor Aeriene Americane. Am fost surprins să găsesc acolo câteva cuști operante (“Cutiile lui Skinner”) folosite în cadrul unui curs electiv în știință comportamentală. Studenții care urmau cursul, i-au învățat pe șobolani cum să parcurgă o impresionantă cursă cu obstacole. În Statele Unite, laboratoarele multor universități se închid din cauza costurilor ridicate de îngrijire a animalelor. Deci am fost bucuros să găsesc un laborator, acolo unde nu mă așteptam.

Conduci un laborator, sau ai acces la unul în calitate de student? Dacă da, indiferent dacă animalele sunt șobolani, porumbei, gândaci, pești, sau oricare altă specie, te rog anunța revista Operants. Am fi interesați de experiențele tale.

Russian Translated by Alexander Fedorov

Недавно я посещала Академию американских военно-воздушных сил. Я была удивлена тем, что увидела там несколько оперантных камер (т.н. «ящиков Скиннера»), используемых в элективном курсе, посвященном поведенческой науке. Студенты рассказали, что на этом курсе они обучали своих крыс проходить путь с очень сложными препятствиями. В Соединенных Штатах многие лаборатории для студентов закрываются из-за высокой стоимости ухода за лабораторными животными. И именно поэтому мне было приятно увидеть лабораторию там, где я этого не ожидала.

Руководите ли вы лабораторией или у вас есть доступ к ней, как у студента? Если так, пожалуйста, дайте знать об этом Operants, вне зависимости от того, используете вы крыс, голубей, тараканов, рыб или других животных. Нам было бы очень интересно узнать о вашем опыте.

Spanish Translated by Kenneth Madrigal and Gonzalo Fernández

Recientemente realicé una visita a la Academia de la Fuerza Aérea Norteamericana (American Air Force Academy) y me sorprendió encontrar una gran cantidad de cajas experimentales (“Cajas de Skinner”) con las que se imparte un curso optativo de ciencia de la conducta. Los estudiantes inscritos en el curso entrenan a las ratas a realizar un recorrido lleno de obstáculos. En los Estados Unidos de América se han cerrado numerosos laboratorios universitarios debido al costo elevado para el cuidado de los animales, por lo que me sorprendió gratamente encontrar un laboratorio en donde no me lo esperaba.

¿Tienes un laboratorio o acceso a uno como estudiante? De ser así, háznoslo saber en Operants. Ya sea que tus animales sean ratas, palomas, cucarachas, peces, o cualquier otra especie, estamos interesados en conocer tus experiencias.

Swedish Translated by Dag Strömberg

Nyligen besökte jag American Air Force Academy. Jag blev överraskad av att finna flera operanta kammare (“Skinnerboxar”) till en valbar kurs i beteendevetenskap. Studenterna på kursen lärde sina råttor att springa genom en imponerande hinderbana. I Förenta staterna är det många universitetslabb som stänger på grund av höga kostnader för djurskötsel. Så jag var glad att hitta ett labb där jag inte förväntade mig det.

Driver du ett labb, eller har tillgång till ett som student? I så fall, oavsett om dina djur är råttor, duvor, kackerlackor, fiskar eller vilka andra arter som helst, var snäll och låt Operants få veta det. Vi skulle vara intresserade av dina erfarenheter.

Thai Translated by Sirima Na Nakorn

เมื่อเร็ว ๆ นี้ดิฉันได้เข้าเยี่ยมชม The American Air Force Academy และรู้สึกประหลาดใจที่พบกล่องทดลอง ของ ดร. สกินเนอร์ หรือที่เรียกกันว่า “Skinner Boxes” สำหรับผู้ที่เลือกลงวิชาด้านวิทยาศาสตร์พฤติกรรม (Behavioral Science) นักเรียนที่เรียนในหลักสูตรสอนหนูทดลองของพวกเขาให้วิ่งผ่านเส้นทางที่เต็มไปด้วยสิ่งกีดขวาง ในสหรัฐอเมริกาห้องทดลองของมหาวิทยาลัยจำนวนมาก ปิดตัวลงเพราะค่าใช้จ่ายในการดูแลสัตว์ทดลองนั้นสูงมาก ดังนั้นดิฉันจึงดีใจมากที่ได้พบห้องทดลองดังกล่าว สำหรับท่านที่เป็นนักศึกษาที่ทำงานกับสัตว์ทดลองในห้องทดลอง ไม่ว่าจะเป็นสัตว์ชนิดใด เช่น หนู นกพิราบ แมลงสาบ ปลา และอื่นๆ กรุณาแจ้งให้ Operants ทราบ เราอยากรู้ประสบการณ์ที่ท่านมี

Turkish Translated by Yeşim Güleç-Aslan

Yakın bir zamanda Amerikan Hava Kuvvetleri Akademisi’ni ziyaret ettim. Davranış bilimlerinde seçmeli dersler için çeşitli edimsel koşullanma odalarına (“Skinner Kutuları”) rastlamak beni şaşırttı. Dersi alan öğrenciler, farelere engel parkurunda koşmayı öğrettiler. Amerika Birleşik Devletlerinde, öğrenciler için olan pek çok üniversite laboratuarı hayvan bakımının yüksek maliyeti nedeniyle kapanıyor. Bu nedenle, bulmayı beklemediğim bir yerde bir laboratuar bulmaktan çok memnun oldum.

Laboratuvar mı çalıştırıyorsunuz? Yoksa bir öğrenci olarak mı erişiyorsunuz? Eğer öyleyse, hayvanlarınız fare, güvercin, hamamböceği, balık veya başka türler olsun, lütfen Operants’a haber verin. Deneyimlerinizle ilgileniriz.

editorial staff

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We would like to thank all contributors to this issue.

Operants *preserves the intellectual tradition of Skinner's writings: Of interest to the field, but also written without heavy use of citations and references. In most articles intellectual credit to others is given, not by citing and referencing specific studies or articles/books, but rather through discussing the "big idea" or "concept", and naming the person/affiliation. In this way, then, the intellectual credit is provided while still writing for a wider audience. Especially today we would like to continue to advance the relationship between basic and applied science, and its theory, and make that available to the public.*

Cover art: Illustration by Gilbert from 'La Nature' (Paris, 1881). On the back cover: Gravure de Varney the Vampire. 19th century. Author unknown.

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Table of Contents

I am delighted to introduce the first issue of *Operants* in 2018. The purpose of *Operants* is to provide high-quality invited articles and interviews that focus on operant behavior as initially emphasized by B. F. Skinner, and that establish links between basic and applied research, applications, and practice. As part of this mission, our pieces include theoretical and philosophical bases from a behavioristic perspective.

As the new Editor-in-Chief, it is truly remarkable to work with the *Operants* team on the current issue. Many thanks to our past Editor-in-Chief, Ernie Vargas, who is a wonderful mentor as I take the reins in this new role. I am grateful to Julie Vargas for her ongoing support, contributions, and advice. In addition, without the hard work of our managing editor, Konstantin Evdokimov, and associate editor, David Roth, this issue would not be possible. I would be remiss if I did not also include the contributions of David Palmer. It is indeed a pleasure to be working with the B. F. Skinner Foundation on this project, as it is well organized and a meaningful experience. In short, this organization uses the principles of positive reinforcement to help make what they do possible.

In this issue, we continue in the tradition of providing readers with pieces that we believe are of interest to a wide audience. Virués-Ortega and Yu are known in the field for their commitment to bridging the gap between experimental or applied research and practice, and have kindly provided us with a piece about knowledge transfer and translation. At this point in history, there is no better time for us to remember that an ongoing dialogue between scientists and practitioners is imperative for the continued health of the field.

We have also reprinted Schlinger's letter to the New York Times as an example of why it is important to clarify positions and to debunk misrepresentations and misinterpretations of the field. Having a clear representation and interpretation of the theoretical and philosophical bases for our field leads to many good outcomes for us personally and professionally. We can see examples of this in the piece about how Skinner's works affected Chandrasekhar's worldview, and how we might interpret other areas of interest such as hypnosis (Holborn). Holborn's piece also allows us to see how we might extend our analysis to what might normally be considered a cognitive domain. Roth's paper on generic classes reminds us that a behavior analytic approach to increasingly complex behavior is possible without succumbing to hypothetical constructs. After all, our field has had a great impact on educational processes, as evidenced by the Ogden R. Lindsley Lifetime Achievement Award from the Standard Celeration Society, and the work of Holland, who recently passed away. Finally, my interview with Leite allows us to see how the single-subject, small-N designs can be extended to the exciting field of human-machine learning. It is imperative that as a field we understand how we can extend Skinner's analysis to other areas, and benefit from the work of other fields as well. In this way, we work toward a more complete account of behavior.

In this issue, there is also a call to include more examples of behavior analytic interpretations of popular culture. Any reader of Skinner will appreciate that he was well-read, and included various examples from literature in his writings to illustrate various principles, procedures, or concepts. Most of the literary analysis during the past century has been dominated by Freudian and neo-Freudian psychodynamic interpretations; however, there are relatively few of these types of interpretations coming from our field. As editor, I would like to encourage us to think about how we might analyze the behavior of fictional and historical characters in a way that contributes to a fuller account of behavior. As evidenced by the standing-room only turnout at several symposia I have organized during the past few years at the Association for Behavior Analysis on this topic, it is indeed of great interest to our audiences. Such overwhelming reinforcement encourages us at *Operants* to move forward with pieces of various lengths to illustrate how this might be useful. In this issue, I include a brief overview of how I have used this in one of my undergraduate ABA courses.

To conclude, I leave you with the words of the late Stephen Hawking, which I use to remind us that even as we gain a fuller, or more complete, account of behavior that our understanding has to evolve as the universe does: "The universe does not behave according to our preconceived ideas. It continues to surprise us."

Darlene E. Crone-Todd, PhD

The Process of Knowledge Translation in Behavior Analysis

Javier Virués-Ortega, PhD, University of Auckland, New Zealand
C. T. Yu, PhD, University of Manitoba, Canada

Javier Virués-Ortega *(left) is a senior lecturer and director of the Applied Behaviour Analysis Programme at the University of Auckland (New Zealand). He is also a member of the board of directors of the BACB. His research focuses on the neural, emotional, and behavioral factors of problem behavior, particularly among individuals with developmental disability. He also has an interest in the extension of behavior analysis applications to general clinical psychology and complex language processes. Dr. Virués-Ortega authored over eighty specialized publications.*

C. T. Yu *(right) is Professor of Psychology at University of Manitoba in Canada, and Distinguished Researcher at St. Amant Research Centre. He is a Certified Psychologist and a Board Certified Behavior Analyst. His research interests include staff training, knowledge translation, and behavioral assessment and intervention strategies for people with developmental disabilities.*

Behavior-analytic discoveries and findings would not be useful in advancing human services to benefit society if they remain buried in scientific journals catered to a tiny academic audience. Graduate students also account for a portion of the readership mainly because of coursework requirements by their instructors or research requirements by their educational programs. Except for the small number who will later become academics and researchers themselves, most students will be severed from the scientific literature after graduation due to a lack of access or to day-to-day practical demands of their professional lives. In addition, professionals from allied disciplines who could benefit from and recommend behavior-analytic services may never have been exposed to the scientific basis of behavior analysis at all. That's why it is so important to ensure that objective and well-researched information is made available to the people who need it. The terms "translational research" and "knowledge translation" are commonly used to refer to this process. In this essay, we attempt to clarify some of the key knowledge translation concepts and highlight the value that knowledge translation has for behavior analysts.

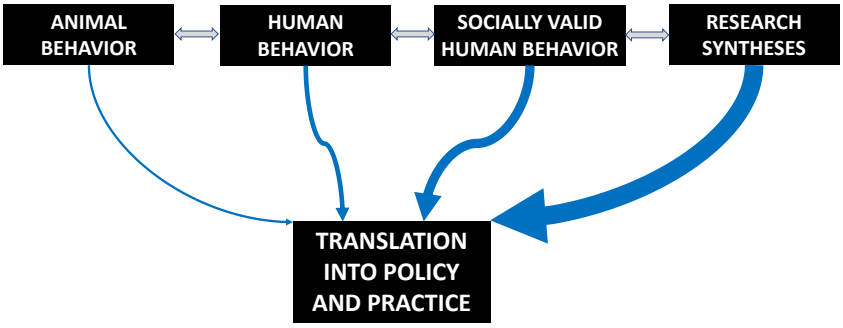
The National Center for Advancing Translational Sciences defines translation as "the process of turning observations in the laboratory, clinic and community into interventions that improve the health of individuals and the public." Therefore, translational research may be seen as involving multiple stages beginning with basic research, followed by applied or clinically-oriented research, and then by clinical effectiveness and usability analyses conducted in real-world settings. The relationship between stages is bidirectional in that researchers at each stage use information and discoveries from the previous stages. In turn, their findings inform researchers at previous stages and may lead to new research questions. The term has a biomedical origin: The development and testing of a new drug, and eventually bringing it to market, exemplifies the process.

What would this process look like in the field of behavior analysis? How does a new behavioral procedure come about? Among many possible examples, the differential outcomes effect can help to illustrate the process. The basic literature on the differential outcomes effect suggests that pairing a learned response with a particular outcome can expedite learning when multiple novel responses are being required from the individual. For example, presenting a red toy after a child utters the word "red" and a green toy when the child utters the word "green" may result in expedient learning, whereas using the same reinforcer would result in comparatively slower learning. The process was first shown in the animal literature by Trapold from University of Minnesota in 1970. Its relevance for humans was later demonstrated by Estevez from University of Almería and others. Yet, most studies have focused on arbitrary responses lacking social validity. Finally, a series of ongoing studies led by Ms. Jessica McCormack, a student from University of Auckland, is attempting to demonstrate whether the effect holds, not just in humans, but in specific clinical populations in real-life settings

and for developmentally important target behaviors. As shown in this example the process of knowledge translation is multi-staged. The translational research cycle is often finished when direct recommendations can be made to practitioners, for example, via research syntheses from multiple relevant studies (see diagram).

Knowledge synthesis is not the final step in the knowledge translation process but it can sometimes by itself close the knowledge translation circle. For example, service providers and health decision-makers often cite research syntheses such as systematic reviews and meta-analyses to support their policies. Some of the meta-analyses published by our team illustrate this process. Our meta-analyses in the area of evidence-based interventions for people with developmental and intellectual disability have been cited in the policies of major health insurance providers including UnitedHealthcare, Blue Cross Blue Shield Association, Priority Health, and Molina Healthcare, among others, having an indirect impact on the health coverage of over 90 million subscribers.

Another stage of the translational research process involves research to enhance the adoption of evidence-based best practices. This stage does not seem to be as well described as the other stages and it has received less attention in the translational research process. This stage is important to behavioral scientists in that uptake of new and evidence-supported procedures is not automatic and cannot be assumed. The process of "knowledge translation", described by the Canadian Institutes of Health Research (CIHR), may shed some light on this last stage.



A diagram of the basic knowledge translation process in behavior analysis. Thicker arrows suggest a stronger impact on practive and policy.

CIHR defines knowledge translation as "a dynamic and iterative process that includes synthesis, dissemination, exchange, and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the health care system." Research evidence in support of a procedure or practice must first be extracted from the scientific literature and synthesized in the form of systematic reviews. The information needs to be disseminated not only in scientific journals read by other researchers, but also in forms and language that are accessible by the target audience who may not be well versed in scientific methods (e.g., decision-makers, administrators, clinicians, practitioners, and teachers). The third component of knowledge translation involves the exchange of information between the researchers and the knowledge users, implying a bidirectional instead of a unidirectional relationship, similar to those described in the translational research process. The last component involves working with knowledge users to adapt the new knowledge to their context such as to promote the implementation of new procedures or practices to enhance health outcomes for the consumers.

A recent project by our team illustrates the bidirectional interaction between researchers and end users. The project focused on the evaluation and implementation of evidence-based practices for individuals with intellectual disability in a school setting. The project involved a multi-disciplinary team of special education teachers, behavior analysts, public health, and nursing specialists in an integrated knowledge translation initiative. The project was also supported by a group of students from these various disciplines. We surveyed special education teachers from a collaborating school on pressing knowledge and training gaps in their everyday work. Teachers identified and ranked order a number of areas. The team then created working groups to address these targets using or developing knowledge syntheses and then developing user-friendly deliverables such as evidence-informed forms, video tutorials, decision trees, etc. to facilitate adoption of procedures. End-users — teachers — had the opportunity to provide input throughout the development of these materials. For example, teachers participating in the study highlighted "being able to identify easily enjoyable activities for students with profound disabilities" as their top training need. Specifically, they were interested in time-efficient and easy-to-implement strategies that would allow them to engage students in educational activities for as long as possible. They went on to specify that suitable strategies should be amenable to students with sensory impairments, and also to those with limited verbal and motor skills. Finally, strategies needed to be adaptable to the presence of challenging behaviors. In response, the working group entrusted with this knowledge gap created a collection of evidence-informed user-friendly materials about preference assessments and activity engagement. The group also created a decision tree intended to help users to identify the most suitable preference assessment strategy among the various ones available. Teachers had various opportunities to provide feedback throughout the process, thereby making the final outcome relevant to the knowledge users. A sample of these materials have been made freely available at https://stamant.ca/research/school-kt-project/.

The science of knowledge translation is still an emerging field. Many target behaviors have not yet been defined and contingencies that influence these behaviors deserve study. Behavior analysts can contribute a great deal in this area to promote the adoption of evidence-based information to improve health outcomes and to disseminate the science of behavior in positive and practical ways.

A Letter to New York Times

Hank Schlinger, PhD
introduction by David C. Palmer, PhD

David C. Palmer studied interresponse times and conditioned reinforcement in pigeons at the University of Massachusetts under John Donahoe in the early 1980s. Upon graduation, he took a job teaching statistics and behavior analysis at Smith College, where he remains today.

His interests in behavior analysis are broad, but his main contributions have all been attempts to extend Skinner's interpretive accounts of human behavior, particularly in the domains of language, memory, problem solving, and private events. He remains convinced that behavioral principles offer an adequate foundation for interpreting such phenomena. Together with John Donahoe, he authored the text, *Learning and Complex Behavior*, which was an attempt to justify such optimism.

Dr. Palmer was the Invited Editor of a special edition of *Operants* in 2017.

Jerry Fodor was an influential philosopher who died on November 29, 2016. It is impossible for me to do justice to his views, because they are so alien to my own that we have no common vocabulary. Perhaps he would dispute this, for he was an extreme nativist who believed that most concepts are innate. He argued that the mental world is a real thing, governed by an innate "language of thought." The philosophy of mind, as practiced by Fodor and his intellectual ally, Noam Chomsky, lacks an underlying science that could serve to anchor one's speculations or to resolve disputes. It is a game of words only. Far from being a source of insight, Skinner and his science served a negative role for Fodor. The empirical findings of the science of behavior served, not as guideposts to a coherent philosophy, but as poisonous swamps to be avoided.

Nevertheless, speculating about the mind, without respect to an underlying science, is a game that anyone can play, and perhaps for that reason, there is a substantial audience for ideas such as Fodor's. He was indeed famous, so upon his death the New York Times published a long obituary by Margalit Fox, a staff writer with a master's degree in linguistics. Like most obituary writers, she found much to praise in her subject. But it is hard to praise Fodor without discussing the context for his work, and in attempting to do so, she invoked a familiar set of misconceptions about Skinner. (The obituary can be found in the Times' archives at goo.gl/6nidQH.)

Misconceptions about Skinner are tiresome, and it would be an endless task to swat them all down. But the New York Times has some nine million readers and is one of the most influential newspapers in the world, so Hank Schlinger promptly fired off letters to the Times and to the author of the obituary, objecting to its errors. The damage could not be undone, but we can hope that the next time Skinner is mentioned in the Times an editor will remember to try to find out what his position actually was.

Hank has the admirable habit of responding to published misconceptions of Skinner, and often a letter will lead to a productive exchange. Howard Gardner, one of the central figures of cognitive psychology, recently posted their correspondence on his blog and invited others to join the discussion. Chomsky, among others, took up the offer. (Readers are still welcome to join the conversation at https://goo.gl/vk43vM).

Hank's habit of addressing misconceptions is one that all of us should emulate. In the service of disseminating his response to the Times obituary to a wider audience, we are reprinting his letter to Ms. Fox.

Dear Ms. Fox,

It's odd that I find myself writing a letter in reaction to an obituary. However, in the case of your obituary of Jerry Fodor, I find that I must:

1. Skinner never said anywhere that "a child is born with its mind a blank slate." Others who did not understand his science or philosophy said that about him, but he never "maintained" it.

2. Chomsky never "demonstrated that language was not learned behavior." Chomsky, like Fodor, (and Descartes for that matter) was a rationalist, not a scientist. "Demonstrate" is a strong word to use for someone who is not a scientist. On the other hand, following from Skinner, behavior analysts have taught thousands of individuals various levels of language and, thus, demonstrated in each case that much of what we call language

is learned. And even if they hadn't, it's pretty obvious to anyone who's ever had a kid.

3. As I've argued more than once, a book review did not -- and cannot -- demolish a scientific enterprise and theory. Only good experiments can do that; and Chomsky NEVER conducted any experiments.

4. "His work, scholars now agree, vanquished behaviorism, especially as far as the study of language was concerned." Really? Which scholars? You might want to tell that to the tens of thousands of behaviorists all over the world who are conducting research and teaching at universities and who are providing therapies and treatments for myriad behavioral problems in numerous populations. I can show you just as many scholars who would disagree with your scholars. Also, it's difficult to understand how someone of Fodor's stature can find a scientist's work "reprehensible." Those are strong words and one wonders what the real motivation behind them is.

5. The principle of parsimony is on Skinner's side and not on Chomsky's or Fodor's. Skinner was an impeccable scientist who ushered in an experimental science of behavior. Like other natural scientists -- yes, empiricists -- in a variety of other disciplines throughout history, Skinner extrapolated from the experimental laboratory to phenomena not amenable to experiment, such as behaviors we call language, reason, consciousness, perception, etc.

6. The rationalists have never produced any technology that I am aware of; only scientists have.

7. Finally, I can think of no higher praise for a behavioral scientist than to say "We claim that Skinner's account of learning and Darwin's account of evolution are identical in all but name." For my money, I'll go with Darwin and Skinner.

One wonders why, in an obituary, even about Fodor, you felt it necessary to offer counterfactual statements about B. F. Skinner that have been shown for decades to be false.

In any case, with all due respect to you and to the late Jerry Fodor, it is Skinner's science that has already begun to win the day in terms of understanding human behavior and changing it, not rationalism.

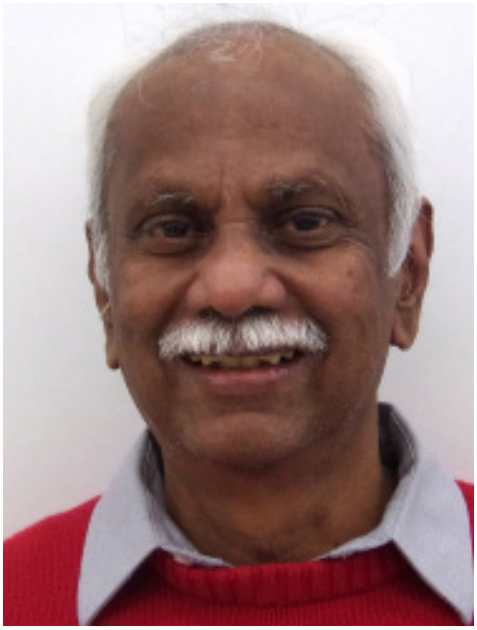
Respectfully,

Hank Schlinger

Henry D. (Hank) Schlinger Jr. received his PhD in psychology (applied behavior analysis) from Western Michigan University under the supervision of Jack Michael. Dr. Schlinger is professor of psychology and former director of the M. S. Program in Applied Behavior Analysis in the Department of Psychology at California State University, Los Angeles. Dr. Schlinger has published numerous scholarly articles and commentaries in more than 25 different journals. He also has authored or co-authored three books, Psychology: A Behavioral Overview *(1990),* A Behavior-Analytic View of Child Development *(1995), and* Introduction to Scientific Psychology *(1998). He is past editor of* The Analysis of Verbal Behavior *and* The Behavior Analyst, *and on the editorial boards of several other journals. He received the Distinguished Alumni Award from the Department of Psychology at Western Michigan University in 2012, and the Jack Michael Award for Outstanding Contributions in Verbal Behavior from the Verbal Behavior Special Interest Group of the Association for Behavior Analysis International in 2015.*

What B. F. Skinner Means to Me

Venkataraman "Shaker" Chandrasekhar
Indianapolis, IN



Venkataraman ("Shaker") Chandrasekhar has had an ongoing forty plus year interest in behavior analysis, even though his education and livelihood were in the fields of metallurgical engineering and software engineering, respectively.

Originally from India, he has been living in the US for almost fifty years, currently in Indianapolis, and (hopefully) in a year or two in a locale a bit more south and a clime a bit more warm.

Recently retired, he is trying to split his time between learning to cook Indian food, reading, writing, table tennis, and exercising, the last two being more fantasy than reality. He would love to get work developing programmed instruction materials. (He is disappointed that Skinner's attempts to reform education have not taken off.)

Shaker considers Verbal Behavior *the most important book he has ever read and feels grateful to have had in his life the influence of* oonche log *("great men," in Hindi) like B. F. Skinner.*

I am a retired software engineer — not someone, perhaps, who you would expect to write an homage to B.F. Skinner — but Skinner has made a big impact on my life. You can ask those around me. After my first son graduated from college, I discovered an article he had once written for his college newspaper. The article offered a critique of Freud's *Beyond the Pleasure Principle*, which he had read for a class. In his essay, he made the "full disclosure" that he had been raised by "a disciple of the behaviorist, B.F. Skinner." Prior to this moment I had not thought of myself as "a disciple of Skinner," but I will certainly not quarrel with this depiction.

My Development as a Skinnerian

When I came to the United States from India in September, 1971, I knew nothing about psychology. I had come for graduate study in engineering, and the research group I was in turned out to be a pressure cooker. Our research director's motto was "You should live your thesis" (with "or else" being definitely implied). He arranged for me to live with two other graduate students of his and played us against one another. This was 24-hour aversive control and I constantly felt that the walls were closing in on me.

Around that time I stumbled across an old Time magazine that had a cover story on Skinner following the publication of *Beyond Freedom and Dignity*. In the Time story, Skinner mentioned that he had the amount of time he worked automatically plotted, so that he could refuse social invitations and the like if the plot showed that he was not working enough. I started disliking him immediately. Facing aversive control around the clock, I thought, "What a terrible man, he is punishing himself for not working enough." The rest of the article did not improve my opinion of him either. Not only did I dislike him, I also felt very strongly that his views were utterly wrong and could very easily be disproved. I began a "demolishing Skinner" project with the ultimate goal of writing to Skinner to show him how he was wrong.

I started stealing some time from my thesis and poring over *Beyond Freedom and Dignity*. Almost immediately, however, Skinner's arguments in it began to excite the engineer in me. He pointed out that everyday cause and effect should be thought of expressly as independent and dependent variables. He wrote that even though Greek science was primitive, it had something in it to eventually give rise to modern science (a similar thing has not happened with Greek humanities). Though I had not done so before, I found myself predisposed to thinking about the everyday human world in scientific terms, and over a period of several months the Skinnerian worldview started winning me over. Coincidentally, things changed in other parts of my life also. I left the high-pressure research group and started working as a software engineer. I did not have to live my thesis anymore and could read more of Skinner's books. This accelerated my conversion.

The next step in my evolution as a Skinnerian was still a big sur-

prise. Having seen in his other books frequent references to a book called *Verbal Behavior*, I borrowed it one day from a library and started reading it, without any particular expectations, at a salad bar where I had stopped for dinner. A shock was waiting for me a few pages into the book: Skinner was actually proposing that verbal responses are determined responses. I was not ready for this and began putting up a fierce resistance -- but only for a minute or two. Soon, I was completely overcome not only with the conviction that Skinner was absolutely right but also with the realization that this was a huge breakthrough; he was solving something I (along with the vast majority of the people in the world) had not previously even recognized as a problem. My whole body started shaking with this realization. This was a true epiphany, the only one I have had in a rather nerdish life. I consider this to be as momentous as the births of my two children.

"Shaker" in the 1980s

More things changed in my personal life. I had had a lot of responsibilities related to my family in India, and these started easing up around this time. Although I come from a very risk-averse background, I began contemplating the unimaginable: leaving engineering to pursue a future in behavior analysis. I attended a couple of conferences where I had the opportunity to hear Skinner speak. I even got the chance to walk up to him, get his autograph, and ask the first question that popped into my head, "Can your theories explain dreams?" "No," said Dr. Skinner, "but nor can the other side."

I went so far as to contact a professor in this field, and we met a few times and even chose a potential PhD problem to work on. I began wondering whether Skinner would take me on as an unpaid volunteer. Having read *Walden Two*, I looked for an intentional community to live in.

In the end, I could not figure out a way to pursue behavior analysis full time, and instead continued with my software engineering career. But I did not throw away my behavior analysis books or abandon my interest. For example, I did my best to keep up with developments in behavior analysis journals. To accomplish this I relied mostly on the Psychology department library of a nearby university. I would go there on Sunday afternoons, when the doors to the building were closed and I needed some kind soul to let me in.

As I learned more, I grew bolder in pursuing my interests. In the late seventies, after reading about a number of developments that some interpreted as challenging to Skinner's framework (e.g., the Breland effect, the Garcia effect, autoshaping, and Herrnstein's critiques in his exchange with Skinner in the *American Psychologist*), I wrote to Skinner for clarification, and got two valuable insights about his character. First, he replied to a total stranger; despite being an incredibly busy man he apparently did as often as he could. Unfortunately, I did not make clear the extent of my knowledge in behavior analysis and he took me to be a rank beginner. The reply was pleasant and polite but it did not really address my questions with much substance, and mainly referred me to articles I had already read. I came to realize, however, that Skinner was inundated with correspondence from people of all walks of life, so it is understandable that he assumed me to be a beginner.

Second, the Skinner letter contained a typo that, given Skinner's reputation for meticulousness, surprised me. Several years later, reading M. J. Willard and Robert Epstein's article on Skinner, *Our Most Unforgettable Character*, I got a clue as to what might have happened. Around the time I wrote to him, Skinner had a secretary with poor typing skills. She was very surprised that he never criticized her for it. But Skinner never criticized. He always waited for an approximation of the desired response, and then started shaping the desired one. Learning this made me happy and also a bit sad that I had not followed through on my interest in working with Skinner.

I mentioned earlier my youthful "demolishing Skinner" project. I probably am the only person in the whole world to have wanted to demolish Skinner at one time and Noam Chomsky at another. After having read *Verbal Behavior*, I emailed Chomsky, and a series of email exchanges followed in which I queried him on points related to his scholarly disagreements with Skinner. Contrary to his irascible reputation, Chomsky was pleasant in these exchanges, but we made zero progress in discussing anything substantial. At one point, in an attempt to establish some common ground between Chomsky and Skinner, I mentioned Skinner's opposition to the Vietnam War. Chomsky denied that Skinner ever opposed the Vietnam War. I tried another tack. Skinner mentioned in his autobiography that when he and his daughter Julie were having breakfast at the University of Chicago during the weekend that he and Chomsky both received honorary doctorates, Chomsky stopped at their table to say hello. I brought up this incident, but Chomsky replied, "Not true, never happened, you can check on this." (Several years later, I did just that, asking Julie about it during a chance meeting at a conference. "It happened," she said.) These roadblocks put a quick end to my "demolishing Chomsky" project.

How Skinner's Ideas Enrich My Life

Having read Skinner has helped me both professionally and personally. Prior to becoming a Skinnerian, I had not given much thought to scientific epistemology. What I learned from Skinner has allowed me to more than hold my own in arguments and discussions – I recall a conversation in which a PhD in physics from Cal Tech and a PhD in computer science were taken aback upon hearing me make points that I had learned from

HARVARD UNIVERSITY
DEPARTMENT OF PSYCHOLOGY AND SOCIAL RELATIONS

WILLIAM JAMES HALL
33 KIRKLAND STREET
CAMBRIDGE, MASSACHUSETTS 02138

June 15, 1978

Mr. V. Chandrasekhar
L-11 Van Mar Avenue
Cardiff, New Jersey 08232

Dear Mr. Chandrasekhar:

Thank you for your letter. I'm am just finishing the second part of my autobiography and it should appear perhaps next Spring.

I do not believe there has been a set back in the field of the experimental analysis of behavior in the past ten years. There have been many rapid developments in other areas but generally of an unscientific nature and I am satisfied with the progress being made in my own field. There are many criticisms of the operant analysis but I do not take them seriously. I do not, however, spend much time in answering them. You may have seen the exchange between Professor Herrnstein and myself in the American Psychologist last Fall. I too regret the Herrnstein emphasis on heritability but chacon à son gout. Estes did some brilliant research when he was my graduate student but then became seduced by mathematical model building and I do not regard his recent work as promising. I have never bothered to reply to Chomsky because it was so obvious that he completely misunderstood my position. There are several replies to him, among which I prefer that by MacCorquodale.

Thank you very much for your letter which I very much appreciated.

Sincerely,

B F Skinner

B. F. Skinner

BFS/sh

Skinner about the nature of the scientific process (e.g., "a result reported in a journal is often attempted to be replicated only when someone has a need for that result," which runs contrary to the assumption that all results get replication-tested as a matter of course).

There is a lot of confusion in modern physics about determinism at the quantum level. It has been suggested that fundamental processes are stochastic rather than determined, and some have used this conclusion to defend the concept of "freedom" in human actions. Skinner's model helps me to have faith in a world of causal laws. The conceptions of behavior in mainstream Psychology and lay thinking that Skinner confronted were skeptical of strict determinism and put a lot of stock in human agency, but Skinner steadfastly pursued a deterministic science, to great effect. Perhaps the same will prove true for physics. Consequently, even in the face of modern trends in physics my faith in determinism has not been shaken. I believe that the confusion in modern physics will one day be resolved with saner conclusions, and I have never doubted that behavior is determined.

Skinner has also helped me get my work done. In my professional writing, I have tried to use the techniques recommended in *How to Discover What You Have to Say*. In a loose interpretation of Skinner's guidance, initially I write as much as I can without too much self-editing. Then I distill the product to an outline that is at least a couple of levels deep, and move topics around as seems logical before attempting to revise. Almost always, including in the writing of the present paper, this process has improved the result.

On a personal level, I often use Skinnerian resources for recreation and entertainment. I continue to try to keep up with behavior analysis journals, though that is growing difficult as libraries cease acquiring paper journals and electronic versions of journals increasingly are hidden behind pay walls. When the world begins to feel chaotic, I take comfort in refreshing myself on the frames of *The Analysis of Behavior*. Other books to which I frequently return are *About Behaviorism*, *Science and Human Behavior*, and *B. F. Skinner: Consensus and Controversy* (I enjoy both the essays that support Skinner and those that, sometimes laughably, attempt to critique him).

In terms of personal adjustment, I learned from Skinner how to live comfortably within the laws of behavior. Where I grew up, much emphasis is placed on innate talent and personal initiative. A popular adage (which may not translate perfectly into English) was, "What the eye sees, the hand should do." The implication is that when placed in a new situation a smart person should employ his intellectual gifts and free agency to perform whatever is necessary to succeed. Only the weak need instruction or dare ask for help. At the same time, perhaps paradoxically, it is also said, when referring to the quality and effectiveness of people's actions, "Unless something is in the pot, it will not come in the ladle." Many who were raised like I was learned to pretend that there was more in our pot than actually existed, and there are a lot of people somewhat bluffing their way through life, posturing as more effective than they really are, while suffering the perpetual stress of suspecting otherwise. As a Skinnerian, I find it liberating that I can dispense with the pretense of infallibility. Instead, I can openly admit (at least to myself) to the limits of my ontogeny and focus on enhancing it. My expertise is the product, not of innate gifts, but of favorable environments -- which I can have a hand in arranging.

When I experience unpleasant thoughts, it helps to remember Skinner's admonition that these are caused, not causal. A never-fail gambit I learned from an essay by Gaynor is to ask myself "What is the tenth word in the national anthem?" I then let one finger out and say silently "Oh", let a second finger out and say "say", and so on, and come up with "light" as the answer. This process reminds me that private responses and public responses differ only in their thresholds of observability. Both are emblematic of causal environments, and neither defines me in an essentialist way.

Skinner is remembered as the 20th Century's most influential psychologist mainly on the appraisal of other professional psychologists, but I am living proof that his influence extends far further. I came from another country to study something else and, in the unlikeliest of environments (a popular magazine article) discovered a lifelong interest which has been a source of much fun and great personal comfort. I cannot credit Skinner directly because he was not a fan of assigning personal blame or credit (these imply a form of agency that his analysis undermines; e.g., see *On Having a Poem*). But I am grateful for the environments that shaped Skinner's repertoire and yielded the many inspirational works that have meant so much to me over the years.

Operants asked Dr. Julie S. Vargas to recall the episode Venkataraman ("Shaker") Chandrasekhar is referring to. She wrote:

I was once at a conference with my father, B. F. Skinner. We were having breakfast when Noam Chomsky walked by. He saw my father and said, 'Hello, Fred." My father replied "Hello, Noam." Noam continued walking. When he was out of hearing, I said to my father, "You ***SPEAK*** *to him?" My father smiled and said, "of course."*

My father always separated personal interaction from professional differences.

Sophia Leite: Researching the Interaction Between Humans and Computers

Interview by Darlene Crone-Todd, PhD

Sofia Leite is currently a clinical psychologist and a doctoral student pursuing a PhD in Biomedical Engineering at the Faculty of Engineering, University of Porto, in Portugal. Specifically, as a researcher, she is working in the field of artificial intelligence, applying principles of the Theory of Complex Systems to developmental cognition and artificial learning, developing a Stacked Neural Network model based on orders of complexity. She develops her work as a collaborator at CINTESIS, the Center for Health Technology and Services Research, also at University of Porto. In 2016, she was offered a Fulbright Research Grant, and worked with Professor Michael Lamport Commons at Harvard Medical School. During her stay in the USA, she became lead research collaborator at Dare Institute in Cambridge, MA, working on the Stacked Neural Networks project.

During the past two years, I had a wonderful opportunity to meet Sofie Leite through mutual colleagues. Ms. Leite is currently completing her PhD in Biomedical Engineering/Artificial Intelligence at Faculdade de Engenharia da Universidade do Porto in Portugal. She is a lead researcher on a project related to stacked neural networks at the Dare Institute in Cambridge, MA. What struck me as most interesting about her past and current work is how the methodology she uses to investigate human-computer interactions mirrors that of the small N, within-subjects designs used in behavior analysis. As our discussions evolved, she graciously agreed to this interview. What follows, then, is a transcript of our interview meetings, both in person and through email, over the past year.

Let's first start with your work at Microsoft (with whatever you feel comfortable sharing).

At Microsoft — Microsoft Language Development Center in Portugal — I worked as a biometric data analyst for multimodal human-machine interfaces. But my experience in this field is not restricted to what I did at Microsoft. What I have to say about it is the result of my collaboration in several projects operating on the overlap between human behavior (mostly physiology/biometrics) and technology. So, I first want to make clear that what follows is not about the particular work I conducted at Microsoft Portugal, but it rather concerns general ideas and research methods that are applied to the design and development of human-computer interfaces. This is information I have been collecting along my experience.

You mentioned that you were researching the interaction between humans and computers.

Yes, I have been researching in that field since 2012. More specifically, I have been researching on the "*human-end*" of this interaction, i.e., how humans can implicitly communicate with computers, not so much on the actions that computers send back to humans. I am interested on how computers can learn to read the states and/or intentions of the users without them (the users) being required to explicitly state them, through the mouse, joystick, or written text.

When you say that you want to know "…how humans can implicitly communicate with computers", it seems that this is through their actions (e.g., mouse movements, joystick movements, written text, etc.). Do you think this is possible? I ask because psychologists and behavior analysts have, for years, considered that what people say and what they do are two different things. How would a computer analyze behavior differently in these cases?

Yes, this is exactly the question that is being researched. By collecting data on their behaviors, including physiological measures, and their reports of their current states, the computer should theoretically over time be able to detect or read a person's state or intension,

without a human continually having to state them.

In this research, you learned that it was best to go beyond one data point per person, and instead take multiple measures over time. Can you tell me a little about that research design, and how it evolves?

A human-computer interface is, generally speaking, the circuit of messages that connect a human and a machine. How does this circuit go? The human behaves, the machine reads the human`s behavior, and sends information back to the user through the screen. The screen of a computer might be seen as the physical body of the machine. The human then reads the information provided, reacts to it, and the machine again reads the human`s behavior; and so on, and so forth.

Among the many, many, questions that this circuit implies, we now stick to one: What features of behavior will the program be set to read?

From now on, for simplicity, instead of human I will use the term user, who is a human in the specific situation of using a human-computer interface.

There are many features of human behavior that might be taken in as inputs. In my experience, I have been researching on inputting biometrics - (neuro) physiological measures of human behavior. My goal has been to define a biometric data analysis pipeline that ultimately informs the machine about the states and intentions of users. From the heart rate, heart rate variability, galvanic skin response, etc., we can extract features such as changes, peaks, on so on. We can then use those features to make comparisons across conditions.

Now, it is unquestionable that we witness the variability among humans. If this is true for observable behavior, imagine the case for physiological behavior! Hence, another question follows: How can one define a baseline from which (neuro) physiological features can be read and informative across users and usability conditions?

Yes, also just being measured probably changes the neurophysiological measures (at least temporarily) due to reactivity on the part of the subject.

Yes, this is why we need to have baseline procedures, but they include having a period after which people habituate to the data collection environment.

First, this question arises because of a fundamental assumption. When someone develops a program, one ultimately wants the program to run everywhere and to work for everyone. This is true for the scope of utility of the program in benefit of humans and this is also true for the chance of increasing its market place and potential profit. Even if market segmentation is a way for optimizing profit, there must be a common background that allows product differentiation.

Interesting. Is the purpose of this information to talk about how, despite the variation, it is important to try to come up with a solution that works for a large number of users?

Well, here is the issue: If looking for a system that responds to the user, you need to study the variability within people. If you want to compare conditions between groups, then you need a large sample size, and that increases the cost and decreases the possibility of zooming in on an experimental factor. You don't know how much the change based on the factor is due to the factor itself or to other uncontrolled variables. It is very difficult to detect small effects that might be meaningful.

To get back to answering the question about research design, when it comes to categorizing a state/intention of a user through biometrics, to use an inter-subject (between-groups) design is inaccurate. In these designs, generalization is assumed, but is not real. Inter-subject designs will set an averaged baseline, collected synchronically. This will necessarily make it more difficult to read the idiosyncrasy of each user. Intra-subject designs are more suitable, in that they allow one to set a relative baseline, or "self-referenced". And this is what we want to begin with if the goal is setting up a program ultimately suitable for "everyone" under every condition.

Hence, intra-subject designs are a good option not only for measuring and learning the user`s behavior across time, but also to model the relationship of measures between themselves, and how they co-vary. This is also an issue in research work on human-computer interfaces, specifically called multi-modal human-computer interfaces.

This is very interesting, as in behavior analysis we emphasize the use of intra-subject designs, or repeated measures. There are several types of designs used, including one that involves reversal to baseline and replication of the experimental effect (ABAB), as well as multiple baseline designs that incorporate one baseline and one intervention. However, the baselines are staggered, with the intervention introduced at different time points across subjects, behaviors, or settings. If possible, can you tell me about the quantitative and qualitative measures?

Yes. In the previous answer, I left aside the importance of qualitative measures. But they can be an important part of the process, as well.

We can learn about a user`s states through self-referencing patterns of physiological activity to each other over time (usually called unsupervised learning in machine learning). This is where a program needs to "read" the user. But we should not forget that the user must also be able to "read" the machine. So, sometimes, depending on what information the machine is intended to convey, it might be useful to estimate the correlation and reliability of these patterns with the actual experience of the user: To be the most general that I can about it, we want to know if the user is sad, happy, tired, concentrated, etc.

conclusion on p. 20

On Skinner's Analysis of Generic Classes

David Roth, MA

David Roth is currently a behavior analyst consultant for the Pennsylvania Training and Technical Assistance Network (PATTAN) Autism Initiative supporting public school classrooms throughout the state of Pennsylvania. He received his master's degree in Behavior Analysis at California State University, Stanislaus. For over a decade, David has been a passionate student of B. F. Skinner's works, specifically his analysis of verbal behavior. His current interests in the field range from the application of behavioral programming for individuals with verbal deficits to the behavioral interpretations of complex issues that are currently on the fringes of our science.

Since Skinner's foundational paper, *The Generic Nature of the Concepts of Stimulus and Response*, was published in 1935, the field of behavior analysis has grown considerably. The BACB has certified over 20,000 behavior analysts, hundreds of schools and clinics around the world apply the principles of behavior to treat individuals with verbal and non-verbal deficits, and there exists a wide range of special interest groups who focus on behavioral solutions to other widespread socially significant problems. In addition to the expanding number of practical applications of behavior analysis, conceptual analyses continue to provide interpretations of behavior too complex for experimental control within a laboratory setting. While some of these interpretations continue in the tradition of Skinner's many works, most notably *Science and Human Behavior*, *Contingencies of Reinforcement*, and *Verbal Behavior*, a branch of the behavioral field proposes a new theory in which a "post-Skinnerian" approach to complexity is supposedly warranted. A critique of this discipline's assumptions is beyond the scope of the present paper and has been accomplished elsewhere by David Palmer of Smith College. The present essay draws attention to the foundational paper published by Skinner over 80 years ago, discusses the handful of critical facts he discovered through his empirical investigations of the concepts of stimulus and response, and addresses the paper's important relevance to an understanding of all behavior and its controlling variables, including those commonplace examples outside the laboratory whose complexity, from the perspective of a natural science, continues to leave us puzzled.

Pre-Experimental Preparations

Prior to experimentally investigating the concepts of stimulus and response, Skinner assumed that there must be defining properties of both behavior and its controlling variables. In a natural science, these properties must be defined in terms of their physical dimensions captured under rigorously controlled experimental conditions. While his Pavlovian predecessors had experimentally demonstrated nearly identical reproducible units of stimulus and response by narrowly restricting the location of a stimulus, as well as the mobility of the organism, Skinner wanted to identify the behavioral units of the organism as it moved "freely" about the world. Therefore his subject matter required definitions of more loosely constrained *classes* of stimulus and response. The inescapable challenge of identifying reproducible classes is that the units of both stimulus and response must necessarily include members that differ in form; Skinner did not shy away from this problem, however, and instead set out to identify a way of empirically determining the topographical boundaries of these concepts.

The Discovery of Definitions

Although the initial stage of defining a property of a stimulus or a response entails arbitrary specifications, it is only through the direct observations of orderly functional relations in the data over time that the non-arbitrary nature of our units is eventually discovered. While orderliness in our data can take various forms, Skinner referred

to "smooth curves" within his data as representations of the functional relations between stimulus and response classes. Any absence of orderliness between the defined variables must guide the scientist to narrow or expand his or her definitions accordingly. For example, a scientist may first define a rat's lever-pressing behavior as each instance of its right paw pressing down on the lever, but when subsequent responses are observed to include variations in the topography, such as a lever-press with its left paw or both paws, the scientist must then expand the definition to include the broader range of physical forms. It is important to note that in addition to the variability observed in a response class there are corresponding differences in the topographies of a stimulus class as well; the visual properties of a lever approached from its left side are quite different from those approached from the right.

Determining the Members of a Class

On successive occasions, variations in both stimulus and response topographies presumably continue to maintain orderly relations with each other through the processes of response induction and stimulus generalization. Skinner explained that although we may observe a novel topographical variation within either a stimulus or a response class, we can determine its inclusion within the class when a change in the contingencies to that member directly affects all of the other members of that class equally; this is what Skinner referred to as *quantitative mutual replaceability.* For example, if, after identifying a wide range of topographies in lever pressing, the experimenter schedules extinction for an instance of the rat pressing with its right paw, that momentary consequence will directly affect the rat's behavior of pressing the lever with its left paw, both paws, and all of the other variations within that class. The concept of quantitative mutual replaceability enables us to exclude rare and unusual instances of "lever pressing" from our defining criteria. Take for instance a rat that, while exploring areas within the operant chamber, adventitiously operates the lever with its tail. We may now observe a new class of lever pressing behaviors but the members of this class will be restricted to a unique range of topographies, and any contingency changes to the originally selected lever-pressing class are not quantitatively mutually replaceable with the members of our new response class whose correlated stimulus class is also of a very distinct form from the originally established units.

At the time his paper was written, Skinner classified his subject matter as a special case of the "reflex." The following is an excerpt from Skinner's autobiography, *The Shaping of a Behaviorist,* in which he described his abandonment of the term "reflex" in favor of "operant" when writing his 1938 publication — *The Behavior of Organisms*:

> *I had come to psychology devoted to Pavlov, and I had soon discovered Sherrington and Magnus. They seemed to be closer than any of their contemporaries to a true science of behavior. The concept of the reflex had served them well, and in my thesis I had said that it was all that was needed in the study of behavior. I knew better by the time I began to write my book. My field was the operant rather than the respondent, and my measure of strength was probability (or at least rate) of responding rather than magnitude of response or latency or after-discharge.*

Stimulus and Response Subclasses

The above distinction between the two different, yet functionally similar, operants is not to deny that new classes of responses can be derived from existing classes. Among Skinner's experimental facts is the observation that in producing a stimulus subclass, by restricting properties of a previously established stimulus class, we discover a corresponding restriction in a new subclass of responses. Consider the following thought experiment: We have already identified wide, yet topographically constrained, reproducible units of the lever as a stimulus and lever-pressing as our response for our hypothetical rat, and we arbitrarily restrict the properties of the lever by shutting off the lights within the chamber and illuminating only a small corner of the lever with a narrow beam of light. Through the process of induction the sight of the lever's corner should evoke the lever-pressing response but with a more restricted topographical range. Skinner's experimental facts provide a complete explanation of the emergence of this new subclass — "pressing the illuminated corner of a lever."

In a section of his personal notes, titled "Behavioral Unit," written 40 years after the publication of the 1935 paper, Skinner described an analogous example culled from his own experience in which he identified a subclass with respect to his own door opening behavior:

> *At the top of the basement stairs I turned to shut the door to the basement. Instead I shut the kitchen door, which is at a right angle to it. The kitchen door has a baseboard clasp, and as the door came free I saw that it was the wrong door.*
>
> *"Closing a door" is a behavioral unit acquired with respect to hundreds of doors. "Closing the basement door" is a special case under special stimulus control. I emitted "closing a door" by responding to the first door that came to hand. (I was turning around and closing the basement door as an afterthought.) This kind of analysis is needed, but I am afraid that we won't see much of it for a long time.*

It is difficult to determine whether Skinner's claim in the final sentence is either a statement about the inevitable creeping pace of scientific progress or the conceptual limitations of the behavioral field as a whole at the time the note was written. In any case, the reader is left to ask what Skinner would say about the ability of the current field to provide analyses of this sort to other and more complex examples.

Extensions to Complex Behavior

As noted in the introduction of the present essay, some prominent behavior analysts are currently interpreting complex human behavior within the framework of Skinner's explanatory foundations.

Through a meta-analysis of Palmer's published works I have discovered references to Skinner's 1935 paper in at least 12 separate publications that interpret complex behavior. Some of the topics include memory, structural regularities in spoken and written verbal behavior, private events, and the emergence of novel responses to unique arrangements of controlling variables. In an effort to further the discussions of Skinner's concept of generic classes, I intend to provide for the subscribers of *Operants* excerpts of Palmer's references in this and subsequent issues. The following example is a brief description of the importance of Skinner's 1935 paper from Palmer's review of a book that proposes the "post-Skinnerian" approach to complexity mentioned in the introduction of this essay:

> *That operants are flexible does not mean that they can be defined according to the whim of the experimenter, or that the unit of analysis is a matter of convenience. If we have no independent criteria for deciding units of analysis, all behavioral interpretation becomes an exercise in circular reasoning, and prediction becomes impossible. Unfortunately, to go further would be a digression that I cannot spare, and I refer the reader to Skinner (1935) for what is still the definitive discussion of this topic.*

Notice that Palmer saw no need to provide further descriptions of Skinner's foundational paper since he considered the facts of Skinner's analysis to be self-evident. The present paper, in addition to the excerpts from Palmer's publications, can only function as supplemental support for reading Skinner's 1935 paper. The readers of this magazine are strongly encouraged to go directly to the source for a complete understanding of these topics. Perhaps after reading or re-reading Skinner's paper, the *Operants* readership will participate in the continuing discussions of its conceptual implications as the field ventures toward a more complete account of all human behavior.

You can download a copy of the article *The Generic Nature of the Concepts of Stimulus and Response* from the B. F. Skinner Foundation's website:
https://www.bfskinner.org/publications/pdf-articles/

Interview with Sophia Leite
continued from p. 17

This is usually done through the inclusion of self-reported measures with the other measures, under a variety of methodological procedures.

So, the priority is always to identify the goals of the program and then ascertain the best research method for developing it, which most often will include intra-subject designs and procedures.

What can you tell me about your current research, and how the work you have done in the past informs what you do know?

Now we come to the idea of machine learning where the interface, the software, receives the input data and then needs to generate a response. But because we don't know the variability of this input data, we want to determine how many different types of input data can be input into a given system.

Ideally, we can create a multimodal system. But to have that, you have to have software that is designed in a way to progressively make meaning out the subsets of information. You can also have software system that, even if not parallel, can process all of the data at once.

For example, suppose you have several inputs such as pupil dilation/constriction, heart rate, galvanic skin response, and such. All of these can then correspond to a previously-identified general summary label, such as "cognitive overload", and then when the machine detects that the inputs match the criteria for this label, the machine changes the environment to produce less stress on the individual.

You can also have lower-level inputs that coordinate into successively more and more complex modules. Each module can be rated according to relative strength of the coordinated inputs. However, this relies on various methods to determine the validity of the connections between the inputs and the modules. In theory, this could lead to a more flexible way of processing data and managing the objectives of the machine-learning environment using a modular architecture. Ideally, this is done in stacks to increase the complexity of the data and the results.

With machine learning and AI, it is the case that the systems are a result of the models used to develop them. The constraints posed by the mathematical functions and algorithms used to program them are not the results of constraints restricted to algorithms *per se*, but rather are the result of how we think about the problem. The models we use to think about how to approach any problem reflect on how we simulate the environments.

Dr. Charles Merbitz Receives The Ogden R. Lindsley Lifetime Achievement Award

Carl Binder and Kent Johnson, for the Board of Directors of the Standard Celeration Society

At its annual conference in St. Pete Beach, Florida, November 2-4, 2017, the Standard Celeration Society celebrated the contributions of one of its pioneering leaders who has served the standard celeration charting community in innumerable ways for decades. Honoring Dr. Charles Merbitz with the Ogden R. Lindsley Lifetime Achievement Award was a pleasure for those who have known him for decades, and a well-deserved acknowledgement of his dedicated mentorship for more recent students and protégés.

Dr. Charles Merbitz accepting the Ogden R. Lindsley Lifetime Achievement Award from the Standard Celeration Society. November 2017.

Chuck's contributions have been remarkable in their variety, inventiveness, and far-reaching ramifications: conducting innovative research and technology development; training teachers, psychologists, and medical rehabilitation professionals; consulting to a wide variety of organizations and programs; publishing important papers and chapters, serving on editorial boards; founding, developing and leading academic and clinical programs; helping to establish and support educational programs for children; and serving on boards and in leadership roles at organizations that include the Cambridge Center for Behavioral Studies, the Association for Behavior Analysis International, the Standard Celeration Society, and the American Association of Spinal Cord Injury Psychologists and Social Workers. His relationships with individuals – developing protégés, collaborating with colleagues, and bringing a palpable humanity to friends – have always set the context for his technical and professional contributions. Chuck is both a multi- talented behavior scientist and a truly good man.

Mentored by Dr. Henry Pennypacker at the University of Florida, Chuck first became a school psychologist before moving to Jacksonville State University to found the innovative Center for Personalized Instruction, which combined instructional technologies including the Personalized System of Instruction ("Keller Plan") and Precision Teaching to serve college students struggling academically. The Center still exists, thriving under its third Director, more than 40 years later.

Following his work at JSU, Chuck moved home to Chicago in 1980, and plunged into an entirely different field at the Rehabilitation Institute of Chicago. He served as Director of the Institute's grant-supported Learning Research Unit and on the faculty at Northwestern University Medical School. His technological innovations while at RIC combined computerized data collection and analysis of behavioral data related to rehabilitation with standard celeration charting applied to those data. He designed, prototyped, and tested a number of pioneering electronic and mechanical devices in pursuit of behavior measurement and feedback, several of which were adopted

by other researchers and practitioners. His strategy was to apply Skinner's measurement principles and radical behaviorism to the continuous, unobtrusive measurement of important events and behaviors to facilitate progress. For example, monitoring persons in the hospital with spinal cord injuries, he instrumented wheelchairs to become rolling operant chambers, enabling patients to learn new health behaviors without additional effort. His research and development at RIC led to the publication of an article on measurement which, three decades later, is the 23rd most cited paper in the medical rehabilitation literature (Merbitz, C. T., Morris, J., & Grip, J. C. (1989). *Ordinal scales and foundations of misinference.* Archives of Physical Medicine and Rehabilitation, 70, 308 - 312).

In 1991 Chuck left RIC for the Illinois Institute of Technology, becoming a tenured professor in 1996, where he also served as the University's disability accommodations officer. During his service as accommodations officer, not a single lawsuit was filed with the university over disability issues, a remarkable record in contrast to that of his predecessors. At IIT he taught Rehabilitation Counseling and Clinical Psychology students, who helped him articulate a blend of radical behaviorism and person-centered rehabilitation that was effective, compassionate, and uncompromising of the basic science.

In 2004, following the advice of his wife, co-author, and intellectual partner, Nancy Hansen Merbitz, Chuck abandoned tenure to become Professor of Psychology at The Chicago School of Professional Psychology. At the Chicago School he created Master's and Doctoral programs in applied behavior analysis, and became the first Chair of the new ABA Department. Curricula and procedures from that department became models for similar departments in Washington, DC and Los Angeles, and subsequently for an online ABA Program. His Behavior Analysis Department graduated scores of master's and doctoral students in applied behavior analysis with the power of Precision Teaching learned from and practiced by Chuck and faculty members whom he recruited to the program. Here again he found that students with a foundation in radical behaviorism could easily and usefully integrate counseling tools and a person-centered approach into an effective behavior-analytic system.

Throughout his career Chuck has been a frequent contributor to research and development related to the standard celeration chart. He and his son, Ben Merbitz, created and continued to develop one of the first online tools for creating, storing, and sharing computerized standard celeration charts. He carried forth the power and precision of behavior research and standard measurement learned from his mentor, Hank Pennypacker, without reservation or compromise. He became a much revered and beloved colleague, mentor, and friend to countless peers and students, always ready to help with wisdom, wit, and remarkable generosity of spirit. He has been a constant voice for methodological integrity, scientific rigor, and the power of standard measurement as a foundation for the natural science of behavior and its application.

Chuck's self-effacing manner can at times mask his brilliance and insatiable intellectual curiosity, which shine through when it matters – raising issues that others might miss, advocating for philosophical or methodological precision when needed, and always looking out with a sharp eye for the welfare of students, clients, patients and other beneficiaries of applied behavior science. Friends and colleagues can always depend on Chuck for a warm greeting, authentic empathy, humor in the face of adversity, and optimism about the future. He is a visionary, always looking ahead to what could be, and often contributing in innovative ways to transform possibilities into reality.

Those of us who served with him on the Board of the Standard Celeration Society were saddened to learn that Chuck had been diagnosed with terminal cancer, but we were happy that time remained for us to honor him with our highest form of recognition and appreciation, The Ogden R. Lindsley Award. We were even happier and grateful to learn a few months later that improvement from his most recent treatment regimen promises longer time remaining with us, his family, and the scores of colleagues and friends who love him dearly.

Even after Chuck's nominal retirement, he continues to serve on several boards and compose manuscripts that promise to be important contributions to our science. We encourage all of our friends and colleagues to reach out to Chuck, to thank him for his contributions, and to celebrate a remarkable career of service, dedication, deep humanity and rigorous scientific exploration. Thank you, Dr. Merbitz!

A Behavior Analyst's Perspective on Hypnosis

Stephen W. Holborn, PhD
University of Manitoba

Perhaps unsurprisingly behavior analysts appear to have made relatively little contact with hypnosis. Hypnosis seems to have remained largely under the purview of psychiatrists, clinical psychologists, and stage hypnotists. While, for behavior analysts and others, this likely has resulted in an air of mystery surrounding hypnosis, hypnosis has not escaped conceptual and experimental scrutiny, particularly by social psychologists (e.g., Ted Barber, Martin and Emily Orne, and Nicholas Spanos).

What follows is a story about my own personal history in grappling with understanding hypnosis from a behavior analytic perspective. Rather than providing an exhaustive coverage of hypnotic phenomena, I will illustrate the application of a behavioral account in selected areas. In addition, I will extend the account to another related area (i.e., the misinformation effect) in order to provide a unifying theoretical account consistent with behavior analytic principles and methods of operant and respondent conditioning.

Hypnosis: First Contact

My first encounter with a demonstration of hypnosis occurred while I was an undergraduate psychology student at the University of Victoria in Victoria, British Columbia, Canada in the early 1960's. Several of my friends and I purchased tickets for the performance of the stage hypnotist Peter Reveen. Reveen, at the time, was an extremely popular stage performer in Canada, particularly in Eastern Canada. The billing was: "Reveen the Impossibilist."

The script for the show went like this: Early on, various exercises in compliance to instructions were given to members of the audience. One example is what I'll call the "molten hands" exercise. People in the audience were asked to clasp their hands together with fingers intertwined. Next, audience members were requested to close their eyes and to visualize their hands as being in a smelter where their hands had turned into a mass of molten metal. Then the visualization was to be of the metal gradually cooling and leaving behind a solid, hardened mass. Finally, Reveen instructed everyone to open their eyes and to try to pull their hands apart. If you try this visualization exercise (and you should, even without Reveen), you will find that there is some resistance to pulling your hands apart. Nonetheless my friends and I easily overcame this resistance to quickly pull our hands apart. A number of other individuals, however, appeared to have great difficulty pulling their hands apart, even to the point of requiring help in doing so from Reveen's assistants who were strategically placed in the aisles of the theatre.

Some of the individuals who were the most compliant with Reveen's instructions were selected to join him on stage where they apparently were quickly put in a hypnotic trance. My friends and I (feeling rejected) remained in our seats, believing that we lacked some essential attribute that would have rendered us hypnotizable. Next the entertainment began. An individual instructed by Reveen to become a chicken began to cluck and to strut around like a chicken. Similarly, an individual told that he was a dog began to crawl around on all fours and bark like a dog. When Reveen instructed a person to become an exotic dancer, suddenly the dancer appeared, full of undulating

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moves (the trance dance, I called it). If Reveen suggested that the person was a juggler, the individual began to juggle imaginary objects. Even post-hypnotic suggestion was demonstrated. While hypnotized an individual was told to complete a task later after awakening. Then she was awakened and returned to her seat. Several minutes later she arose and walked zombie-like to complete the assigned task. Except for the last demonstration which sent a hush over the audience, the other examples of hypnosis were greeted with uproarious laughter.

At the end of the show my friends and I decided that Reveen's performance was entertaining, so we got our money's worth. However, we were puzzled about exactly what hypnosis was. I thought that Reveen's portrayal of himself and his feats as the Impossibilist, likely was deceiving, but at that time I had no alternative, conceptual framework ready to account for hypnosis. Towards the end of his career, Reveen had to admit that what he did in his show was simply entertainment. Peter Reveen died in 2013. Today we are greeted with the second coming of Reveen in the form of Peter Reveen's son, Tyrone Reveen, who is to continue "the Legend" of Reveen. The former special effects expert now, will like his father before him, put us in touch with the "Super-Conscious" realm. All I have to say is "Caveat Emptor" (buyer beware).

The Development of a Theoretical Framework

After graduating from the University of Victoria, I undertook my graduate training in experimental Psychology at the University of Iowa, and hypnosis was moved to the back burner. Initially I was immersed in Hull-Spence theory and animal learning involving straight alleys and T-mazes (not operant chambers). I eventually specialized in verbal learning and memory.

I accepted my first position in the Department of Psychology at Boston University in 1968. One key factor in my decision was access to the large participant pool for my research in verbal learning and memory. Unexpectedly something else happened while I was there, partly due to the influence of my behaviorally-oriented colleagues: Mike Harrison, Henry Marcucella, Garry Margolius, and Leo Reyna. I began a transformation into a behavior analyst. In 1973, I was working on an introductory psychology manuscript for Appleton-Century-Crofts. One chapter for which I anticipated difficulty was: "States of Consciousness." Conveniently Ted Barber was teaching an evening course in hypnosis at Medfield State Hospital in the fall of 1973. I thought that I might as well give it a whirl, so at least I might come to an understanding of the purported altered state of consciousness produced by hypnosis.

Some of the highlights of my time with Ted Barber follow. Right off the hop, Ted indicated that he had performed as a stage hypnotist for several years. He stated that he sometimes paid individuals to perform on stage, but usually you didn't need to pay anyone. Instead, you could select individuals based upon their responses to exercises given at the beginning of the show. (Now what was going on in Reveen's performance began to become clear to me.) Ted said that even when he paid the performers, their friends often wouldn't believe them when they told them that it was "just a job"; their friends so wanted to believe in hypnosis.

Next came the revelation that there were two intellectual camps with respect to hypnosis. The first camp included individuals who believed in a trance state and the second camp included individuals who didn't believe in a trance state. The first group is what I later came to refer to as BITS (believers in a trance state) and the second group as NBITs (non-believers in a trance state). Ted said that he was in the NBITs camp. I immediately signed up for NBITS. At this point in time I was feeling the kind of relief that I had felt as a graduate student when contacting aspects of B. F. Skinner's philosophy and finding out that I didn't have to adhere to a dualistic mind and body position (as advocated by the philosopher Rene Descartes). Instead I could adhere to a monistic position that there is just one type of stuff — that in the physical (natural) world.

Another central feature of Ted's teaching was not new, but deserves emphasis: In order to know if the hypnotic induction procedure has any special effects, a control comparison is necessary. In order to determine if hypnotic induction via instructions to close your eyes and that you are sleepy and tired (what Ted referred to as the "mumbo jumbo" of hypnotic induction) has any special effects, a control treatment must be arranged. For example, in a large-N experiment, degree of compliance to a hypnotist's instructions must be compared between the experimental group (with hypnotic Induction) and a waking control group or a group simulating hypnosis, etc. Turning to stage hypnosis, in the human plank feat, after induction, the hypnotized person makes the body rigid and then the head is placed upon one chair and the feet upon a second chair. Next a second, husky individual stands on the hypnotized individual's chest. It seems amazing; however, since bone (the rib cage) is extremely strong, this feat easily can be accomplished without the mumbo jumbo of hypnotic induction.

By the time I was halfway through Ted's course I was trying to persuade Ted that operant (particularly principles of stimulus control and conditioned reinforcement, emphasizing social contingencies) and respondent conditioning could account for most, if not all, hypnotic phenomenon. Ted acknowledged by the end of the course that I had him 90% persuaded.

I left Boston in 1974 to take up a position in the Department of Psychology at the University of Manitoba where I have spent the remainder of my professional career. Due to my involvement in other research and teaching tasks, my attention veered away from the topic of hypnosis, and it is only now that, after officially retiring, I have had the opportunity to revisit it in a conceptually systematic way.

An Operant Model

Prior to considering selected "hypnotic" phenomena, some orienting remarks should prove helpful, although they will be familiar to most readers of this article. As a behavior analyst, I view hypnosis as involving, particu-

larly, instructional and contextual control over behavior. The behavior may be public or private, but there is no way to validate private (internal) behavior directly (it is only observable by one person). Thus accounts based upon unobservable entities are not likely to be scientifically profitable. The task of the behavior analyst is to conduct a searching behavioral assessment to determine the controlling variables for "hypnotic" behavior.

The major theoretical model of most service in this endeavour is Skinner's three term contingency derived from research on operant conditioning. The three terms are: antecedents, behavior, and consequences. Antecedents may include specific environmental discriminative stimuli, contextual stimuli, and verbal instructions (rule-governed behavior). A rule is a type of verbal discriminative stimulus that specifies a contingency relationship between antecedent, behavior, and consequence. Consequences may be reinforcers which increase the probability of the behavior that they follow or punishers which decrease the probability of the behavior that they follow. Reinforcers may involve presentation of stimuli or removal of aversive stimuli. Punishers may involve presentation of aversive stimuli or removal of positive reinforcers.

While I primarily adhere to an operant model in accounting for hypnotic behavior, it is also possible for respondent conditioning to play a role. It may be that particular verbal stimuli (e.g., words such as "sleepy" or "tired"), or contextual stimuli (dim illumination) may elicit certain behavioral reactions (e.g., relaxation or sleepiness). Also, individual differences due to some combination of genetics and conditioning history may result in different reactions during hypnosis.

Verbal Behavior

More particularly in terms of an operant model, hypnosis can be seen from the perspective of verbal behavior wherein the hypnotist assumes the role of speaker and the hypnotized person assumes the role of listener. As speaker, the hypnotist will be reinforced by the compliance of the listener to instruction. In the case of the listener, Skinner has identified two major categories of controlling variables: generalized conditioned reinforcement and stimulus (instructional) control.

Considering reinforcement first, the hypnotist moves from more believable to less believable suggestions, as hypnosis proceeds. The less believable suggestions may not have been followed, if introduced right away (cf. behavioral momentum). For Skinner believability is defined in terms of response strength, more believable suggestions are correlated with a higher probability of compliance and more generalized conditioned reinforcement. Of course, the listener also may comply with instructions to avoid the aversive outcomes associated with noncompliance (e.g., those associated with embarrassing the hypnotist).

Turning to stimulus control second, hypnosis is conceptualized as involving an extreme case of control by instruction, wherein it is narrowed to verbal stimuli expressed by the hypnotist (which are replete with mands, such as requests). Skinner stated that the hypnotic situation can be compared to that where an individual is "lost in a book." In such instances the textual stimuli in the book have assumed virtually exclusive control over attending behavior with other potential discriminative stimuli being ignored.

In Skinner's (and my) perspective then, hypnosis does not differ in kind from the normal (usual) behavior of a listener. In turn the behavior of the listener is to be understood as under the control of the usual suspects, stimulus control and reinforcement.

Application of a Behavior Analytic Model to Understanding Hypnotic Phenomena

Now let's consider some of the special effects of hypnosis. Starting first with stage hypnosis; there is little difficulty in comprehending why a person who is paid for doing so would follow instructions from a hypnotist who is the employer. Presumably the employee's rule would be, "If I do what the hypnotist suggests, I'll get paid." While at Joseph Wolpe's Behavior Therapy Training Institute in May of 1974, I observed a clinical psychologist "hypnotize" his secretary, which I found unsurprising. Thinking back to the time of Sigmund Freud (or Jean–Martin Charcot) when women were in much less powerful positions in society, surely they likely would have followed the instructions of Dr. Freud too.

But what about the audience member who is selected to be hypnotized because of compliant responses to practice exercises? Presumably these individuals have a conditioning history which produces greater compliance to instructions. They also may have a rule, which specifies that they may be selected to be hypnotized, if they are more compliant to instruction, and thereby may obtain more social attention from the hypnotist and others. For example, their friends will likely want to inquire about their special experiences under hypnosis. Ted Barber has provided a list of factors contributing to success as a stage hypnotist including "stage whispers" by the hypnotist who asks the hypnotized individual to play along with the demonstration.

Let's now consider the notion of a "trance state" or "altered state" of consciousness. Generally, the hypnotic induction procedure is assumed to produce the trance state. Ted Barber's approach then became one of repeatedly demonstrating that a hypnotic induction group was no better than say a waking control group or a group simulating hypnosis in producing "hypnotic" phenomena. In addition, other experimental groups given task-motivating instructions or "think along with" instructions outperformed the group given a hypnotic induction procedure.

Barber and Wilson postulated a "Cognitive Behavioral Theory" of hypnosis. According to the theory, participants who think along with and imagine circumstances according to the suggestions of the hypnotist/experimenter will be more likely to demonstrate limb heaviness, age regression, temperature hallucination, anesthesia, etc. According to the theory, participants will not do so, if they have passive, negative, or cynical attitudes about hypnosis. Treatment procedures derived from the theory involve modeling how to possibly think

along with and imagine according to instruction while at the same time providing instructions designed to remove passive or negative attitudes. As indicated in the preceding paragraph, experimental results favored the Cognitive Behavioral Theory.

Perception

Turning now to alterations in perception, individuals under the influence of hypnosis have been reported to experience a transparency visualization where they can see a person sitting in a chair and still see the chair behind the person. They also have been reported to visualize a person before them and behind them at the same time. If this is even possible, they may be able to do so without having to be exposed to a hypnotic induction procedure. Barber delineated three main categories of participants: fantasy-prone; amnesia-prone; and positively-set (cooperative) individuals corresponding to skills that would enable and enhance particular hypnotic phenomena. That organismic variables (genetic and past history effects) might produce such differences is compatible with a behavior analytic account.

Barber went on to argue that a willingness to cooperate with the experimenter was essential, as was a shift in perspective from the objective and pragmatic to the suggestions of the hypnotist (a change in discriminative control over attending behavior, as contemplated in Skinner's consideration of verbal behavior). Barber went so far as to say that the phenomena of interest actually were independent of hypnotic induction or even the presence of a hypnotist. For me that means that hypnosis has been abandoned. I am comfortable with such abandonment, along with abandoning Reveen the Impossibilist.

It has been asserted by BITS theorists that dramatic changes in sensation or perception can be produced via hypnosis. Polar extremes include sensory responding in the absence of the stimulus understood to usually occasion it (hallucinating) to absence of sensory responding in the presence of such a stimulus (e.g., temporary blindness, deafness). While private seeing and hearing in the absence of the stimulus known to produce such responding may occur (B. F. Skinner), another noted behavior analyst, Israel Goldiamond, directed attention to, and solved, the more fundamental problem: When such visual "hallucinations" occur, are they indications of alterations in sensory responses, or alterations in verbal responses (reports)? In the case of vision, is the hypnotized participant seeing differently or just saying so? Complementary negative afterimages which occur spontaneously after visualization of the complementary color are often referenced as important evidence for special effects of hypnosis by BITS researchers. To illustrate, the hypnotized person is asked to visualize a blue patch of color on a white background and subsequently reports seeing the color yellow in its spot. In a clever experiment Goldiamond (with Leslie Malpass) used a special apparatus which enabled presentation of colored stimuli, and, as well, could induce long-lasting positively-enhanced, or complementary negative afterimages. Results revealed that the "hallucinatory" effects have a report rather than a sensory locus. In other words, hypnotic induction affects what participants say, not what they see. Of course such data indicate that verbal responding has been controlled by social contingences (including instructions) by the hypnotist in the experiment. Some of these contingencies within Goldiamond's research involved training participants to identify complementary colors (such as magenta/green and blue/yellow).

The same problem arises with exhibitions of analgesia (reduced perception of pain) via hypnosis. Is the hypnotized individual experiencing less pain or just reporting less pain? The classic case is when a participant under hypnosis is exposed to stimuli that usually would produce a painful reaction, little or no pain is reported. Upon awakening, the person reports that pain was experienced while hypnotized. The BITS explanation often is that there was another self (a hidden part) observing the pain while the self in the trance did not experience pain. A more parsimonious explanation is that pain was experienced while "hypnotized" but was not reported. Individuals reporting less pain while "hypnotized" sometimes have reported engaging in distracting private behaviors, such as solving problems in mathematics. Distraction (shifting attending behavior from antecedent stimuli controlling pain responses to other discriminative stimuli controlling other behaviors) is a well-established technique for pain reduction. Furthermore, Bill Fordyce has approached the problem of pain in behavioral terms. He reconceptualised pain as "pain behaviors." Reductions in experienced pain seem to be produced by social contingencies designed to reduce verbal complaints of pain in the patient and also can be produced by increased levels of participation in various activities (which presumably distract the patient from painful stimuli).

Memory: True or False

The effects of hypnotic induction on memory are confounded by the parallel problem to that for sensation and perception, that is, are memorial reports veridical or not? A reported memory may be false in the sense that what is reported did not happen, or incidents which did happen may not be reported. The former has been of interest (often in therapeutic contexts) during exploration of negative experiences such as clients' reports of early sexual abuse or after abduction by aliens. The latter has been of interest in the context of improving memory, for example in eyewitness reports. In the first instance, Martin and Emily Orne have advocated caution because of the social contingencies exercised by the hypnotist on verbal reports by the client who may be following a script prescribed by the therapist. The Ornes emphasized that it is prudent to view such verbal reports (memories) sceptically and to require independent corroboration of them outside of a therapeutic context. With respect to improving memory, hypnosis may do no better than control comparisons. Further when improved recall seems to be observed, what can happen is that the criterion for reporting a memorial experience is lowered, so that both memorial errors and correct responses increase in frequency. In other words, the hypnotist has, via instruction, set the occasion for loosening the criterion for saying that particular events had occurred in the past, some of which are hits and some of which are misses.

The Misinformation Effect: A Reconceptualization

Although not involving hypnotic induction procedures, Elizabeth Loftus's research on the misinformation effect may be considered to also involve suggestibility. In her classic research she originally showed participants a video showing the driver of a small Datsun proceeding into an accident after going through a stop sign. Subsequent misinformation indicated that the Datsun had proceeded through a yield sign. When assessed after a 20-minute interval of filler activity, many participants reported that the accident had occurred after the driver went through a yield sign. Loftus argued that for these participants a corresponding engram in the brain had changed from a stop to a yield sign, an unverified assertion. Gaylene Stevye, one of my honours students, replicated the Loftus's findings. Participants who reported that they had seen a yield sign, were brought back to the laboratory later and were told that there may have been a mistake in the original video that was shown to them (the experimenter screwed up), so that it was not in correspondence with the information provided afterwards. They were asked to make every attempt to try and accurately remember exactly what they had seen in the video. Almost uniformly these participants reported that the Datsun went through a stop, rather than a yield, sign. The shift in the rule provided by the experimenter and accompanying social contingencies (demand characteristics) in the experiment, produced a change in the verbal report.

Multiple Personailty Disorder

Returning to the topic of a hidden self (or selves), Nicholas Spanos (and colleagues) questioned the role of hypnosis in the identification of multiple personality disorder (now termed dissociative disorder). They asserted that patients diagnosed as multiple personalities were role-playing in response to the therapeutic context and particularly in response to verbal stimuli provided by the therapist who is usually a psychiatrist. Of course individuals who have unfortunate past histories which have left them with few other skills for obtaining social (or other) reinforcers may be particularly vulnerable to adopting these different roles ("personalities"). In accord with Spanos's viewpoint, a number of years ago a psychiatrist whose specialty area was multiple personality disorder was hired in the Department of Psychiatry at a local hospital in Winnipeg. During his tenure at the hospital the incidence of multiple personality disorder rose from extremely low levels to epidemic proportions. It then miraculously dropped back to low levels again after he left Winnipeg.

Anti-Social Behavior

In a classic experiment Martin Orne (and colleagues) tested the assertion that hypnosis may produce anti-social behavior. Based on earlier research in hypnosis, they chose three tasks of an anti-social nature: a) to grasp a poisonous snake and place it in a bag; b) to catch, with a bare hand, a coin which was dissolving in nitric acid; and c) to throw acid in the research assistant's face. The purported reason for the last request was because the experimenter was displeased with the research assistant having asked the participant to engage in the prior two tasks. Of course steps were taken to prevent harm to participants and to the research assistant (otherwise, it's tough to recruit either). Under hypnosis participants completed all three tasks. However, the researchers found that participants simulating hypnosis, in addition to participants in waking control groups, completed them as well. However, faculty members and students brought into the laboratory from the adjacent hallway resisted the invitations to do any of the tasks. Orne concluded that the demand characteristics of the experiment legitimized the tasks, and that participants assumed that the tasks were safe because the research was under the control of a competent, responsible scientist. Also, according to Orne, in general, participants assume a "good subject" role; they try to help the experimenter out with the research, particularly in terms of confirming hypotheses. Similarly, in the context of hypnosis the selected participant may play the "good hypnotized subject" role. In behavior analytic terms participants engage in rule-governed behavior appropriate to the experimental context and respond cooperatively to instructions (including stage whispers), contextual stimuli, and social reinforcers provided by the hypnotist.

Post-hypnotic Suggestion

It is fitting that I end with consideration of the topic of "post hypnotic suggestion," since I hope that reading this article will result in some lasting effects. The Ornes have provided important research evidence that perceived demand characteristics (in behavior analytic terms, contextual stimuli, Instructions, and social reinforcers) account for compliance to requests made during hypnosis, but completed at a later time, well after supposed awakening. Also, they were able to demonstrate that control participants' compliance to a waking social request (mailing only a single, addressed postcard every day) was greater than that in the experimental group where participants underwent hypnotic induction.

Conclusion

There always will be different audiences receptive to explanations originating from different paradigms. Researchers in the BITS camp likely will continue to seek a few truly hypnotizable individuals, hidden observers, new evidence for special effects of hypnosis, or to find physiological correlates of hypnotic states; researchers in the NBITS camp, not so much. For a behavioral audience, I hope that my perspectives (interpretations in terms of behavior analysis, including concepts and principles of operant and respondent conditioning), and a description of some of my own experiences, have proved eye-opening. What "hypnotized" individuals do after all is behavior, the usual starting point for behavior analysis. A searching, thorough behavior analysis to uncover the controlling variables of "hypnotic" behavior, should provide mystery enough to the behavior analyst. What is clear to me is, as B. F. Skinner has argued already in saying that we must get beyond concepts of personal "freedom" and "dignity" to understand human behavior, so too must we get beyond concepts of "trance state," "hidden observer," "multiple personality," "super conscious," "dissociation," etc., if we are to advance our understanding of that which is called "hypnosis."

Remembering Jim Holland

Julie S. Vargas, PhD

Julie S. Vargas is president of the B. F. Skinner Foundation. She began her professional life as an elementary school teacher, and has kept her interest in public education from that time on. After receiving her doctorate, she taught at West Virginia University, working with practicing teachers and with undergraduate education majors. Her publications include Behavior Analysis for Effective Teaching *(2nd Ed. Routledge, 2013). She is currently working on a biography of her father, B. F. Skinner.*

In the 1950s, Jim Holland came to work on a project with my father, B. F. Skinner. Skinner had been working in education for several years. He had designed materials to "shape" skills with small steps and immediate feedback. Around 1956, Skinner decided to convert his own undergraduate course into this new "programmed instruction." His text *Science and Human Behavior* would be converted into steps delivered by a special "teaching machine." He hired Jim Holland to help write the steps.

Skinner could not have picked a better collaborator. Holland had been researching "vigilance". He had determined conditions needed for radar operators to continue watching screens that almost never showed anything important. That research had made him sensitive to what features would attract the attention of a person looking at material. Within a semester or two after arriving at Harvard, Jim had developed what he named the Blackout Ratio. If students could respond correctly to material with a part blacked out, that part was not critical for developing expertise.

In a publication, Jim gave an example of a statistics program with a high blackout ratio. More than fifty words"explained" probability. Then came the sentence, "Thus there are 3x2x1 = ____ ways in which 3 balls can fill 3 cells." With the entire "explanation" blacked out, a student could still answer correctly.

Following up on the suspicion that students didn't read what they didn't need, Jim and his colleague Judith Doran, designed a study to see where students looked while studying. He found just what he expected: Most students looked around on a page to locate just what was needed to answer. All the rest was ignored. Material with a high blackout ratio was not only inefficient: It discouraged reading a page sequentially from top to bottom.

Today, more than ever, educators need Jim's Blackout Technique. Increasingly, instruction is delivered over the internet. Most on-line lessons give a video lecture and then a quiz. No shaping of behavior occurs through steps taken by students. Instead the lecture is supposed to do the teaching. Even where students are given steps, few screens of on-line lessons have a desirable low-blackout ratio. One exception is Holland and Skinner's *The Analysis of Behavior*. Students all over the world are learning about behavior from the program Holland and Skinner designed. Its instructional effect provides a lasting tribute to Jim Holland.

The Analysis of Behavior in Instruction: Science and a Technology Based on Science

James G. Holland, PhD

For me, the beginning of behavior analysis in education began when I arrived in the fall of 1957 at a gray clapboard building, Batchelder House. Batchelder House, then in decay, had been a rambling residence just across the street from Harvard's Memorial Hall, where the Psychology Department, including Skinner's office and laboratory, was housed. A year earlier, Skinner had received a modest grant from the Ford Foundation and, to accommodate the new staff of two, was assigned one medium size room in this off-campus building which had dust that must have dated back to the days of the McGuffey Reader. Memories of those days in Batchelder House give me a special personal verification of humorist Francis Parkinson's claim that active, productive, and innovative activities are to be found, not in new buildings that instead house moribund organizations, but in small, converted, understaffed, and unkempt buildings. In this light, it seems fitting that this room in Batchelder House served as cradle for an offspring of Skinner's basic science, the experimental analysis of behavior. The infant, programmed instruction and teaching machines, was to take many forms as it grew and exerted an influence on many educational practices. Moreover, the efforts at instructional design were to reveal omissions in the basic science and were to prompt new directions of research, which would, in time, enrich the parent theory.

But when I moved into Batchelder House that fall day in 1957, this scenario was unclear. Lloyd Home and Sue Markle had been at work for a year. Homme was about to return to the University of Pittsburgh as his year's leave was over. In Batchelder House, he had prepared units teaching the uses of suffixes and prefixes to build vocabulary. These units were both exercises in programming aimed at discovering more about the process, and examples of the possibilities that this use of the science of behavior held for instruction. I joined this enterprise by setting out to prepare a program to teach the content of a course that Fred Skinner had taught for many years.

Harvard's course—Natural Sciences 114—taught undergraduates the nature and findings of the experimental analysis of behavior pioneered by Fred Skinner. It dealt considerably with Skinner's extrapolation of the science to interpreting human behavior in society at large. He had earlier written his book, *Science and Human Behavior*, for this course, and now, our task was to prepare a teaching machine program covering this content. We were particularly pleased that the first actual use of our new technology in a regular educational setting would be to teach the

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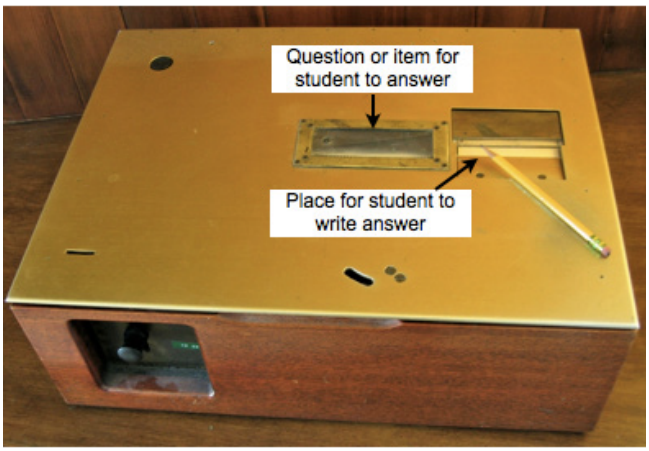
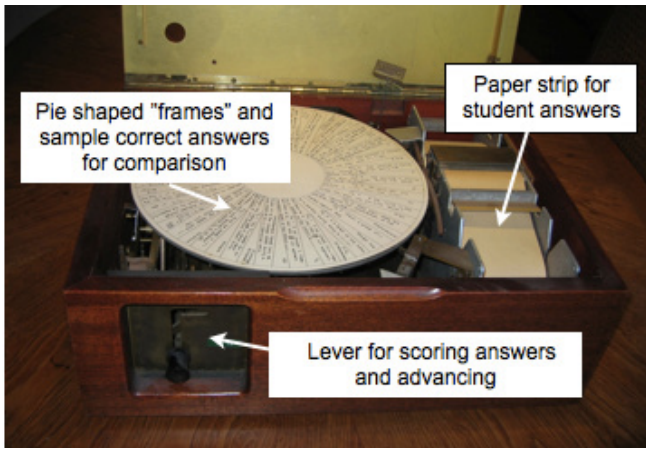
science which provided the fundamental principles of the technology itself.

The teaching machine portion of the course took place in a small room in the basement of Sever Hall, a venerable old building in Harvard Yard. Our room had been used for storage but now was remodeled to accommodate ten cubicles each lined with acoustical tile and each containing a teaching machine. The machine itself was one of several designed by Skinner. It was a mechanical marvel and was reminiscent of the age of brass instrument psychology. It was, in size and shape, like a small suitcase. The brass coated lid and face was one of the larger sides of this box. The student opened the lid and placed in it a paper disc, 12 inches in diameter, which was divided into 30 wedge shaped areas each containing a single item, or frame, of the teaching program. The usual form was a completion item, a sentence with one or more words missing. A small triangular corner of each frame contained the answer to the item. With the lid closed, a single frame was exposed. Under an additional window, the students could write their answers on a strip of adding machine tape. They would then move a lever that operated a small shutter that exposed the correct answer, simultaneously advancing their own constructed answer to a position under a glass plate, where it could be seen and compared with the correct answer but not changed. If the student judged the answer to be correct, an additional movement of the lever punched a small hole beside the constructed answer and internally set a detent so that this item would not be presented again. On completion of all 30 frames, the student would start through a second time, and the disc would rapidly rotate past all correctly answered items stopping only on the few items answered incorrectly. The lever used for exposing items and indicating correctness of answers also wound a spring that powered the disc mechanism.



Teaching machine. Photos by J. Vargas



It was not long after my arrival that Natural Science 114 was due to be taught, so we rapidly began to program material but had only a small portion of the course ready on the first day of class. The lights of Batchelder House burned late as I worked to stay ahead of the students in generating material for the machine. During the day, students appeared at the machine room at times of their own choosing, worked as long as they wished, and left better prepared to understand and enjoy the lecture part of the course.

The 30 small wedges were a tight constraint on the writing of material. Strunk and White in their classic book, *Elements of Style*, gave the would-be author the strong dictum, "Get rid of unnecessary words." Writing small frames to fit the boundaries of the wedge made it important to get rid of unnecessary words. Unfortunately, those very small frames became identified by many as the defining characteristic of programmed instruction, a characteristic that took a decade to outgrow.

As the semester progressed, box after box filled with strips of adding machine paper covered with student answers. There was our data. At the end of the term, we tallied item by item, correct and incorrect, for each student. Each of the 250 students had generated about 3000 answers. We were interested in precisely what answers they might give when the item was answered incorrectly. We had attempted to prepare items that were correctly answerable only through mastery of what the item was supposed to teach. That is, we designed, in the language of our science, a contingency of reinforcement. At the same time, it was important for the student to be able to perform what was expected of him at each step along the way. Hence, we were striving for error-free performance. In this first year we were very far from error free performances or even the 5% error rate which, as pragmatists, we considered the maximum allowed without requiring revisions. After our tally of the data, we carefully rewrote the program. We were excited by the fact that unlike any other efforts in education, we had the means to gather detailed data on our teaching procedures and were able thereby to make fine adjustments. As behaviorists, after all, we were not allowed the luxury of accusing the nonlearner of stu-

pidity. The fault, according to an experimental analysis of behavior, must rest in environmental contingencies, and it was just those contingencies which formed our program.

Three development cycles, classroom use, data analysis, and revision, were completed with dramatic improvement in our program after each recycling, and eventually, it was published under the title *The Analysis of Behavior.*

But back at the time of our first use at Sever Hall, interest and activity in programming materials began to sweep the country. The concept had excited many in universities who enthusiastically set out to program their courses or to prepare materials for the primary grades. Publishers became interested. Authors of industrial training material turned in overwhelming numbers to programming. Special new companies devoted to teaching machines and programming emerged, and large industrial firms explored the possibilities for teaching machines. But before considering where this interest led, let us consider the antecedents, for programmed instruction is an example of the use of a basic science in generating specific, deliberate applications. In addition, the use of this basic science in programmed instruction eventually permeated standard practices until the new principles became intuitive truths.

B. F. Skinner(left) and Jim Holland, discussing The Analysis of Behavior *project.*

In the 1930s, Skinner had developed the concept of operant behavior and the means of analyzing the controlling variables for the behavior of individual organisms. His approach and the shape of his science was articulated in 1938 in his book, *The Behavior of Organisms*. Most that has followed in the science has been refinement and expansion of the discoveries revealed in this seminal work. In the concluding chapter of the book, Skinner says:

The reader will have noticed that no extension to human behavior is made or suggested. This does not mean that he is expected to be interested in behavior of the rat for its own sake. The importance of a science of behavior derives largely from the possibility of an eventual extension to human affairs. But it is a serious, though common, mistake to allow questions of ultimate application to influence development of a systematic science at an early stage. I think it is true that the direction of the present inquiry has been determined solely by the exigencies of the system. It would, of course, still have been possible to suggest applications to human behavior in a limited way at each step. This would probably have made for easier reading, but it would have unreasonably lengthened the book. Besides, the careful reader should be as able to make applications as the writer. The book represents nothing more than an experimental analysis of a representative sample of behavior. Let him extrapolate who will.

It was not long after this that Skinner did extrapolate. He did so first in his teaching. Natural Science 114 was just such an extrapolation to day-to-day life. But it was only when he began using these principles to design teaching machines that an explicit effort was made to apply his science and create a technology for the solution of behavioral problems.

Our early programming activities functioned in the development of the technology. These served as models for the use of fundamental behavior principles and the basis for describing this new technology. The lab had taught us the power of establishing contingent relationships between behavior and reinforcement, and we defined programmed instruction as the arrangement of careful sequences of contingencies of reinforcement leading to the objectives of education. From the laboratory, we knew that through shaping, difficult forms of behavior could be established that would never appear naturally without the arrangement of a progressive series of contingencies, and here was the basis for designing programs. The science had abandoned mythical inner causes of behavior and had demonstrated the power of analyzing behavior and its controlling events. In this, the science has provided the basis for behavioral objectives in education and holds the possibility, as yet unfulfilled, of an experimental analysis of knowledge itself.

In the flurry of activity that followed these first examples of applied behavior analysis in instructional design, many impressive results were obtained for a wide variety of skills and subject matter areas. At the same time, a number of programs followed the superficial characteristics of the techniques without reflecting the laboratory-based principles. One common failure of teaching materials is to aim at certain behavioral objectives while allowing the student to perform tasks that only superficially resemble the desired behavior. For

example, science education materials may have a goal of teaching scientific inquiry, while the instructional techniques only guide the student through certain problem-solving methods without ever teaching the student to generate the steps.

But perhaps, the most frequent and damaging problem in poorly designed educational materials is the failure to ensure a contingent relationship between the student's correct answer and what is to be learned through that answer. A student learns what he or she performs. Usually, in an instructional situation, only a small part of the student's activity is public and available to the instructor; i.e., a question is answered about material the student has read, or an answer is written to a problem in the lesson material. The task of the developer of educational materials is to ensure that the final public performance depends upon the correct execution of the private act—a correct answer indicates that the material has been read and that the problem has been worked out. This is the problem of response contingency. This common failing in poorly-prepared materials involves over—cueing or inappropriate cueing, which enables the student to answer correctly without having actually performed the task that the lesson was intended to evoke.

We had failed apparently to make this principle clear. Subsequently, we developed a technique that would make response contingencies very clear. This technique involved deleting, by covering with black crayon, all material which did not contribute to reaching a correct answer. For example, a lengthy exercise in a statistics program for engineering students described the determination of arithmetic combinations and permutations, but when the student was finally asked to do something with this information, the question was simply "3 x 2 x 1=__". None of the information on combinations or permutations was necessary for the answer. A contingent relationship was lacking since all of the preceding material could be covered with black crayon without affecting the student's answer. This total blacking-out of the material demonstrates the need to rewrite the material so that the student must make use of the information to obtain a correct answer. This technique permitted a quantitative measure of the degree to which the contingency principle was met. We called it the black-out technique.

On the heels of this first effort to program, our lab as well as others began turning away from programming verbal knowledge. We moved to areas and skills that traditionally have been taught poorly. Demonstrations were prepared for teaching difficult musical discriminations, and a gadget was designed to reinforce matching an auditory rhythm. Visual discrimination programs were developed to teach spatial thinking and inductive reasoning skills. Under a grant from Carnegie Corporation, the Committee on Programmed Instruction was formed to facilitate Harvard and MIT faculty efforts in programming skills in their own areas. Languages and sciences were particularly emphasized, and I enjoyed the paradox of two Chomsky students programming language teaching objectives derived from Chomsky's structural linguistics, which he felt to be a refutation of Skinner's analysis of verbal behavior.

Across the country, programming efforts had become so widespread that Carl Hendershot provided a major contribution by keeping an updated compilation of programs.

But gradually, the term "programmed instruction" became less fashionable even as the influence spread more widely. Objectives in education became behavioral objectives. Books and lesson plans, whether they were touched by programmed instruction or not, at least benefited by borrowing the method of defining their teaching objectives.

Doug Porter, from the beginning a resident of Batchelder House although not administratively on the project, branched out from his early involvement to work for the Office of Education in developing a training package for The Job Corps. Faced with the immediate problem of creating a reading curriculum for Job Corps trainees, he gathered together a variety of curriculum materials from pre-reading to high-school level, including a programmed package for beginning reading. Porter then designed a graded examination for diagnosing the particular needs of the corpsmen for placement in these materials. Shortly after this, one of the leading centers in programmed instruction at the University of Pittsburgh, spearheaded by Robert Glaser who had carried out research in programmed instruction, turned to the idea of diagnosing individual needs through prescriptive testing and placement under the coined name "individually prescribed instruction." While this new emphasis focused on diagnostic procedures, the teaching material generally followed the experimental analysis of instruction.

To implement developments in individualized instruction, in 1964, Glaser and Gow formed a new organization, the Learning Research and Development Center, devoted to facilitating education through fostering an interplay between science and practice in education. The creation of the Center embodied the metaphor of a long hallway with a lab at one end, a classroom at the other end, and between the two, all the sequential stages of technological development with busy scientist-developers running back and forth through the hall. A few years later, Fred Keller extended the concepts into the Personalized System of Instruction. In his system, the wedge-shaped frame is gone, the teaching material comes in larger hunks, and students answer questions of larger scope, but still, the questions are prepared so that an answer is contingent on mastery of preceding material.

The influence of the beginning of these appli-

cations of our science was not limited to the world of education. More than an opportunity to improve education through behavior science had begun. The teaching machine was the first step in what we now call applied behavior analysis. The science was there waiting to be used to improve conditions for people. No doubt various areas of application could have emerged but one opening was made through programmed instruction. Many of the simple applications involve only reinforcing a single response already in the person's repertoire. For example, orienting toward the teacher might be reinforced. When more difficult performances are involved, however, the similarities to the techniques developed in programmed instruction are apparent. Establishing speech in an autistic child requires a slow, gradual shaping process that carefully constructs utterances of sounds, then simple single words, and later sentences.

By the end of the 20th century, even clinicians explicitly drew upon principles of programmed instruction. For example, Israel Goldiamond suggested that the therapist in producing a clinical program specify target or outcome, specify entry behaviors and beginning repertoire of the person, sequence behavior—change steps, and finally provide maintenance consequences for each step in the sequence. This clinical approach emphasizes constructing new operants by building on the current repertoire of the individual as in programmed instruction.

Programmed instruction illustrates the usefulness of basic research in leading to important applications, but the flow of influence goes the other way as well. Attempts at using basic science in dealing with real-world problems removes the tunnel vision of the basic scientist. The complexities of the applied settings may reveal oversights and gaps that exist in the theory. The practitioner, to solve his immediate problems, does the best he can by improvising to cover the deficiencies, but when basic and applied scientists are closely related, or even perhaps the same person, experience in application can open new research areas and enrich the parent theory.

One of the several serious gaps was revealed as we set out to teach discriminations errorlessly. Until this time, laboratory research in stimulus discrimination had always proceeded by reinforcing a response to one stimulus while extinguishing it in the presence of another stimulus. Animal discrimination typically progressed slowly. They responded in the presence of what was to be the negative stimulus as well as the positive stimulus until gradually, after hundreds or even thousands of responses to the negative stimulus, extinction was complete with the animal responding only to the positive stimulus. This was the only way discriminations were formed in the laboratory, and it was assumed that it was the only way to do it. As Keller and Schoenfeld put it in their textbook, *Principles of Psychology*, "Extinction is the hallmark of discrimination."

Nevertheless, when we attempted to program discrimination learning, we worked out gradual progressions of stimuli to obtain as close to errorless performance as we could. Even relatively simple discriminations were unmanageably difficult otherwise. Children could not be kept at the task long enough to run off the necessary extinction curve. But here was a paradox. The way we were teaching discriminations in an applied context was not in agreement with the basic research. A graduate student, Herb Terrace, looking for a dissertation topic, saw this paradox, and he carried the problem into the laboratory. He established errorless discriminations in pigeons and began investigating the properties of discriminations established this way as contrasted with the classical procedure. It turned out that the two types of discrimination learning were quite different. Not only was the errorless procedure faster, but the resulting discrimination differed in ways that are important to a systematic understanding of behavior.

Terrace, and the work he stimulated, focused on the properties of discriminations after they were formed. Forming errorless discriminations in the laboratory or in practice was still an art. Not every progression worked. Here, another gap in our knowledge was revealed, and the interplay between laboratory and practice continued. Subsequently, an active area of laboratory research was the determination of the conditions for establishing control by a new stimulus dimension. This work involved a number of people, such as Paul Touchette and Judith Doran, and moved back and forth between laboratory and practice. Studies seemed to indicate that successful fading is not due to an "associative" transfer of control by pairing a controlling stimulus with the new stimulus. Instead, successful fading seems dependent upon the arrangement of conditions that ensure a response contingent relationship with the new stimulus similar to that found in response shaping. Again, we saw that a steady interplay between research and application improved both.

In sum, the analysis of behavior in instruction, from the early teaching machines to today, is an interesting case study of the interplay between basic science and a technology based on science. The effects of contingencies of reinforcement, the nature of shaping, and the analysis of psychological phenomena in behavioral terms were learned from our basic science, which now serve us as we attempt to arrange sequences of contingencies to meet behaviorally-defined educational objectives. Applications spread to the modification of behavior outside educational settings into therapy and social management situations. When practice remains true to the proven principles of the laboratory, impressive gains are made; when basic principles are neglected, the results are less impressive or even embarrassing. At the same time, practice is the ultimate test of theory, and applied behavior analysis in instruction opened new directions that continue to provide a more complete understanding of behavior.

An Example of Using Pop Culture to Teach Undergraduates

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During the past 5 years or so, it has become a tradition in my courses to have at least one lecture devoted to a pop culture exploration of the principles, concepts, or processes being covered in the course. I typically create the lecture as a review of sorts, especially prior to an exam. While some students may at first be unsure about the purpose of such a lecture, as evidenced by their looks of surprise (including some eye rolling), I have consistently had nothing but positive comments from students following such lectures. As if this positive praise were not enough, students' scores on exams following such a review are much higher than in previous years with a "typical" review covering our usual topics in human and animal behavior. Any psychinfo search will reveal that these observations are entirely consistent with the cognitive literature: humor helps us to both "recall" and "retain" information. As behavior analysts, we might suggest that this finding is due to some verbal behavior coming under better control of the relevant verbal stimuli as a result of additional conditioned and generalized reinforcement.

Here is just one example to sink your teeth into: As a science of behavior, one of the main philosophical foundations is that of "probabilism." The vampire genre is one way to introduce the idea that "free will" is really rule-governed behavior, but in fact does not make the behavior more free in any way. For example, consider Bela Lugosi's portrayal of Bram Stoker's Dracula in the 1931 film, "Dracula". His invitation to "Enter freely of your own will" can be analyzed in terms of his verbal behavior exerting simultaneous stimulus control over his future victim Jonathan Harker: Dracula provides both an auditory verbal prompt as well as gestures in the form of his eyes and hand to "invite" the victim in. While this gives the illusion of "freely choosing", the vampire in these stories has power in the form of stimulus control over the victim the entire time. (I encourage readers to review Holborn's explanation of hypnotism in this issue for a further understanding of how we might interpret the vampire's use of this procedure.) Once the victim complies with the "invitation", there is immediate reinforcement and an apparently unforeseen and unfortunate end. (That part always "sucks".)

Now, one can think of many other examples in our terminology that relate to the overall analysis of vampire behavior. For example, in the old "Dark Shadows" TV series from the 1960's, the vampire Barnabas Collins is awoken (after a couple of centuries of being chained in his coffin) by the grave-robbing Willie Loomis. While Loomis was looking for jewels, he instead found a blood-deprived vampire who immediately had a "bite to eat." It is a great example of how establishing operations (long deprivation period) can lead to behavior such as eating the first thing (or victim) you see. Of course, there is much more to tell about the stories related to the likes of Dracula, Barnabas, and Willie. However, dear reader, it will have to wait for another issue…