Acad Psychiatry
DOI 10.1007/s40596-014-0183-y

EMPIRICAL REPORT

Attitudes Toward Neuroscience Education in Psychiatry: a National Multi-stakeholder Survey

Lawrence K. Fung · Mayada Akil · Alik Widge · Laura Weiss Roberts · Amit Etkin

Received: 20 March 2014 / Accepted: 11 June 2014

Abstract
Objective The objective of this study is to assess the attitudes of chairs of psychiatry departments, psychiatrists, and psychiatry trainees toward neuroscience education in residency programs and beyond in order to inform future neuroscience education approaches.
Method This multi-stakeholder survey captured data on demographics, self-assessments of neuroscience knowledge, attitudes toward neuroscience education, preferences in learning modalities, and interests in specific neuroscience topics. In 2012, the authors distributed the surveys: by paper to 133 US psychiatry department chairs and electronically through the American Psychiatric Association to 3,563 of its members (1,000 psychiatrists and 2,563 trainees).
Results The response rates for the chair, psychiatrist, and trainee surveys were 53, 9, and 18 %, respectively. A large majority of respondents agreed with the need for more neuroscience education in general and with respect to their own training. Most respondents believed that neuroscience will help destigmatize mental illness and begin producing new treatments or personalized medicines in 5–10 years. Only a small proportion of trainees and psychiatrists, however, reported a strong knowledge base in neuroscience. Respondents also reported broad enthusiasm for transdiagnostic topics in neuroscience (such as emotion regulation and attention/cognition) and description at the level of neural circuits.
Conclusions This study demonstrates the opportunity and enthusiasm for teaching more neuroscience in psychiatry among a broad range of stakeholder groups. A high level of interest was also found for transdiagnostic topics and approaches. We suggest that a transdiagnostic framework may be an effective way to deliver neuroscience education to the psychiatric community and illustrate this through a case example, drawing the similarity between this neuroscience approach and problem-based formulations familiar to clinicians.

Keywords Neuroscience · Education · Psychiatry · Attitudes

L. K. Fung · L. W. Roberts · A. Etkin (✉)
Stanford University, Stanford, CA, USA
e-mail: amitetkin@stanford.edu

M. Akil
Georgetown University, Washington, DC, USA

A. Widge
Massachusetts General Hospital, Boston, MA, USA

Psychiatric disorders have long been perceived as diseases of the brain [1]. However, understanding psychiatric disorders through neurobiology is a challenge. On one hand, part of the challenge may be related to the similarities of neurobiological signatures of many Diagnostic and Statistical Manual (DSM) diagnostic groups [2–4]. On the other hand, it is clear that psychiatrists often find it difficult to fit their patients cleanly into an established diagnostic category. These observations are further supported by rates of comorbidity between disorders much higher than expected by chance [5].

Basic science in humans and experimental animals has defined relationships between brain circuits and specific mental, behavioral, or physiological capacities. These neurobehavioral systems may be quite substantially differentially affected across individual patients, contributing to each patient's specific pattern of symptomatic and functional impairments (i.e., clinical heterogeneity). Thus, a neurobiological view of psychopathology from this perspective would argue that mental illness is best described as a set of dimensional impairments in a range of neurobehavioral systems. However, despite these clinically relevant scientific advances and the "disruptive" impact that neuroscience is expected to have on psychiatry [6, 7], neuroscience and its dimensional implications are not

Published online: 08 July 2014

currently a consistent or central part of the training and clinical practice of psychiatry [8, 9].

The clinical practice of psychiatry is bound by our diagnostic and therapeutic traditions. The dominant diagnostic system, as codified in the DSM, refers to diagnostic entities defined by sets of symptom criteria. By contrast, many clinicians' psychotherapeutic and psychopharmacological approaches focus inherently on problems that cut across DSM diagnoses. We propose that a neuroscience case formulation overlaps in important ways with problem-focused clinical models. Because of this overlap, a transdiagnostic neuroscientific approach may be a natural fit with a clinical orientation already common among psychiatrists. If psychiatrists at multiple levels of training and clinical practice experience express positive attitudes toward a transdiagnostic view of neuroscience and its clinical relevance, as well as a desire to engage in continuing education on neuroscience, this may be a path by which neurobiology can best enter psychiatric training and practice [10]. In this study, we sought empirical data via a national multi-stakeholder survey regarding the attitudes and readiness of clinicians for a dimensional neuroscience-based framework for understanding psychiatric disorders.

Methods

Survey Content We designed a survey to capture four main types of information: (a) demographic information (gender, age, level of psychiatric training, years of experience after graduation, advanced scientific training, and scope of psychiatric practice), (b) self-assessments of knowledge in neuroscience and its clinical applications, (c) attitudes toward neuroscience and neuroscience education (modality of learning, prediction on how soon neuroscience will yield significant new interventions, effect of neuroscience in reducing stigma for mental illness, salience of domains and specific topics of neuroscience relevant to psychiatry, and the need for more neuroscience education in residency and beyond), and (d) attitudes toward specific domains and topics of neuroscience. We selected specific domains of neuroscience in part to encompass levels of study (genetics, molecular/cellular, and systems levels) and research tools and strategies (neuroimaging and animal models) commonly used in basic and translational neuroscience, as well as selected topics in neuroscience that cover broad themes relevant to psychopathology. Much of neurophysiology is captured in cellular and molecular biology, functional neuroimaging, and animal models. In order to assess the level of interest in neuroscience education, we asked psychiatrists and psychiatry trainees whether they would be interested in taking a 3-day neuroscience course (based on the feedback obtained from participants in the pilot study, this duration of the course was found to be sufficient to cover a broad range of material, but not excessive in duration for practicing clinicians). Depending on the group surveyed, the survey was between 42 and 45 items. The questions consisted of Likert scale items, agree/disagree items, categorical response items, and an open-ended item asking for additional comments on neuroscience education. In this investigation, we defined "neuroscience" as the study of the nervous system and behavior using cellular and molecular biology, animal models, neuroanatomy, neuroimaging, genetics, cognitive neuroscience, and basic pharmacology (but not clinical pharmacology).

Survey Dissemination Participants included three groups after an initial pilot phase: (1) *Chairs*—This group represents the psychiatry department chairs in the USA. We sent paper copies of the survey directly to 133 chairs of US departments of psychiatry by US mail in July 2012. We used responses received before October 31, 2012 for data analysis. (2) *Psychiatrists*—In order to help generalizing our findings, the sampling of this group was randomly chosen from the general membership of the American Psychiatric Association (APA). In March 2012, the APA invited a total of 1,000 selected full members via e-mail to complete an online version of the survey. The online survey asked the psychiatrists to identify themselves in the very beginning. Those who were department chairs were routed to a similar set of questions. This methodology assured that chairs were not double-counted in both groups. The APA sent two reminder e-mails to these APA members within 2 weeks. The online survey was closed 30 days after the initial invitation was sent. (3) *Psychiatry trainees*—This group represents residents and fellows enrolled in training program in a department of psychiatry at the time of completion of the online survey. In March 2012, the APA invited 1,000 randomly selected members-in-training by e-mail to complete an online version of the survey. Due to the low response rate in this sample, we repeated this part of the study in October 2012. In the second round of this survey, the APA invited all psychiatry trainees who were not invited in March 2012 (N=2,563) via e-mail to complete the survey. To increase the response rate, a raffle for an Apple iPad was held among participants of this round of survey. The survey was closed 30 days after the initial invitation was sent. We used responses received in the October 2012 survey for data analysis.

Data Analysis We conducted data analysis with SPSS 19 (SPSS Inc., Chicago, IL). Descriptive statistics was used to determine percent response. We conducted repeated measures *item* (within-subjects repeated measures)×*gender*×*participant role* (i.e., chairs vs. psychiatrists vs. trainees) multivariate analysis of variance or multiple analysis of variance (MANOVAs) for conceptually related sets of items regarding (a) self-assessment of knowledge of neuroscience, (b) attitudes toward neuroscience, (c) preference for neuroscience learning modalities, and (d) domains and topics of interest in neuroscience modalities. If statistically significant in Box's test of equality of covariance matrices ($p<0.05$), then multivariate tests on gender, participant role, and gender×participant role were performed. If statistically significant in either Pillai's Trace or Wilks' Lambda in these tests ($p<0.05$), then statistical effects (as determined by ANOVAs) for between-subjects effects for specific items were examined.

Results

Response Rates The response rates for the chair, psychiatrist, and trainee surveys were 53 % (69/133), 9 % (94/1,000), and 18 % (462/2,563), respectively. Table 1 summarizes the characteristics of the three study samples, with salient information for each group described below.

Characteristics of Respondents Psychiatry department chairs—Most responding chairs were male (61; 91 %), >60 years old (58; 85 %), had an M.D. (66; 96 %), graduated from residency >20 years ago (55; 82 %), and represented a range of experience as department chairs. Approximately, half indicated that their scope of clinical practice was evenly divided between psychopharmacology and psychotherapy. The other half of the respondents indicated that their scope of practice consisted of 75 % psychopharmacology and 25 % psychotherapy. Department sizes ranged from 4 to 400 full time faculty, with a range of total funding from the National Institutes of Health (NIH) (33 % received <$2 million per year, 29 % received $2–10 million, and 38 % received >$10 million). The amount of NIH funding did not correlate with the responses on attitudes toward neuroscience education.

Psychiatrists—Respondent ages were distributed evenly across the selected ranges and most were male (63; 59 %) and had an M.D. (103; 96 %). A third (34; 32 %) graduated less than 5 years ago; a third (40; 37 %) graduated 6–30 years ago, and a third (33; 31 %) graduated more than 30 years ago. Half (57; 54 %) of the respondents indicated that their scope of practice consisted of at least 75 % psychopharmacology. Unlike the chairs' group, a significant percentage (17; 16 %) of psychiatrists showed that their scope of practice was mainly psychotherapy (i.e., 75 or 100 %). Thirty-nine (37 %) respondents reported teaching fellows, residents, and/or medical students with more than 5 % of their total effort; 38 % were not teaching trainees.

Psychiatry trainees—The trainees represented 139 psychiatry residency or fellowship programs listed in American Association of Medical Colleges, as well as 50 unlisted programs, and represented all 4 years of residency and a variety of fellowships in psychiatry. Unlike the other two groups, there were more female respondents (235; 54 %). Further, more held a non-M.D. degree [52 (12 %) for D.O. and 48 (11 %) for MBBS]. Most of the respondents (291; 67 %) anticipated that

Table 1 Characteristics of study samples by primary role

Characteristics	Psychiatry department chairs (n=69) % (N)	Psychiatrists (n=107) % (N)	Psychiatry trainees (n=436) % (N)
Age[a]			
30 or younger	0 (0)	2 (2)	45 (196)
31–40	0 (0)	27 (29)	48 (208)
41–60	15 (10)	35 (37)	7 (32)
61 or older	85 (58)	36 (38)	0 (0)
Gender			
Male	91 (61)	59 (63)	46 (201)
Female	9 (8)	41 (44)	54 (235)
No. of years as chair of psychiatry department			
0–5 years	30 (21)	N/A	N/A
5–10 years	26 (18)		
10–20 years	30 (21)		
more than 20 years	13 (9)		
No. of years since graduation from residency			
0–5 years	0 (0)	32 (34)	N/A
6–10 years	0 (0)	4 (4)	
11–20 years	18 (12)	13 (14)	
21–30 years	43 (29)	21 (22)	
more than 30 years	39 (26)	31 (33)	
Advanced degrees			
M.D.	96 (66)	96 (103)	79 (343)
D.O.	1 (1)	1 (1)	12 (52)
MBBS	3 (2)	3 (3)	11 (48)
Ph.D. or equivalent	7 (5)	7 (7)	6 (27)
Master's	25 (17)	15 (16)	13 (56)
Other advanced degree	0 (0)	3 (3)	2 (7)
Scope of clinical practice[a]: % psychopharmacology, % psychotherapy			
0 %, 100 %	0 (0)	2 (2)	0 (0)
25 %, 75 %	2 (1)	14 (15)	5 (22)
50 %, 50 %	50 (34)	30 (32)	28 (123)
75 %, 25 %	47 (32)	36 (38)	60 (261)
100 %, 0	2 (1)	18 (19)	7 (30)
NIH funding per year over the last 5 years			
Less than $100,000	17 (12)	N/A	N/A
$100,000 to $2,000,000	16 (11)		
$2,000,000 to $10,000,000	29 (20)		
$10,000,000 to $50,000,000	26 (18)		
More than $50,000,000	12 (8)		
Approximate numbers of faculty members			
Full-time faculty	4 to 400	N/A	N/A
Part-time faculty	0 to 200		

N/A not applicable

[a] Totals may not add up to total number of respondents due to missing values

their scope of practice would encompass at least 75 % psychopharmacology. Unlike the psychiatrists' group, most respondents (429; 94 %) planned to be involved in teaching residents and/or medical students.

Self-assessed Knowledge of Neuroscience Significant differences in responses were seen among different participant groups but not between genders (see Table 2). MANOVA analyses yielded significance in Box's test of equality of covariance matrices in this group of questions (p=0.00002), as were Pillai's Trace (p=0.000004) and Wilks' lambda (p=0.000004). Specifically, a significantly higher percentage of chairs (50; 76 %) rated the neuroscience education they received in training as "Adequate," "More than adequate," or "Excellent" compared to psychiatrists (54; 51 %) and psychiatry trainees (262; 62 %). Likewise, the percentage of chairs (39; 57 %) rating their fund of neuroscience knowledge More than adequate or Excellent was higher than psychiatrists (25; 23 %) and psychiatry trainees (55; 13 %). Most chairs (57; 84 %), psychiatrists (81; 76 %), and trainees (307; 72 %) felt comfortable discussing neuroscience findings with their patients, and the differences were not statistically significant.

Attitudes Toward Neuroscience Education in Psychiatry Participants in all groups showed overwhelming (556; 94 %) agreement on the need for promoting neuroscience education in psychiatry (see Table 3) as well as the power of neuroscience to destigmatize mental illness (539; 90 %). Most participants (434; 73 %) indicated that advances in neuroscience would lead to discovery of new treatments or personalized medicines in 5 or 10 years. Of the three groups, trainees were the least optimistic (86 % of chairs, 80 % of psychiatrists, and 70 % of trainees) for this outcome (F=4.133; p=0.02). With regard to the desire to engage in continuing education focused on neuroscience, 48 (83 %) faculty members, 24 (89 %) private practitioners, and 410 (92 %) psychiatry trainees expressed interest in attending a 3-day course in neuroscience.

Preference for Neuroscience Learning Modalities As shown in Table 4, the overall trends in preferences of learning modalities were similar among the three groups, with only a few exceptions. Overall, didactics and expert-led small group discussions have the most responses for "Most helpful" and "Helpful." Journal club and internet-based modules have the most responses for "Least helpful" and "Not quite helpful." However, a few specific differences among groups were found [Box's test of equality of covariance (p=0.001); Pillai's Trace ($p=3\times10^{-9}$) and Wilks' lambda ($p=3\times10^{-9}$)]. Compared to psychiatrists, psychiatry trainees found case conference and ward- or clinic-based teaching significantly more helpful (p=0.0004), but grand rounds or conference symposia less helpful (p=0.02). The chairs felt that journal club is helpful compared to the other two groups (p=0.004 and 0.01, respectively).

Domains and Topics of Interest in Neuroscience Modalities MANOVA analyses yielded significant differences among the three test groups but not gender [Box's test of equality of covariance ($p=1\times10^{-19}$); Pillai's Trace (p=0.0003) and Wilks' lambda (p=0.0003)]. Among the six

Table 2 Survey responses regarding self-evaluation on knowledge in neuroscience

Questions	Department chairs[a] (n=68) % (N)	Psychiatrists (n=106) % (N)	Psychiatry trainees[a] (n=437) % (N)	Between-subject effects p value	% extremes[b]
Self-assessed fund of knowledge in neuroscience					
Inadequate	0 (0)	6 (6)	2 (9)	<0.001***	10 %
Less than adequate	16 (11)	21 (22)	36 (155)		
Adequate	27 (18)	50 (53)	49 (207)		
More than adequate	29 (20)	17 (18)	9 (39)		
Excellent	28 (19)	6 (7)	4 (16)		
Self-assessed quality of neuroscience education where participant was trained					
Inadequate	0 (0)	17 (18)	6 (25)	0.03*	11 %
Less than adequate	23 (15)	32 (34)	33 (139)		
Adequate	32 (21)	36 (38)	46 (195)		
More than adequate	32 (21)	11 (12)	13 (55)		
Excellent	12 (8)	4 (4)	3 (12)		
"I am comfortable discussing neuroscience findings with my patients."					
Strongly disagree	6 (4)	2 (2)	1 (4)	0.09	20 %
Disagree	10 (7)	22 (23)	27 (114)		
Agree	43 (29)	47 (50)	61 (260)		
Strongly Agree	41 (28)	29 (31)	11 (47)		

*p<0.05; **p<0.01; ***p<0.001

[a] Totals may not add up to total number of respondents due to missing values

[b] Percentage of total participants choosing the options at the extremes (i.e., "Inadequate" or "Excellent"; "Strongly disagree" or "Strongly agree")

Table 3 Survey responses regarding attitudes toward neuroscience education in psychiatry

Questions	Department chairs[a] (n=68) % (N)	Psychiatrists (n=106) % (N)	Psychiatry trainees[a] (n=437) % (N)	Between-subject effects p value	Percent extremes[b]
Years needed for advances in neuroscience to lead to the discovery of significant new treatments or to the personalized application of existing therapies					
In 5 years	29 (18)	32 (34)	15 (65)	0.02*	26
In 10 years	57 (36)	48 (51)	54 (230)		
In 20 years	13 (8)	13 (14)	23 (98)		
In more than 20 years	2 (1)	7 (7)	7 (30)		
"Greater public understanding of the neuroscience of psychiatric disorders and their treatments will help in reducing stigma for patients with mental illness."					
Strongly agree	54 (37)	45 (48)	50 (211)	0.65	51
Agree	34 (23)	45 (48)	41 (172)		
Disagree	7 (5)	9 (10)	8 (34)		
Strongly disagree	4 (3)	0 (0)	1 (6)		
More neuroscience education in psychiatric residency training					
Strongly agree	49 (34)	48 (50)	52 (217)	0.24	51
Agree	46 (32)	46 (48)	42 (175)		
Disagree	3 (2)	7 (7)	6 (23)		
Strongly disagree	1 (1)	0 (0)	0.2 (1)		

*p<0.05; **p<0.01; ***p<0.001

[a] Totals may not add up to total number of respondents due to missing values

[b] Percentage of total participants choosing the options at the extremes (i.e., "In 5 years" or "In more than 20 years"; "Strongly disagree" or "Strongly agree")

neuroscience domains, the three test groups showed similar responses on their importance in neuroscience education in psychiatry, with genetics, basic pharmacology, neuroimaging, and neural circuits found to be more important than animal models and cellular and molecular biology (see Table 5). The only exceptions were genetics and genomics (rated as more important among chairs and psychiatrists compared to trainees; p=0.003 and 0.008, respectively) and animal models (more important to chairs than trainees; p=0.02). Among specific neuroscience topics, emotion regulation and attention/cognition attracted most interests from all three groups (see Table 5). There were no differences between groups except developmental biology (more psychiatrists showed higher levels of interest compared to psychiatry trainees; p=0.006).

Discussion

To our knowledge, this study represents one of the first studies to report a cross-sectional sample of attitudes toward neuroscience education among psychiatry department chairs, psychiatrists, and psychiatry trainees. We found that psychiatrists, both in practice and in training, have a uniform opinion of the significant need of neuroscience education. Psychiatrists at all levels of training and practice feel that neuroscience will lead to discovery of new treatments or personalized medicines in 5 or 10 years and will help destigmatize mental illness. Psychiatrists expressed great interest in dedicating time to learning neuroscience in the form of a participatory and engaged learning modality such as a 3-day course despite their busy clinical schedules and with no difference between academic

Table 4 Preference in neuroscience learning modalities

Leaning modality	I. Department Chairs (n=68) Mean (standard deviation)[a]	II. Psychiatrists (n=106)	III. Psychiatry trainees (n=428)	Between-subject effects p value
Case conferences, ward, or clinic-based teaching	3.71 (0.88)	3.58 (1.09)	4.02 (0.90)	0.001**
Expert-led small group discussions	3.99 (0.89)	3.68 (1.07)	3.94 (0.99)	0.10
Formal didactics	3.81 (0.66)	3.99 (0.92)	3.74 (0.96)	0.05
Other independent learning	3.77 (0.89)	3.63 (1.06)	3.59 (1.03)	0.23
Grand rounds or conference symposia/talks	3.64 (0.71)	3.67 (0.92)	3.39 (0.98)	0.03*
Journal club	3.65 (0.64)	3.17 (1.17)	3.30 (0.99)	0.02*
Internet-based modules	3.27 (0.73)	3.23 (1.11)	3.16 (1.06)	0.31

*p<0.05; **p<0.01; ***p<0.001

[a] 1=least helpful, 2=not quite helpful, 3=moderately helpful, 4=helpful, 5=most helpful

Table 5 Responses from participants to the questions: (1) "For each domain of neuroscience please indicate how salient, and thus important, it is to teach." (2) "Beyond learning about the neurobiology of individual diagnoses, please rate your interest in learning about the following neuroscience domains which cut across different psychiatric diagnoses"

Question	I. Department chairs (n=69) Mean (standard deviation)	II. Psychiatrists (n=108)	III. Psychiatry trainees (n=419)	Between-subject effects p value
Question (1)[a]				
Basic pharmacology	4.49 (0.74)	4.39 (0.79)	4.38 (1.01)	0.86
Neuroimaging/neuroanatomy	4.43 (0.65)	4.30 (0.84)	4.26 (1.03)	0.41
Neural circuits (macro and microcircuits)	4.32 (0.80)	4.28 (0.86)	4.21 (1.03)	0.67
Genetics and genomics	4.28 (0.84)	4.04 (0.90)	3.69 (1.02)	0.001**
Cellular and molecular biology	3.88 (0.91)	3.63 (0.87)	3.61 (1.06)	0.35
Animal models	3.26 (0.86)	3.27 (0.87)	3.11 (1.02)	0.05*
Question (2)[b]				
Emotion regulation	4.64 (0.62)	4.62 (0.58)	4.31 (1.35)	0.34
Attention/cognition	4.60 (0.63)	4.50 (0.70)	4.27 (1.16)	0.18
Reward systems	4.41 (0.75)	4.39 (0.74)	4.26 (1.14)	0.92
Neuroplasticity and psychotherapy	4.09 (0.89)	4.04 (1.06)	4.12 (1.33)	0.45
Fear/extinction	3.96 (1.02)	4.07 (0.85)	3.91 (1.24)	0.48
Perceptual systems	3.79 (0.94)	3.62 (0.65)	3.88 (1.36)	0.84
Neurobiology of attachment	4.01 (0.98)	3.62 (0.93)	3.84 (1.18)	0.92
Developmental neurobiology	4.31 (0.83)	4.13 (0.77)	3.77 (1.30)	0.006**
Pain perception	3.72 (0.93)	3.47 (0.70)	3.76 (1.36)	0.31
Epigenetics	4.38 (0.80)	3.68 (0.94)	3.55 (1.31)	0.08
Basic research-driven drug development	3.88 (1.03)	3.16 (0.87)	3.47 (1.45)	0.38

*p<0.05; **p<0.01; ***p<0.001

[a] 1=unimportant, 2=of little importance, 3=moderately important, 4=important, 5=very important

[b] 1=not interested, 2=of little interest, 3=moderately interested, 4=interested, 5=very interested

faculty members and private practitioners. One factor driving this interest in learning neuroscience is the gap between the overall enthusiasm for neuroscience and the fact that only a small minority of psychiatrists (23 %) and trainees (13 %) considered themselves to have a strong knowledge of neuroscience. Even among department chairs, who hold leadership positions with the capacity to influence psychiatric education, only 57 % reported having a strong neuroscience foundation.

A paradigm shift in defining, diagnosing, and treating mental disorders is anticipated [11–13] within which a dimensional and transdiagnostic framework oriented around neurobehavioral systems is an emerging theme in basic and clinical neuroscience [7, 14]. We propose that this type of neurobiological framework for understanding psychopathology is congruent with many psychiatrists' disposition toward a problem-focused clinical approach. The survey results bear out this proposition. Of greatest interest to all groups were topics such as emotion regulation, attention/cognition and reward—domains that are explicitly transdiagnostic and strongly rooted in an understanding of their neural underpinnings. Moreover, respondents felt that describing neuroscience at the level of neural circuits, neuroimaging, and pharmacological mechanisms are the most salient domains. In other words, the level of organization of neurobehavioral systems that most appealed to our wide range of respondents were those that match our current understanding of how the nervous system achieves these capacities—through the operation of neural circuits.

Some topics, however, received much less interest, such as the case for attachment, epigenetics, and fear/extinction despite the fact that these topics are of fundamental importance to clinical phenomena across diverse DSM diagnoses and have a strong neurobiological evidence base. Similarly, basic research-driven drug development (i.e., "rational" drug design) attracted less interest, as did the domain of animal models. These findings identify the areas in which the greatest challenges exist for effectively teaching neuroscience to psychiatrists and translating neuroscience insights into the clinical domain.

What form might transdiagnostic clinically relevant neuroscience teaching take? First of all, neuropsychiatry and neuropsychology are recognized as one of the links between clinical psychiatry and neuroscience. As illustration, we use the difficulties in attention and concentration commonly observed in many psychiatric disorders. Through teaching of the neural systems that normally mediate attention (micro- and macro-circuits, neuromodulators, etc.), similarities can be drawn to specific elements of fairly disparate DSM diagnoses such as schizophrenia, depression, and attention-deficit/hyperactivity disorder. This teaching can be done using neuroimaging studies as well as post-mortem pathology studies. Promising research on quantification and remediation of cognition, such as through novel pharmacological compounds or cognitive training, may also be introduced. The opportunity for exposure to current and future novel therapeutics may be particularly critical since existing interventions do little to fix attentional abnormalities. The ability of clinicians to take advantage of these therapeutics and appreciate the severity of cognitive impairment in their patients, however, requires first-hand experience objectively assessing executive functions. As a demonstration of how easily these systems can be assessed by any clinician once their role in psychopathology is illustrated, simple well-validated "bedside" tasks such as trail-making, anti-saccade, or color-word Stroop can be taught to the clinician, which they can be encouraged to try on patients with a variety of DSM diagnoses.

In addition to this transdiagnostic approach of teaching neuroscience [10], other approaches and perspectives in teaching neuroscience are emerging in various psychiatry departments in the country. In order to integrate neuroscience into psychiatric practice, educators in psychiatry have articulated creative approaches in narrowing the seemingly large gap between traditional psychotherapy and emerging neuroscience [15] and in teaching neuroscience with a humanistic approach [16]. To fulfill the need of training the next generation of psychiatrists who can utilize the new knowledge in neuroscience, Anders and Roberts proposed a 5-year Clinical Neurosciences/General Psychiatry/Child Psychiatry triple board program, which would allow psychiatry trainees to be proficient in neuroscience, genetics, and neurodevelopment [17].

Our primary limitation is the relatively low response rate, which may constrain generalization of our findings, though these response rates are typical of web-based surveys [18] of busy health professionals [19]. The response bias could go either way, i.e., those with the most neuroscience expertise might be least likely to respond because they feel well prepared. On the other hand, those with the least neuroscience expertise might be most uncomfortable and, therefore, did not respond to our survey. Future work is needed to clarify this more. Second, there is also a question of self-report reliability, as survey participants often overstate their own confidence, competence, and future likelihood of taking desirable action [20, 21]. This is directly seen in our own data in statements regarding teaching; over 90 % of trainees expected that they would continue to teach residents and medical students, whereas the vast majority of practitioners had minimal engagement with teaching. However, such an effect would only further underscore the pressing need for greater neuroscience education throughout psychiatry. Third, although most respondents in this study felt that neuroscience would help to destigmatize mental illness, we did not ask specifically whether neuroscience makes any significant difference in clinical care/informs the clinician at present.

Despite these limitations, this study demonstrated a demand from psychiatry department chairs, practicing psychiatrists, and psychiatry trainees for more neuroscience education (see Fung et al. [22] for more detailed analyses for the trainee group). We have identified specific preferences in learning modalities and neuroscience topics, which will pave the way for targeted strategies for effective dissemination of the knowledge in neuroscience to the psychiatric community. The spirit of transdiagnostic neuroscience and problem-focused clinical care are also consistent with the objective of the recently formulated Research Domain Criteria (RDoC) project launched by the National Institute of Mental Health (NIMH) [7, 23, 24]. Moreover, the topics and domains assessed in our survey are closely related to those outlined in RDoC [25]. We therefore suggest that a dimensional framework that encompasses different diagnoses may be an effective way to deliver neuroscience education to the psychiatric community based on (1) the neurobiological evidence indicating the importance of transdiagnostic disruptions in discrete neurobehavioral systems that underlie distinct mental capacities and (2) the close similarity between this neuroscience formulation and that arrived through problem-focused clinical approaches natural to practicing clinicians.

Implications for Educators

- Expanding core competencies in neuroscience may be a priority for psychiatry residency, fellowship programs, and directors for continuing medical education.
- Approaches in teaching neuroscience-based case formulations may be an important component of neuroscience curriculum in psychiatry.
- Of greatest interest to psychiatrists in practice and in training were topics that are explicitly transdiagnostic and strongly rooted in an understanding of their neural underpinnings, e.g., emotion regulation, attention/cognition, and reward system. A transdiagnostic framework may be an effective way to deliver neuroscience education to the psychiatric community.
- The level of organization of neurobehavioral systems that most appealed to psychiatrists in practice and in training were those that match our current understanding of how the nervous system achieves these capacities, i.e., through the operation of neural circuits.

Implications for Academic Leaders

- Advocating for expanding the scope of neuroscience education is crucial. For example, academic leaders who are in committees responsible for setting requirements for psychiatry board certification and revising PRITE exams can have a major impact on changing the scope of neuroscience education for psychiatrists in practice and in training.
- Empowering faculty members to apply neuroscience to clinical settings may be helpful to advance the field of psychiatry.
- Prioritizing on providing resources to expand the scope of neuroscience education will help educators to train residents and fellows.

Acknowledgments The authors thank Dr. John Oldham, Dr. Dilip Jeste, Dr. Eve Moscicki, Ms. Shelly Cohen and Ms. Janet Kuramoto of the American Psychiatric Association for coordinating the invitation of its members to complete the on-line survey, as well as the 2013 graduating class of general psychiatry at Stanford for their feedback in the pilot study. We thank Dr. Jane Kim for her input on the preparation of the illustrations of this manuscript. Finally, we thank all participants of this study for completing the survey. AE was funded by the Sierra-Pacific Mental Illness Research, Education and Clinical Center (MIRECC) at the Palo Alto VA; LKF was funded by a T32 research fellowship at Stanford University.

Disclosure On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. Freud S. Project for a scientific psychology. In: Jones E, editor. The Standard edition of the complete psychological works of Sigmund Freud. London: Hogarth; 1895. p. 295–397.
2. Etkin A, Wager TD. Functional neuroimaging of anxiety: a meta-analysis of emotional processing in PTSD, social anxiety disorder, and specific phobia. Am J Psychiatry. 2007;164(10): 1476–88.
3. Pittenger C, Etkin A. Are there biological commonalities among different psychiatric disorders? Psychiatry. 3rd ed. Chichester: Wiley; 2008. p. 245–56.
4. Hamilton JP, Etkin A, Furman DJ, Lemus MG, Johnson RF, Gotlib IH. Functional neuroimaging of major depressive disorder: a meta-analysis and new integration of base line activation and neural response data. Am J Psychiatry. 2012;169(7):693–703.
5. Clark LA, Watson D, Reynolds S. Diagnosis and classification of psychopathology: challenges to the current system and future directions. Annu Rev Psychol. 1995;46:121–53.
6. Campbell P. A decade for psychiatric disorders. Nature. 2010;463(7277):9.
7. Insel T, Cuthbert B, Garvey M, Heinssen R, Pine DS, Quinn K, et al. Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. Am J Psychiatry. 2010;167(7): 748–51.
8. Benjamin S, Travis MJ, Cooper JJ, Dickey CC, Reardon CL. Neuropsychiatry and neuroscience education of psychiatry trainees: attitudes and barriers. Acad Psychiatry. 2014;38(2): 135–40.
9. Benjamin S; Widge AS; Shaw K. Neuropsychiatric and neuroscience milestones for general psychiatry trainees. Acad Psychiatry;2014.
10. Etkin A, Cuthbert B. Beyond the DSM: development of a transdiagnostic psychiatric neuroscience course. Acad Psychiatry. 2014;38(2):145–50.
11. Reynolds 3rd CF, Lewis DA, Detre T, Schatzberg AF, Kupfer DJ. The future of psychiatry as clinical neuroscience. Acad Med. 2009;84(4):446–50.
12. Rubin EH, Zorumski CF. Perspective: upcoming paradigm shifts for psychiatry in clinical care, research, and education. Acad Med. 2012;87(3):261–5.
13. Insel TR, Wang PS. Rethinking mental illness. JAMA J Am Med Assoc. 2010;303(19):1970–1.
14. Chung JY, Insel TR. Mind the gap: neuroscience literacy and the next generation of psychiatrists. Acad Psychiatry. 2014;38(2):121–3.
15. Watson BO, Michels R. Neuroscience in the residency curriculum: the psychoanalytic psychotherapy perspective. Acad Psychiatry. 2014;38(2):124–6.
16. Griffith JL. Neuroscience and humanistic psychiatry: a residency curriculum. Acad Psychiatry. 2014;38(2):177–84.
17. Anders TF, Roberts LW. Clinical neurosciences training for psychiatrists: one proposed model. Acad Psychiatry. 2014;38(2):151–3.
18. Cook C, Heath F, Thompson RL. A meta-analysis of response rates in web- or internet-based surveys. Educ Psychol Meas. 2000;60:821–36.
19. Braithwaite D, Emery J, de Lusignan S, Sutton S. Using the Internet to conduct surveys of health professionals: a valid alternative? Fam Pract. 2003;20(5):545–51.
20. Davis DA, Mazmanian PE, Fordis M, Van Harrison R, Thorpe KE, Perrier L. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. JAMA. 2006;296(9):1094–102.
21. Ehrlinger J, Johnson K, Banner M, Dunning D, Kruger J. Why the unskilled are unaware: further explorations of (absent) self-insight among the incompetent. Organ Behav Hum Decis Process. 2008;105(1):98–121.
22. Fung LK, Akil M, Widge A, Roberts LW, Etkin A. Attitudes toward neuroscience education among psychiatry residents and fellows. Acad Psychiatry. 2014;38(2):127–34.
23. Cuthbert BN, Insel TR. Toward new approaches to psychotic disorders: the NIMH Research Domain Criteria project. Schizophr Bull. 2010;36(6):1061–2.
24. Morris SE, Cuthbert BN. Research Domain Criteria: cognitive systems, neural circuits, and dimensions of behavior. Dialogues Clin Neurosci. 2012;14(1):29–37.
25. NIMH Research Domain Criteria (RDoC). Bethesda, MD: National Institute of Mental Health. 2013. Available from: http://www.nimh.nih.gov/research-priorities/rdoc/nimh-research-domain-criteria-rdoc.shtml. Accessed 1 May 2013.