EMIGRE NEUROPHYSIOLOGISTS’ SITUATED KNOWLEDGE ECONOMIES AND THEIR ROLES IN FORMING INTERNATIONAL CULTURES OF SCIENTIFIC EXCELLENCE

by

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This article investigates the scientific performance and impact of Jewish and politically oppositional émigré German-speaking neurophysiologists from Nazi-occupied Europe since the 1930s. The massive loss of nearly 30% of all academic psychiatrists and neurologists in Germany between 1933 and 1945 also shattered the basis of German-speaking neuroscientific research. A focus will be laid here on the contingency of situated knowledge economies in Central Europe, the UK and North America, as well as their roles in the formation of international cultures of scientific excellence in the forced migration process. While examining excellent émigré laboratory research, the intriguing biographies of three Nobel Prize-winning neurophysiologists—Otto Loewi (1873–1961; from Germany/Austria to the USA), Bernard Katz (1911–2003; from Germany to the UK) and Eric Kandel (b. 1929; from Austria to the USA)—can tell us considerably more about the appraisal of medico-scientific knowledge through an epistemic lens representing world history along explicit regional knowledge economies. This article examines some of the more intricate scientific practices and professional patterns of determining academic excellence related to situated knowledge communities in the contemporary brain sciences.

Keywords: cultures of scientific excellence, émigré neurophysiologists, Eric Kandel, Bernard Katz, Otto Loewi, Nobel laureates

INTRODUCTION

The bestowment of Nobel Prizes constitutes the highest accolade in recognition cultures of scientific excellence in the global community, and it takes an important place in modern cultural imagination.1 This process can be studied as a significant element of the forced migration of Jewish and politically oppositional medical researchers from Nazi-occupied

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1 Hillevi Ganetz, ‘The Nobel celebrity-scientist: genius and personality’, Celebr. Stud. 7, 234–248 (2015); Sven Widmalm (ed.), ‘Special Issue: The Nobel Prizes and the public image of science’, Publ. Underst. Sci. 4, 390–494 (2018).

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Europe, which allows a better history of science understanding of the contingent nature of situated knowledge economies in Central Europe, the UK and North America, as well as insights into culturally laden research styles in the twentieth century. Whereas three of the Nobel laureate émigrés in the wider neuroscience field are presented here, the general patterns of knowledge economies and their roles in the formation of international cultures of scientific excellence need to be emphasized too, vis-à-vis the advancement of science in the USA, which had been particularly invigorated by international collaboration, despite tangible cultural barriers. Overall, more than 40% of US Nobel awards have been given out to immigrant scholars, while about 50% of all postdocs and 33% of faculty in the engineering and science disciplines in US research institutions were identified as being of foreign origin. Given the focus of this Special Issue on awards as indicators of excellence that elicit ‘new perspectives on scientific reward mechanisms and the role of credit, cultures of excellence and gender in medicine’, viewing the contingency and variability of situated, institutional cultures of excellence becomes important.

The examination of three Nobel Prize laureates in the field of neurophysiology, namely the neurochemists and neurophysiologists Otto Loewi, Bernard Katz and Eric Kandel, allows viewing some intricate paths in their forced migration, leading towards the recognition of their fundamental authority. Some similarities but also the illuminating specificities in their emigration stories are underscored in the sections below, as they offer insights into the ground-breaking process of forced migration, which was established through racial, anti-Semitic and political reasoning, endemic in the 1930s in Europe, while also contributing to the new field of neuroscience with its ‘regional knowledge economies’ which are rooted in situated knowledge settings, which are in turn shaped by a bilateral knowledge transfer. I take the concept of regional knowledge economies to designate collaborative research groups that are built by distinct connections between individuals and institutional settings, often centring on specific disciplinary communities or encircled by regional or sub-national networks. My analytical lens is on the reciprocal adjustment of arriving émigré neurophysiologists in their new host countries and situated knowledge communities, as sources of scientific change and methodological innovation regarding knowledge production and the origins of new practices in the brain sciences.

From the inter-war to the post-war period, research into mental illness and neurological care in the Anglo-American world and the German-speaking countries had changed profoundly after the expulsion of several hundred émigré brain researchers. It is because of these significant changes to the foundations of modern biomedicine as well as clinical care politics that the case of forced migration implores an in-depth study of the place of science in society, the establishment of international relations, and germane networks of mutual benefits.

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2 Frank W. Stahnisch, ‘The ‘brain gain thesis’ revisited: German-speaking émigré neuroscientists and psychiatrists in North America’, in Global transformations in the life sciences, 1945–1980 (ed. P. Manning and M. Savelli), pp. 128–145 (University of Pittsburgh Press, Pittsburgh, 2018).

3 Jean-Laurent Casanova, David M. Holtzman, Susan M. Kaech, Lewis L. Lanier, Carl F. Nathan, Alexander Y. Rudensky, David Tuveson and Jedd. D. Wolchok, ‘Immigration in science’, J. Exp. Med. 217, e20202055 (2020), https://doi.org/10.1084/jem. 20202055 (accessed 18 April 2021).

4 See Nils Hansson and Thomas Schlich, ‘Introduction’, Notes Rec. R. Soc. Lond., pp. 1–27, especially p. 4.

5 Fabio de Sio, Nils Hansson and Ulrich Koppitz, ‘John C. Eccles’ conversion and the meaning of “authority”’, in Attributing excellence in medicine. The history of the Nobel Prize (ed. N. Hansson, T. Halling and H. Fangerau), pp. 143–174 (Brill, Amsterdam, 2019).

6 Timothy Lenoir, ‘Revolution from above: the role of the state in creating the German research system, 1810–1910’, Am. Econ. Rev. 88, 22–27 (1998).
excellence. The performance processes that sustain clusters of scientific excellence can be related in a comparative analysis with institutional structures and acculturation of different scientific discourses in the ‘Old World’ and the ‘New World’. A focus will thereby be laid on the question of regional knowledge economies and their role in the formation of scientific excellence among émigré neurophysiologists, which can instructively exemplify the variability of extant scientific milieux.

Historian of science Timothy Lenoir has emphasized in his seminal book *Instituting science* that historiographical work on the formation of scientific disciplines in the nineteenth century led to a preoccupation with university institutes, rather than extra-university forms of research organization. Furthermore, Lenoir called our attention to the need to ‘depict universities as participants in a situated knowledge community, and in effect, to treat the disciplinary structure of the university as part of a regional knowledge economy’. The concept of regional knowledge economies is particularly useful, since it transcends the traditional view that science is primarily associated with specialized institutes, organized in hierarchical structures, and communities of disciplinary practice. Applying this perspective to the question of discipline-building in the brain sciences may help to clarify the relationship between the performance of scientific excellence and cultural practices that recognize major research contributions.

**THE STATUS QUO ANTE**

Of main concern to this article is an event prior to World War II and its role in bringing about scientific change: the massive loss of nearly 30% of all academic neurologists and psychiatrists in Germany between 1933 and 1945—among them many highly honoured neurologists, ostensibly constituting a *Who’s who* of neurology in Europe—in many ways severed German-speaking brain research. The forced migration of Jewish and politically oppositional physicians from Nazi-occupied Europe has often been viewed from the perspective of contributing to the host countries, leaving out the scientific adaptation and cultural practices that recognize major research contributions.

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7 Thorsten Halling, Ragnar Bjöerk, Heiner Fangerau and Nils Hansson, ‘Leopoldina: ein Netzwerk fuer kuenftige Nobelpreistraeger fuer Physiologie oder Medizin?’, *Sudhoffs Arch.* **102**, 211–233 (2018).
8 Herbert A. Strauss, ‘The immigration and acculturation of the German Jew in the United States of America’, *Year b. Leo Baeck Inst.* **16**, 63–94 (1971).
9 Timothy Lenoir, *Instituting science: the cultural production of scientific disciplines* (Stanford University Press, Stanford, CA, 1997).
10 Stephen T. Casper and Delia Gavrus (eds), *The history of the brain and mind sciences: technique, technology, therapy* (University of Rochester Press, Rochester, NY, 2017); Jonathan Harwood, *Styles of scientific thought: the German genetics community, 1900–1933* (University of Chicago Press, Chicago, 1993).
11 Lenoir, op. cit. (note 9), pp. 19–20.
12 Ibid., p. 53.
13 Richard Watermeyer and Mark Olssen, ‘“Excellence” and exclusion: the individual costs of institutional competitiveness’, *Minerva* **54**, 201–218 (2016); Delia Gavrus, ‘Wilder Penfield dreams of the Nobel Prize’, *Notes Rec. R. Soc. Lond.*, especially pp. 10–11. (doi:10.1098/rsnr.2021.0046)
14 Mitchell G. Ash and Alfons Soellner (eds), *Forced migration and scientific change: émigré German-speaking scientists and scholars after 1933* (Cambridge University Press, Cambridge, UK, 1996), pp. 1–9.
15 This perspective accords with the lists of keynote addresses given to the German Association of Neurologists and Psychiatrists since 1907. Frank W. Stahnisch, *A new field in mind—a history of interdisciplinarity in the early brain sciences* (McGill-Queen’s University Press, Montreal, 2020), pp. 241–242.
16 Jean Medawar and David Pyke, *Hitler’s gift: the true story of the scientists expelled by the Nazi regime* (Arkade Publishing, New York, 2001), pp. 231–240.
modification trajectories. It is due to these discord that the case of forced migration solicits the study of the contribution of science and its interaction with international professional networks.

Research literature on forced migration in neurology and psychiatry is rather dominated by accounts of psychoanalysis and clinical psychiatry in the receiving countries, and it has tended to take primarily the intellectual, academic and institutional dimensions into account. However, what stands out about the historiography of the brain sciences from the late Wilhelminian epoch and World War I through the Weimar Republic, the Nazi era, and the post-war period is that research into mental illness and neurological clinical care in the German-speaking communities and in émigrés’ new host countries changed dramatically with the expulsion of so many émigré researchers. The study of their biographies in this article, including those of Loewi, Katz and Kandel, helps us to narrate global history in its specific regional contexts of the formation and changes of cultures of excellence. These émigré individuals had been trained in the basic medical sciences, such as neuropathology, neuroanatomy or neuropathophysiology, and had often received additional training proficiency in psychiatry in pre-eminent places such as Frankfurt, Leipzig or Vienna. This development, which presents as the unfolding of an important bilateral knowledge transfer, is mapped through the comprehensive individual, network and institutional settings that established forms of scientific recognition, by using archival materials from research foundations, interview and autobiographical materials from Nobel laureates, as well as documents from the online nomination archives of the Nobel Prize, as these offer myriad insights into the topic of scientific credit and the networks of nominators involved in the attribution of scientific credit.

EXPERIENCES OF CHANGE AND DIFFERING PERFORMANCE CULTURES

Following the massive forced migration wave from the German-speaking countries beginning in 1933, the relationship between neurology, psychiatry, pathology and experimental psychology was gradually readjusted. This process also translated into the effective shift of brain science into one of the most proli fic areas of biomedical knowledge.

17 A different view is provided by Ola Larsmo, Djävulssonaten, ur det Svenska hatets historia (Albert Bonniers Förlag, Stockholm, 2007), pp. 8–13, and Pontus Rudberg, The Swedish Jews and the Holocaust (Routledge, London, 2017), pp. 19–23.
18 David John Frank and John W. Meyer, The university and the global knowledge society (Princeton University Press, Princeton, NJ, 2020), pp. 65–89.
19 Elizabeth Lunbeck, The psychiatric persuasion: knowledge, gender, and power in modern America (Princeton University Press, Princeton, NJ, 1994); Joseph Schwartz, Cassandra’s daughter: a history of psychoanalysis in Europe and America (Allen Lane, London, 1999); Lydia Marinelli and Andreas Mayer, Dreaming by the book: a history of Freud’s The interpretation of dreams and the psychoanalytic movement (Penguin, London, 2003); Jonathan Engel, American therapy: the rise of psychotherapy in the United States (Penguin, London, 2009).
20 Axel Karenberg, ‘Die Gruendung der ‘Gesellschaft Deutscher Nervenaerzte’ und die schwierigen Anfaenge der klinischen Neurologie in Deutschland’, Schr. Dt. Ges. Gesch. Nervenhlk. 14, 319–345 (2008).
21 Delia Gavrus, Émigré scientists and the global turn in the history of science: a commentary on the Special Issue “New perspectives on forced migration in the history of twentieth-century neuroscience”, J. Hist. Neurosci. 25, 363–368 (2016).
22 Stahnisch, op. cit. (note 15), pp. 237–240.
23 Eric R. Kandel, ‘Essay: the new science of mind’, Scient. Am. Mind 17, 62–66 (2013).
24 Frank W. Stahnisch, German-speaking émigré neuroscientists in North America after 1933: critical reflections on emigration-induced scientific change’, Oesterr. Z. Gesch. Wiss. 21, 56–68 (2010), at pp. 66–68.
25 Sven Kinas, Akademischer Exodus—die Vertreibung von Hochschullehrern aus den Universitaeten Berlin, Frankfurt am Main, Greifswald und Halle, 1933–1945 (Synchron, Krottenmuehl, Germany, 2018), pp. 24–26.
production. The inauguration of the National Health Service in the UK and the National Institutes of Health (NIH) in the USA in 1948 became instrumental for many of the biomedical émigrés, when post-war support initiatives of the Rockefeller Foundation were reoriented from biomedicine towards global public health—something to which historian J. Rogers Hollingsworth has previously drawn attention. It was most obvious to researchers in twentieth century neuroscience that the cognitive understanding of scientific subject matters varied markedly with the influence of time and culture. Émigré researchers were themselves aware of this cultural dimension of science, as manifest in the recollections of Kandel, when he reflected on the experiential background of Vienna’s culture:

Vienna’s culture was one of extraordinary power, and it had been created and nourished in good part by Jews. My life has been profoundly shaped by the collapse of Viennese culture in 1938—both by the events I experienced that year and by what I have learned since about the city and its history.

In contrast to Katz’s chronologically earlier example, Kandel further related to his home country in the way of (re)discovery, while having received his academic training in the USA but being influenced profoundly through the émigré cultural circles of his parents in their New York exile. And most émigrés would have agreed with Kandel’s emphasis regarding the impact that the culture of their home countries exerted on their personal and scientific lives. Yet, even when they were successful in entering UK or US institutions to continue their careers, they realized that the modes of scientific conduct and recognition and the organization of research projects appeared to be quite different from what they had previously been accustomed to:

I began to realize that what makes science so distinctive, particularly in an American laboratory, is not just the experiments themselves, but also the social context, the sense of equality between student and teacher, and the open, ongoing, and brutally frank exchange of ideas and criticism.

Following these lines, the respective émigrés’ narratives consist of much more than just an alignment of the events that occurred in the specific arenas of contemporary neurophysiology. Influential individuals, such as Loewi, Katz or Kandel with their pioneering experimental work along with regional scientific milieux—respectively at Columbia University, University College London (UCL) and the NIH in Bethesda, Maryland—have exerted considerable influence on the development and recognition of scientific excellence. Neurophysiologists Horace Magoun and Louise Marshall have drawn particular attention to the

26 Horace Winchell Magoun, American neuroscience in the twentieth century: confluence of the neural, behavioral, and communicative streams (ed./annot. L. H. Marshall), pp. 81–86 (A. A. Balkema Publishers, Lisse, The Netherlands, 2003).
27 Kathleen M. Pearle, Aerzteemigration nach 1933 in die USA. Der Fall New York’, Med. Hist. J. 112, 112–137 (1984), at pp. 129–130.
28 J. Rogers Hollingsworth, ‘Institutionalizing excellence in biomedical research: the case of the Rockefeller University’, in Creating a tradition of biomedical research: contributions to the history of the Rockefeller University (ed. Darwin H. Stapleton), pp. 17–65 (Rockefeller University Press, New York, 2004), at pp. 17–19.
29 Eric R. Kandel, In search of memory: the emergence of a new science of mind (W. W. Norton & Co., London, 2006), p. 12.
30 Doron Niederland, ‘The emigration of Jewish academics and professionals from Germany in the first years of the Nazi rule’, Leo Baeck Inst. Yearb. 33, pp. 285–300 (1988); Ulrike Eisenberg, Hartmut Collmann and Daniel Dubinski (eds), Verraten – Vertrieben – Vergessen. Werk und Schicksal nach 1933 verfolgter deutscher Hirnchirurgen (Hentrich & Hentrich, Berlin, 2017), pp. 11–23.
31 Kandel, op. cit. (note 29), p. 106.
32 Annual Report of the NIH in Bethesda, Maryland, 1954, Archives of the NIH, Bethesda, MA, USA. R.P.C. 1. Ser. No. NIMH-63, Call No. RA790.6.U559, p. 24.
changes in the field that saw ‘new research ideas and teaching programs, [and] the transfer of apparatus and methodologies became a major element in the growth of neuroscience’.  

LOEWI—PIONEERING WORK IN SYNAPTIC TRANSMISSION

Loewi was born as the son of a Jewish merchant in Frankfurt and attended the Gymnasium high school in his home town, where he excelled in both the humanities and natural sciences. Following his graduation in 1891, he aimed at studying art history, but was criticized by his father who saw this as a breadless endeavour, convincing him to choose a more practical career. Subsequently, he registered with the medical programme at Kaiser Wilhelm University of Strasburg, which had emerged as a leading faculty in Imperial Germany since 1872. Prominent academics were hired as professors, such as Wilhelm von Waldeyer (1836–1921), who co-developed the neuron concept, Friedrich Daniel von Recklinghausen (1833–1910), who described the clinical syndrome of neurofibromatosis, and Richard Freiherr von Krafft-Ebing (1840–1902), who pioneered studies in psychopathology. For Loewi this meant that he could study with leading scientists of the period. In line with the prevailing laboratory-research orientation, he decided to write his medical thesis on a neuropharmacological topic under Oswald Schmiedeberg (1838–1921), analysing the quantitative effects of hydrocyanic acid, arsenic and phosphorus on frog heart preparations.

His thesis was favourably received in the scientific community, which led to invitations for continuing postgraduate work, such as with Martin Freund (1863–1920) and Carl von Noorden (1858–1944) in Frankfurt. Yet before he took up these training opportunities, he travelled to Italy, where he even pondered the idea of becoming a practising physician, while deciding rather to pursue first opportunities in laboratory-based neurophysiology during a period when many faculties were outrightly anti-Semitic, making it difficult for Jewish Privatdocenten to emerge in the professoriate. Following his early exposure to physiological experimentation, he seized on the opportunity of an assistantship in pharmacology at the University of Marburg, to work on metabolic problems. In 1902, he decided to visit pharmacological laboratories in the UK and collaborated with Henry Dale (1875–1968), with whom he upheld a friendship lasting until the end of their lives, while their convergence on the same problem was of a meandering type, to become reconfirmed in the mid-1910s. Two years later, Loewi accepted a position at the University of Vienna, where he commenced his research on blood pressure, salivation and digestion,

33 Magoun, op. cit. (note 26), p. 82.
34 Lindsay F. Haas, ‘Otto Loewi (1873–1961)’, J. Neurol. Neurosurg. Psych. 74, 843 (2003).
35 Otto Loewi, ‘An autobiographic sketch’, Perspect. Biol. Med. 4, 3–25 (1960).
36 Frank W. Stahnisch, ‘Die Neurowissenschaften in Strassburg zwischen 1872 und 1945—Forschungstaetigkeiten zwischen politischen und kulturellen Zaesuren’, Sudhoffs Arch. 100, 227–262 (2016), especially pp. 227f.
37 Otto Loewi, Zur quantitativen Wirkung von Blausaeure, Arsen und Phosphor auf das isolirte Froschherz, MD dissertation, Strasburg, Germany (1896).
38 Fritz K. Ringer, The decline of the German mandarins: the German academic community, 1890–1933 (Harvard University Press, Cambridge, MA, 1969), pp. 135–139.
39 Otto Loewi, ‘Facts’, Nobel Prize Outreach AB 2021, https://www.nobelprize.org/prizes/medicine/1936/loewi/facts/ (accessed 5 December 2021).
40 Loewi, op. cit. (note 35), p. 11.
dependent on indirect sympathomimetic drugs.\textsuperscript{41} In 1909, he moved to assume the directorship of the Institute of Pharmacology at the University of Graz. Here, most of his nerve-related research on acetylcholine was carried out,\textsuperscript{42} contributing to his first major award, the Ignaz L. Lieben Prize in 1924. Receiving the award spurred his renown as a neurochemist and laid the foundation for subsequent awards until his Nobel Prize in 1936, after understanding how the axon endings liberated chemicals and stimulated or inhibited other cells.

The extended nomination network for Loewi comprised 27 prominent male nominators from several countries with a focus on the UK,\textsuperscript{43} which formed a hub in neurophysiological innovations at the time.\textsuperscript{44} These included the Oxford-based neurophysiologist Sir Charles Sherrington (1857–1952),\textsuperscript{45} who also mentored émigré neurophysiologist Katz,\textsuperscript{46} and neurophysiologist Sir Archibald V. Hill (1886–1977) in Liverpool, who had a strong focus on the nerve membrane, while both were also major protagonists of the British Academic Assistance Council (AAC).\textsuperscript{37} The AAC helped in getting émigré scholars out of the ‘Third Reich’ following their dismissal from publicly funded positions, including Loewi’s own flight from Austria and arrival in the UK.\textsuperscript{48} Hill later publicly emphasized that the Nazi government had fostered the nomination of racial anthropologist Alfred Ploetz (1860–1940) for the Nobel Prize in 1936, while officially suppressing initiatives among German scientists to nominate Jewish pharmacologist Loewi.\textsuperscript{49} Likewise, neurophysiologist Edgar Douglas Adrian (1889–1977) in Cambridge, as a pioneer of the study of the neuronal membrane and neurological electroencephalography, became part of the UK-based network as Alan Hodgkin’s (1914–1998) academic patron.\textsuperscript{50} Historian Delia Gavrus has emphasized that the emergence of electroencephalography constituted ‘a broader scientific context, pointing out how other scientists had also previously contributed to the topic’,\textsuperscript{51} including formative elements from membrane neurophysiology, synaptic cleft neuroanatomy, and electrochemical signal transmission as well. Such awareness of previous brain scientists’ achievements featured in the exchanges among the electrophysiologists at Oxford and their interests in synaptic transmission, albeit from different perspectives. The above-mentioned scientists all belonged to the British elite of male neurophysiologists, who themselves appreciated Loewi’s

\textsuperscript{41} Otto Loewi and Alfred Froehlich, ‘Ueber eine Steigerung der Adrenalinempfindlichkeit durch Cocain’, Arch. Exp. Path. Pharmacol. 62, 159–169 (1910).

\textsuperscript{42} Otto Loewi, ‘Ueber humorale Uebertragbarkeit der Herznervenwirkung. I Mitteilung’, Pfluegers Arch. Ges. Physiol. 189, 239–242 (1921).

\textsuperscript{43} Elliot S. Valenstein, The war of the soups and the sparks: the discovery of neurotransmitters and the dispute over how nerves communicate (Columbia University Press, New York, 2005), pp. 83–88.

\textsuperscript{44} In a reciprocal vein, Loewi became a plural nominee for 15 candidates for the Nobel Prize between 1913 and 1953. These nominations are registered in the Nobel nomination database (1901–1953): https://www.nobelprize.org/nomination/archive/ (accessed 18 April 2021).

\textsuperscript{45} Sherrington and Adrian were awarded the Nobel Prize in 1932 ‘for their discoveries regarding the functions of neurons’. The Nobel Prize in Physiology or Medicine 1932, https://www.nobelprize.org/prizes/medicine/1932/summary/ (accessed 20 April 2021).

\textsuperscript{46} Nomination of Dale and Loewi by Sherrington 1935, https://www.nobelprize.org/nomination/archive/show.php?id=14006 (accessed 18 April 2021).

\textsuperscript{47} Nomination by Hill 1935, https://www.nobelprize.org/nomination/archive/show.php?id=14002 (accessed 18 April 2021).

\textsuperscript{48} Society for the Protection of Science and Learning, correspondence related to individual scholars, file Otto Loewi, MS S.P.S.L. 414/1–10, Bodleian Library, Oxford.

\textsuperscript{49} Shula Marks, Paul J. Weindling and Laura Wintour (eds), In defence of learning: the plight, persecution, and placement of academic refugees, 1933–1980s (Oxford University Press, Oxford, 2011), p. 70.

\textsuperscript{50} Nomination of Dale and Loewi by Adrian 1935, https://www.nobelprize.org/nomination/archive/show.php?id=14005 (accessed 18 April 2021).

\textsuperscript{51} Gavrus, op. cit. (note 13), p. 9.
publications since his earlier research visits to their laboratories. They were well acquainted with the scientific progress of his work and recognized it as a fundamental building block for their own programmes, seeking to elicit the electrochemical nature of the synapse as a functional building block to explain individual as well as group neural actions. They knew perfectly well how to work the reward structures in the professional academic networks, which should benefit Loewi too.

This continuing support by British neurophysiologists—since Loewi’s first stay with Dale at UCL—can be interpreted as a recognition of Loewi’s experimental paradigms, intriguing findings, and analytical interpretations. Loewi’s contributions advanced neurophysiology visibly at the time, and were also reflected in the academic standing and the number of prime movers who rallied behind his Nobel nomination by Dale. And, certainly, Dale’s prominence in the neurophysiological community, as well as his scientific leadership after joining the National Institute of Medical Research in 1914, fostered the Nobel reward process for Loewi considerably. Since the death of Carl Ludwig (1816–1895) in Germany, the UK had visibly become a leader in neurophysiology,\(^52\) which was further sustained in its increased veneration of its national research agendas as well as the successful academic and nomination networks in the British Isles and beyond.\(^53\) Among the British nominations that came forward from the UK’s regional culture of excellence since 1935—after Loewi’s consecutive visits to Oxford and London—encouraged by his German–Austrian mentor Hans H. Meyer, in 1902, 1910 and 1928, his English collaborator and life-long friend Dale enticed Sherrington, Hill and Adrian in 1935 to nominate Loewi. Two additional high-standing physiologists, Walter Langdon Brown (1870–1946)—then Regius Professor of Medicine at Cambridge—and Frederic Gowland Hopkins (1861–1947)—then President of the Royal Society—joined in that nomination. Both had previously worked on neurophysiological topics in Dale’s laboratory in 1933–34,\(^54\) and they wrote letters in support following their colleague’s lead.\(^55\) In 1936, chemist George Barger (1878–1939) from the University of Edinburgh seconded Dale as an additional nominee,\(^56\) as did other eminent British neurophysiologists, who wrote letters for their compatriot Dale.\(^57\) The latter nominated Loewi that year again, and emphasized his contributions in understanding the chemical nature of synaptic transmission, which led to Dale and Loewi sharing the 1936 Nobel Prize in Physiology or Medicine for their insights into the chemical nature of acetylcholine action secreted in the vagus nerve and a substance related to adrenalin in the sympathetic nerves.\(^58\)

American neuropsychologist Elliot S. Valenstein has further emphasized that those neurophysiologists who did not nominate Loewi for the Nobel Prize were as important as those who did.\(^59\) Although Nobel awardees generally receive substantial nominations from

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52 Gerald L. Geison, ‘Scientific change, emerging specialities, and research schools’, Hist. Sci. 19, 20–40, especially 33–34 (1981).
53 Stanley Finger, Minds behind the brain: a history of the pioneers and their discoveries (Oxford University Press, New York, 2000), pp. 259–279.
54 Gerald L. Geison, Michael Foster and the Cambridge School of Physiology: the scientific enterprise in late Victorian society (Princeton University Press, Princeton, NJ, 1978), pp. 5–6.
55 Nomination of Dale and Loewi by Brown 1935, https://www.nobelprize.org/nomination/archive/show.php?id=13386 (accessed 7 December 2021); Nomination Hopkins 1935, https://www.nobelprize.org/nomination/archive/show.php?id=14004 (accessed 7 December 2021).
56 Loewi, op. cit. (note 39).
57 Valenstein, op. cit. (note 43), pp. 87–88.
58 Nomination of Loewi by Dale 1936, https://www.nobelprize.org/nomination/archive/show.php?id=12951 (accessed 6 December 2021).
59 Valenstein, op. cit. (note 43), pp. 85–87.
their home countries, after the seizure of power by the Nazi Party no neurophysiologists from Germany and no colleagues of Loewi at the University of Graz were willing to nominate him in an increasingly anti-Semitic climate in the academy. Only two Austrians wrote and submitted their nomination letters, namely the pharmacologists Ernst Theodor von Brücke (1880–1941) at the University of Innsbruck, who nominated him in 1927, 1932 and 1936, as well as Hans H. Meyer (1853–1939) at the University of Vienna, who sent in a nomination letter in 1936.60

Loewi had established a laboratory-based method for examining synaptic transmission, which led him to reject an interpretation that electrical current waves moved from nerve axons to individual muscles. After having experimentally removed a frog’s heart and electrically stimulated its vagus nerve, he extracted the surrounding electrolytic solution and transferred it to another explanted heart, which could be stimulated to beat again by what he perceived as a humoral mechanism (Vagusstoff).61 He also needed to counter early criticisms regarding his work on the nature and importance of the functioning of transmitters in the sympathetic nervous system. These criticisms targeted what was seen as the vague understanding of receptors in the scientific community, which led to multiple research responses from Loewi helping to consolidate him as a leading neurophysiologist.62 Only two years after his Nobel award, the German Wehrmacht annexed Austria and the Law for the Restoration of the Professional Civil Service also extended its legal area of application.63 On the very day of the Anschluss, Loewi was sent to prison. After he was released from captivity, he had to agree to hand over all of his property to Nazi officials, which even included his Nobel Prize money. Loewi could not carry previous research materials with him into exile, apart from his last data regarding a Vagusstoff experiment that he scribbled on a postcard that a prison guard allowed him to write on.64 In 1940, Loewi, who was accompanied by his wife Guida Goldschmiedt (1889–1958), reached New York—after a first stint as refugees in London. However, on reaching the USA on board the RMS Mauretania, he debarked without the address of a contact person.65 A consular official denied him entry into the USA on the grounds that Loewi appeared unable to present his dismissal letter from Graz University to prove that he had held a previous teaching position. After the Atlantic passage, Loewi handed his sealed envelope to the immigration officer and could not believe his eyes:

Upon my arrival in New York harbor, a clerk prepared my papers for the immigration officer. While he was busy doing this, I glanced over the doctor’s certificate—and almost fainted. I read: ‘Senility, not able to earn a living.’ I saw myself sent to Ellis Island and shipped back to Mr. [Adolf] Hitler [1889–1945]. The immigration officer fortunately disregarded the certificate and welcomed me to this country.66

60 Loewi Nomination 1936, https://www.nobelprize.org/nomination/archive/show.php?id=12375 (accessed 5 December 2021); Loewi Nomination 1936, https://www.nobelprize.org/nomination/archive/show.php?id=12679 (accessed 5 December 2021).
61 Bilal Haider, ‘The war of the soups and the sparks: the discovery of neurotransmitters and the dispute over how nerves communicate’, Yale J. Biol. Med. 80, 138–139 (2007).
62 Valenstein, op. cit. (note 43), pp. 57–66.
63 Lawrence A. Zeidman, Brain science under the Swastika: ethical violations, resistance, and victimization of neuroscientists in Nazi Europe (Oxford University Press, New York, 2020), at p. 294.
64 Frank W. Stahnisch, ‘Learning soft skills the hard way: historiographical considerations on the cultural adjustment process of German-speaking émigré neuroscientists in Canada, 1933 to 1963’, J. Hist. Neurosci. 25, 299–319 (2016), at pp. 306–307.
65 Frank W. Stahnisch, ‘How the nerves reached the muscle: Bernard Katz, Stephen W. Kuffler, and John C. Eccles—certain implications of exile for the development of twentieth-century neurophysiology’, J. Hist. Neurosci. 26, 351–384 (2017), especially pp. 377–378.
66 Otto Loewi, ‘The excitement of a life in science’, in A dozen doctors—autobiographical sketches (ed. Dwight J. Ingle), pp. 109–126 (University of Chicago Press, Chicago, 1963), at p. 119.
Although émigré neuroscientists also had positive experiences of help through third parties in their new host countries, the challenges in their working lives as well as the social and practical resources they mobilized tell us more about the situated knowledge communities in which incoming researchers found themselves overseas. This was particularly true for those who were greeted by an anti-German and often anti-Semitic climate. Many met with their exclusion from the job market or facing misunderstandings as to what their previous positions had entailed. Driven by their need to find support and allies, émigrés would seek out their compatriots in the same neighbourhoods, e.g. New York’s Lower East Side in the case of Otto and Guida Loewi. In his Autobiographical sketch—despite recognizing methodological limitations that a ‘retrospective report may not always truly reflect the past as it happened’, Loewi emphasized the challenges that he and other émigré scientists faced when needing to provide copies of certificates, teaching credentials and medical licences, while his exchanges with the American Consul in London did not lead to the completion of his required paperwork. Loewi, like many émigrés, had to leave original documents behind in Austria when fleeing from the Nazis. And so he could not provide them to the Consul, who also refused to accept an oral reference from Dale, whom he discounted as not being a government representative. Loewi’s entry as a Nobel Prize laureate in the American Who’s who, which he had originally penned himself, at least permitted his embarkment on the trans-Atlantic steam liner.

After being allowed to enter the USA, between 1940 and 1955 Loewi worked at New York University (NYU) on his previous research problems, building on personal connections—such as the invitation through experimental physiologist Jacques Loeb (1859–1924) at the Rockefeller Institute for Medical Research—from a former research stay in the 1920s, which led to new mutual research with sea animals at the Marine Biological Laboratory in Woods Hole. Loewi and his wife resided multiple times at the Marine Biological Laboratory, while Guida took up an active role in cultivating a social network with other émigrés and American scientists, such as Walter B. Cannon (1871–1945) and Arturo Rosenblueth (1900–1970) from Harvard University in Cambridge, MA. It is interesting to see how Loewi reciprocated for the support received, when later generously assisting his new American colleagues and friends with their Nobel Prize nominations. Loewi died in 1961, just short of his ninetieth birthday, following a bad fall causing injuries to his thorax. His sustained contributions in laboratories, to education within the experimental programmes in biomedicine, as well as the network-building with other émigré neurophysiologists contributed to a rebalancing of international leadership in the brain sciences. As Belgian physiologist and radiologist Zénon M. Bacq (1903–1983) had argued, Europe had previously

67 Irving Abella and Harold Troper, None is too many: Canada and the Jews of Europe, 1933–1948 (University of Toronto Press, Toronto, 1983), pp. 93–99.
68 Fred Kaufmann, Searching for justice: an autobiography (University of Toronto Press, Toronto, 2005), pp. 45–56.
69 Hans-Joachim Lang, ‘Spaete Reise zu den Erben. Universitaetsbibliothek Tuebingen gibt nach 63 Jahren Privatbibliothek zurück’, Aufbau. Jued. Leben 13, 18 (2001).
70 Loewi, op. cit. (note 35), pp. 3 and 21–22.
71 Philip Pauly, Controlling life—Jacques Loeb and the engineering ideal in biology (Oxford University Press, Oxford, 1987), pp. 48–56.
72 See, for example, nominations by Loewi of Walter B. Cannon 1942, https://www.nobelprize.org/nomination/archive/show.php?id=10606 (accessed 18 April 2021), and 1945, https://www.nobelprize.org/nomination/archive/show.php?id=6749 (accessed 18 April 2021).
73 George H. Bishop and Ram Nath Chopra, The excitement and fascination of science: a collection of autobiographical essays (Annual Review, Palo Alto, CA, 1965), pp. 269–278.
led experimental research on chemical transmission and neuropharmacology. Bacq then contrasted the international symposium on chemical transmission in Philadelphia, 10–11 September 1953—which was exclusively led by Europeans and émigré academics—with the First International Catecholamine Symposium held in Bethesda, Maryland in 1958. At the latter symposium Loewi also presided over panels, while American neurophysiologists and neuropharmacologists now started to prevail. It is apparent that most of Loewi’s major awards were given out after his Nobel Prize of 1935, such as the Edinburgh Cameron Prize for Therapeutics in 1944, and his Foreign Membership of the Royal Society of London in 1954, along with his Membership in the American Academy of Arts and Sciences in 1959. This development demonstrated that being a Nobel laureate did function as an ‘academic door-opener’ for him. Loewi had been forced to leave Austria around the official retirement age, and thus with a remarkable stock of social capital:

Because of the age limit, even under normal political conditions I would have been obliged to metamorphose from an active to a retired professor [in Graz]. As such, one frequently is invited or allowed to stay as a permanent guest in a corner of an institute. … Therefore, I am happy and deeply grateful to the fate that transported me to this country, my new homeland, and to this unique city, where I continue to enjoy the stimulating, almost rejuvenating influence in new friendships.

He had rejoiced at the chance to emigrate to the USA in his autobiographical sketch in 1960, since it provided him with the opportunity to prolong his productive career, well beyond what he could have done in Austria, implying that existential displacement spared him the fate of scholarly displacement. In terms of different cultures of excellence, his example represents a case of reconnection with previous work relationships abroad, in this instance at Dale’s laboratory at UCL in London and in relation to colleagues in neurophysiology at Oxford University. Although it was a coincidence that Dale was acquainted with Hill and William Beveridge (1879–1963), who both served on the council of the AAC, Loewi could rely on his previous contacts:

I am one of those lucky people from abroad who right from the outset could continue here the work they had to abandon in the country they had considered to be their homeland.

This network further helped him with his onward migration to the USA from the UK, in addition to the global recognition for his accomplishments since his participation in the 1929 International Congress of Physiology, at the invitation of Harvard physiologist Cannon. The same could be stressed regarding his collection of accolades from excellent science associations, in which many of his former colleagues in British neurophysiology, such as Nobel laureates Dale, Adrian and Sherrington, were engaged and had assumed leadership positions, such as the National Institute of Medical Research, the AAC and the Royal Society.

74 Zénon M. Bacq, Chemical transmission of nerve impulses: a historical sketch (Pergamon Press, Oxford, 1974), pp. 91–93.
75 Loewi, op. cit. (note 35), p. 25.
76 Henry H. Dale, ‘Otto Loewi, 1873–1961’, Biogr. Mems Fell. R. Soc. Lond. 8, 67–89 (1962).
77 Loewi, op. cit. (note 35), p. 23.
78 Laurel Leff, Well worth saving: American universities’ life-and-death decisions on refugees from Nazi Europe (Yale University Press, New Haven, CT, 2019), p. 64.
The changes in the organizational frameworks of the German-speaking healthcare system from the Weimar Republic into the Nazi period created a compelling influence on neurophysiologist Bernard Katz from Leipzig. He represents an example from neurophysiology in which methodological advances were consequentially transitioned from Germany to England, while he functioned astutely in the context of his new host country. Contemporary researchers hardly liberated themselves from the social conditions of their time, but were socially embedded in their specific environments, a development that is noteworthy in the emigration stories of both Loewi and Katz. Katz’s emigration story can be seen as a sui generis middle way from the scientific traditions of the German-speaking brain sciences, through the adaptation challenges to the empirically minded laboratory work in England, which he noted he would not have overcome without his relatives: ‘And I wrote to my relatives in London who promised to help me in getting my British visa, and who did much more than that when I arrived in England. Without their support, I would not have been able even to cross the English Channel.’

During the first decades of the past century, the neurophysiology of the nerve–muscle connection became increasingly better understood. It is to this knowledge of the delicate interaction between the nerves and the muscles that Katz contributed in the regional knowledge economy of the Anglo-American sphere. Katz’s specific take on the nerve–muscle junction can be wholly related to his British research experience, where the ‘war of the soups and the sparks’ was at its pinnacle and where he demonstrated also that resting state neurons continued to release small amounts of acetylcholine. This was so despite the fact that these quanta were not enough to trigger muscle responses, while still being important for upholding synaptic interaction. In 1938, he furthered contemporary views on chemical synaptic transmission through investigating the nature of the endplate potential, opposing the electrical transmission hypothesis. To appreciate the conversions of the research pathways, it is beneficial to introduce briefly his biography and the story of the development of his laboratory programme.

Katz was born in Leipzig in 1911 and grew up in a merchant family that had emigrated to Imperial Germany from Mogilew in Russia. His parents encouraged him to study medicine and he went to the University of Leipzig between 1929 and 1934. Here, Katz became interested in philosophical questions raised by historians of medicine Henry E. Sigerist (1891–1957) and Owsei Temkin (1902–2002), who were well-known public intellectuals.

79 W. Maxwell Cowan, Donald H. Harter and Eric R. Kandel, ‘The emergence of modern neuroscience: some implications for neurology and psychiatry’, *Annu. Rev. Neurosci.* 23, 343–391 (2000).
80 Stahnisch, *op. cit.* (note 15), pp. 291–298.
81 Bernard Katz, ‘Sir Bernard Katz’, in *The history of neuroscience in autobiography*, vol. 1 (ed. Larry R. Squire), pp. 348–381 (Society for Neuroscience, Washington DC, 1996), especially p. 369.
82 Smith Ely Jelliffe, Arthur S. Link and Leila M. Mendelson (eds), *Fifty years of American neurology: an historical perspective* (Stratford Books, Winston Salem, NC, 1998), 33–79.
83 Valenstein, *op. cit.* (note 43), pp. 65–67.
84 Katz, *op. cit.* (note 81), pp. 364–376.
85 Horst Riedel, ‘Katz, Bernard Sir’, in *Stadtlexikon Leipzig von A bis Z*, 1st edn (ed. Horst Riedel), p. 286 (Pro Leipzig, Leipzig, 2005).
86 Owsei Temkin, ‘Introduction’, in *The double face of Janus—and other essays in the history of medicine* (ed. O. Temkin), pp. 3–37 (Johns Hopkins University Press, Baltimore, 1977).
Katz’s research, however, was completed at the Institute of Physiology, where he graduated with a medical degree in 1934—only one year after the Nazi Party had seized power:

I was attracted to neurophysiology at an early stage, from about 1930 onward. In those days, the establishment of the laws of electric excitation of nerve, and their precise mathematical formulation were regarded as a great thing.87

His neurophysiological thesis was supervised by Georg Eduard Martin Gildemeister (1876–1943), who investigated the functions of sensitive nerves. Although most displaced scholars who had lost their academic positions after 1933 were barred from editorial roles, Katz as a stateless researcher could still continue publishing his own research results as articles in Pflueger’s Archiv der gesamten Physiologie des Menschen und der Tiere and Journal of Physiology prior to his emigration to the UK.88 Gildemeister vehemently advocated against the injustice that Katz was refused the award money for the annual prize named after physiologist Siegfried Garten (1871–1923) owing to anti-Semitic tendencies in the faculty.89 This award constituted the beginning of multiple accolades bestowed on Katz, awards that framed his outstanding scientific career, including a Beit Memorial Fellowship, the pre-eminent junior research award in the biomedical sciences in the UK in 1939. This latter award further launched his career as a physiologist in England,90 being awarded the Copley Medal of the Royal Society in 1967, and receiving a knighthood in 1969, and the Ralph W. Gerard Prize in 1990 from the Society for Neuroscience.91

It is remarkable that even before his emigration from Germany, Katz could still receive the Garten Prize despite the hostile political climate. The fact that the submission was made anonymously had helped him circumvent new anti-Semitic resentments.92 Yet these hostilities in Nazi Germany kept coming, including the difficult situation around the publication of his first textbook, Electric excitation of nerve: a review.93 His earlier connection with Hill’s excitation theory in Britain had led to the commissioning of a lengthy review on the topic, in 1938, through the Bern medicine professor Leon Asher (1865–1943), who then edited the German journal Ergebnisse der Physiologie.94 However, the Nazi authorities intervened since the journal’s publishing house, J. F. Bergmann, had its headquarters in Wiesbaden, Hesse—and thus not in Switzerland. They withheld the permission for the review to appear, demanding that at least one Aryan co-author needed to be included, which caused Katz’s vivid protest and retraction of the manuscript. He subsequently demanded the manuscript be returned to him, augmented it further, and had it translated into English so that it could appear with Oxford University Press during the month that World War II broke out.95 Until 1935, nonetheless, Katz had still been able to

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87 Katz, op. cit. (note 81), p. 364.
88 Bernard Katz, ‘Jahreszeitliche Einflüsse auf Permeabilitäts und Stoffwechsel des Kaltblüttermuskels’, Pflueger’s Arch. Ges. Physiol. Mensch. Tiere Kreatinwirkung am Froschmuskel 234, 492–509 (1934); Bernard Katz, ‘Neuro-muscular transmission in crabs’, J. Physiol. 87, 199–221 (1936).
89 Axel Karenberg, ‘Neurosciences and the Third Reich’, J. Hist. Neurosci. 15, 168–172, at pp. 168–169.
90 Canadian neurosurgeon Wilder Penfield (1891–1976), who is discussed in Gavrus, op. cit. (note 13), pp. 6–8, likewise emphasized the importance of practical and identity-related reasons in accepting multiple academic awards, which helped to launch and sustain his outstanding career as an academic neurosurgeon.
91 Katz, op. cit. (note 81), p. 349.
92 Burkhardt Weiss, Peter Friess and Peter Steiner (eds), Forschung und Technik in Deutschland nach 1945 (Deutsches Museum Bonn, Deutscher Kunstverlag, Munich, 1995), pp. 76–90.
93 Bernard Katz, Electric excitation of nerve: a review (Oxford University Press, Oxford, 1939).
94 Katz, op. cit. (note 81), pp. 374f.
95 Bert Sakmann, ‘Sir Bernard Katz: 26 March 1911–20 April 2003’, Biogr. Mems Fell. R. Soc. 53, 185–202 (2007), at p. 190.
aid Jewish patients as a ‘health practitioner’ (Krankenbehandler) in Leipzig, despite the prohibitions that removed all Jewish physicians from state-funded positions. The most lasting influence that any Leipzig professor exerted on Katz was that of Friedrich Hund (1896–1997), who became renowned in atomic physics. When the political situation deteriorated further, Katz presaged the need to flee to England. In the initial stages of his emigration, he was aided by Zionist leader Chaim Weizmann (1874–1952). Physiologist Hill facilitated the offer of a fellowship at UCL, and Katz formed his main hypothesis about neuromuscular interactions in London, a hypothesis that would come to define most of his experimental work. The acetylcholine hypothesis of chemical transmission at the neuromuscular junction had been known since the experiments by Loewi and by Dale in the 1930s, whereas Katz based his consecutive work on the recognized effects of acetylcholine esterase inhibitors regarding the processes of neuromuscular transmission.

Without sufficient knowledge regarding the tissue excitability and local axonal circuits, it was impossible to make reliable quantitative predictions regarding electrical signals following the connotation established by Hodgkin. With the outbreak of World War II, Katz decided to join John C. Eccles’ (1903–1997) laboratory at the elite Kanematsu Memorial Institute of Pathology in Australia, his move being aided by a fellowship from the Carnegie Foundation. This led to increased international collaborations in neuromuscular research. One year later, Katz met Austrian émigré Stephen W. Kuffler (1913–1980), who had also arrived in Australia, and they developed a lasting friendship. In Eccles’ laboratory, Kuffler began to conduct his own experiments on the nerve–muscle junction, which Katz called ‘a brilliant technical feat [that] immediately and deservedly put him on the map’.

In 1941, Katz, who had been stateless ever since the flight of his parents from the Russian pogroms at the beginning of the century, applied for British naturalization. In his autobiographical interview in 1996 he emphasized that, as bureaucratically difficult as it was, this status made it ‘much easier to tear up my few shallow roots that remained in Germany, the country of my birth, and to strike new roots in England in 1935’. In 1942, accordingly, he joined the Royal Australian Air Force in the Pacific theatre of war. It is amazing to observe that Katz even wrote up research en route from London, while cruising the Pacific on a reconnaissance ship. He dispatched his manuscripts via

96 Michael I. Shevell, ‘Neurosciences in the Third Reich: from ivory tower to death camps’, Can. J. Neurol. Sci., 26, 132–138 (1999), at p. 133.
97 Sakmann, op. cit. (note 95), pp. 193–199.
98 Ibid., p. 191.
99 Bernard Katz and Otto H. Schmitt, ‘Electric interaction between two adjacent nerve fibres’, J. Physiol. 97, 471–488 (1940), at p. 471.
100 Alan Hodgkin, ‘Evidence for electrical transmission in nerve: part I’, J. Physiol. 90, 183–210; Alan Hodgkin, ‘Evidence for electrical transmission in nerve: part II’, J. Physiol. 90, 211–232 (1937); Alan Hodgkin, ‘The subthreshold potentials in a crustacean nerve fibre’, Proc. R. Soc. Lond. B 126, 87–121 (1938).
101 Ronald Winton, Kanematsu’s great gift: the story of the Kanematsu Memorial Institute at Sydney Hospital (Kanematsu Fund, North Parramatta, NSW, 1997), pp. 37–40.
102 Kandel, op. cit. (note 29), pp. 94f.
103 Stephen W. Kuffler, ‘Transmitter mechanism at the nerve–muscle junction’, Arch. Sci. Physiol. 3, 585–601 (1949).
104 Bernard Katz, ‘Stephen William Kuffler: 24 August 1913–11 October 1980’, Biogr. Mens Fell. R. Soc. Lond. 28, 224–259 (1982), at p. 225; Katz, op. cit. (note 81), pp. 377–379.
105 Society for the Protection of Science and Learning, correspondence related to individual scholars, file Bernhard Katz, I.20.18 Physiology, MSS S.P.S.L., pp. 416–419, Bodleian Library, Oxford.
106 Katz, op. cit. (note 81), p. 352.
107 Sakmann, op. cit. (note 95), p. 191.
telegram, giving his affiliation as ‘Australian Battleship—somewhere in the Pacific, 1942’.  

In 1945, Katz travelled back to England, where he worked as a research director in Hill’s unit, to investigate inhibition phenomena in frog muscle–nerve preparations. Another Nobel laureate (1991), biophysicist Bert Sakmann from the Max Planck Society (MPS), visited Katz in 1991–94, relating:

I got to know Bernard Katz personally at a conference [in 1971], where he presented in simple terms what he had discovered; it was the quantal hypothesis of transmitter release, and it was at a conference in Varenna [on Lake Como, Italy] …. I never actually worked with [Katz], though. Manuscripts by postdocs were handed in, Katz corrected them and so on. … Katz told me later, during one of my visits to London, that recording single channel currents was one thing he [would have] liked to have done himself. … Because of Bernard Katz’s influence, I was accepted into all sorts of societies, including the Royal Society and Pour le Mérite, etc.111

It is evident in the interview that Sakmann’s own research was partly fostered through his acquaintance with the Nobel laureate Katz. Of perhaps even more interest to the historian of science, however, is the fact that both of their careers appear as an example of the extant Central European practice of acknowledging scientific excellence through mentorship relations and networks of contacts between younger scientists as protegées of established ones (a process of recognition per patrocinium). Personal relationships of scientific recognition ensued, similar to Hund’s mentorship of Katz in Germany or later Hill’s in England:

Katz had left Germany as a young researcher immediately after his graduation, and, as a stateless refugee who became a British national during World War II he excelled in the supportive research context he found in the UK.114 He adjusted well to British research and academic culture, whose regional knowledge economy he had experienced as a young investigator, while needing to find ways for making himself valuable through his neurophysiology work. Based on his scientific proof that endplate currents could by themselves initiate muscle action potentials, he was appointed as Henry Head Research

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108 Bernard Katz and Otto H. Schmitt, ‘A note on interaction between nerve fibres’, J. Physiol. 100, 369–371 (1942), p. 369.
109 Marks et al., op. cit. (note 49), pp. 59–76.
110 Bernard Katz, ‘Quantal mechanisms of neural transmitter release’, Science 173, 123–126 (1971).
111 Bert Sakmann and Frank W. Stahnisch, ‘Neuroscience history interview with Professor Bert Sakmann, Nobel Laureate in Physiology or Medicine (1991), Max Planck Society, Germany’, J. Hist. Neurosci. (2022) (doi:10.1080/0964704X.2021.1898903) (including excerpts from English translation of the original interview conducted in German in Munich, 2017), at p. 13.
112 This was an unusual ‘protection’, based on their physiological research acquaintance—see Katz, op. cit. (note 81), pp. 365–366. Achelis was a Nazi researcher and dean at the University of Heidelberg during World War II; Wolfgang U. Eckart, Volker Sellin and Elke Wolgast (eds), Die Universitaet Heidelberg im Nationalsozialismus (Springer Medizin Verlag, Heidelberg, 2006), pp. 671–695.
113 Sakmann and Stahnisch, op. cit. (note 111), p. 15.
114 Frank W. Stahnisch and Guel Russell (eds), Forced migration in the history of 20th century neuroscience and psychiatry—new perspectives (Routledge, London, 2016), pp. 10–11, 57, 84 and 87.
Fellow and taught as a Reader in Physiology at UCL, where he was promoted to professor in 1952. Katz was elected as a Fellow of the Royal College of Physicians in 1968 and became a Foreign Member of the Royal Danish Academy of Sciences and Letters in 1968, as well as the American Academy of Arts and Sciences in 1969. Together with Ulf von Euler (1905–1983) in Sweden and Julius Axelrod (1912–2004) in the USA, he received the Nobel Prize in Physiology or Medicine in 1970 for contributions to the functional mechanism of synaptic transmission. Thus, instances of a bilateral knowledge transfer between Germany and the UK were greatly visible in Katz’s emigration story. His outstanding merits were enhanced through the connections built under the influence of the German-speaking and the British neurophysiology cultures as a bilateral knowledge transfer during the post-war period. While he only submitted to British and American journals well into the 1950s, in a scholarly landscape that had become second nature to him, he continued publishing several of his textbooks such as *Nerv, Muskel und Synapse* and a few articles also in the German language.

One additional feature of Katz’s career was his connection to the post-reunification culture of excellence in Germany. Both the Federal Republic of Germany and the German Democratic Republic (GDR) had tried to reinvigorate their international reputation by contacting former refugees abroad to offer them membership to societies of advanced research, such as the MPS, and honorary medals, as well as low-paying academic prizes, while failing to provide salaried visiting positions or lucrative financial recompense. Since German reunification, a greater development of internationalization, reconciliation, and scholarly approaches began actively to tackle the history and legacy of the former period of forced migration. In Katz’s case, such endeavours led to his receiving an honorary doctorate in 1990 from the University of Leipzig’s medical faculty in the GDR, acknowledging his outrageous expulsion from his university position five decades before. A bronze plaque was installed in the garden of the University Hospital by the alumni *Bund der Albertiner* from his high school. A street in Leipzig has also been named after him. Yet despite the commemoration of his productive years, which reciprocally reflected well upon the university’s renown, Katz encountered substantial obstacles to receiving financial recompense for his losses during the Nazi period.

**KANDEL—TRAINING CONTEXTS AND THE EMERGENCE OF A NEW PARADIGM**

With respect to the cultural resources of émigré neurophysiologists, the case of the millennium Nobel laureate Kandel reveals intriguing factors that allowed these new émigrés to ‘fall on their academic feet’ after entering the domain of overseas psychiatry and neurology. Kandel was an Austrian-born neurophysiologist, who received his advanced academic education in

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115 Sakmann, op. cit. (note 95), pp. 201–202.
116 Bernard Katz, *Nerv, Muskel und Synapse: Einfuehrung in die Elektrophysiologie* (Thieme, Stuttgart, 1971); Bernard Katz, ‘Erwiderung von B. Katz’, in Orden Pour Le Mérite fuer Wissenschaften und Kuenste: Öffentliche Sitzung in der Aula der Universitaet Bonn, 31 Mai 1983, Reden und Gedenkworte: Uebergabe der Ordenszeichen durch den Ordenskanzler an Hendrik B. G. Casimir, Sir Bernard Katz (ed. Ernst Kitzinger), pp. 73–79 (Bonn, 1983); Bernard Katz, ‘Hirnforschung am Frosch’, *Natwiss. Rundsch.* 10, 405–410 (1985).
117 Frank W. Stahnisch, ‘Karl T. Neubuerger (1890–1972)’, *J. Neurol.* 265, 1493–1495.
118 Reinhard Rueupr and Michael Schuering, *Schicksale und Karrieren: Gedenkbuch fuer die von den Nationalsozialisten aus der Kaiser-Wilhelm-Gesellschaft vertriebenen Forscherinnen und Forscher* (Wallstein Verlag, Goettingen, 2008), pp. 383–458.
119 Sakmann, op. cit. (note 95), pp. 198–199.
120 Kandel, op. cit. (note 29), pp. 43–50.
New York. In terms of different biographical temporalities, he belonged to the next generation of émigrés, a generation that had arrived in their host countries as adolescents and finished their education abroad. He was born the son of a shopkeeper in November 1929 at the beginning of the Great Depression. His childhood was still touched by the intellectual culture that the Habsburg Empire had left behind in its former capital. Yet with Hitler’s march into Vienna on 12 March 1938, the same race laws that had been in existence in Germany also led to the suppression of Jews in public life, prompting the Kandel family to flee their home country. They eventually emigrated to New York with a document signed by an American guarantor.

It is intriguing that Kandel has emphasized in his autobiography that he chose medicine to become a clinical psychoanalyst owing to the influences of the Kris family. He had befriended a fellow student, Anna Kris (1931–2019), from a familiar émigré circle, and perhaps owing to her parents, Ernst Kris (1900–1957) and Marianne Kris-Rie (1900–1980), being prominent psychoanalysts, Kandel changed his mind and studied medicine at NYU. His own reaction to reading Sigmund Freud (1856–1939) in German is revealing of his relation to his former home country, which he described as having awakened ‘a yearning for the intellectual life’ of Vienna. He even traced his interest in the biochemical aspects of memory to his exposure to Freud’s psychoanalysis as well as its social contours in cultural discussions:

What gave Freud’s new model a dramatic turn was the three interacting psychic agencies. Freud did not define the ego, the id, and the superego as either conscious or unconscious, but as differing in cognitive style, goal, and function. … Although Freud did not intend his diagram to be a neuroanatomical map of mind, it stimulated me [Kandel] to wonder where in the elaborated folds of the human brain these psychic agencies might live.

In similar ways, other émigré neurophysiologists related their orientation in neurology or psychiatry to their previous experiences in their home countries, before they were eventually driven out of Germany, Austria and the neighbouring countries. Following his graduation from Erasmus Hall high school in Brooklyn, Kandel entered several elite US academic institutions, such as Harvard College in 1944. The émigré context of the Kris family and of other Jewish academic refugees in New York also led to his decision to pursue a career in medicine, following his undergraduate studies in literature, in a US context in which clinical psychoanalysis had become the dominating approach to the study of the mind. Also, this development had been driven by European émigrés, while Kandel was exposed to their influence in his immediate social context and to that of many other American scholars of his generation.

With the aim of becoming a clinical psychiatrist, he next approached another German-speaking émigré from Belarus, Harry Grundfest (1904–1983), who was by then a neurology professor at Columbia University. Kandel initially had the idea of learning more
about the ‘biological underpinnings of psychoanalytical memory theory’, something that, to the Columbia-trained neurologist Grundfest, seemed an impossible project. It is likely that their different upbringings, despite their similar emigration age, also influenced their epistemological outlook and their later career orientations—Kandel’s education in Vienna and in New York’s biomedical and psychoanalytical milieu, compared with Grundfest’s traditional views from Minsk and Belarus esteemed by his father, the Ashkenazi rabbi Aaron Grundfest (1873–1931).128 The elective period with Grundfest was crucial for Kandel’s academic development.129 It was a cathartic experience for him when he was forced to admit that it was rather difficult to reduce psychoanalytic theory to neurophysiology. New historical circumstances changed his career path further, when the outbreak of the Korean War (1950–1953) brought him into the NIH, where medical research was accepted as an alternative service. The post-war founding of the NIH in 1948 shortly before, and the work conducted on mental health since the 1950s, became landmark events that shaped this phase of transformations in the brain sciences.130 Conversely, there were now job opportunities for many émigré doctors, once they had been relicensed to work in US institutions.

Eventually Kandel was accepted by the neurophysiologist Wade Marshall (1907–1972) to work in his laboratory from 1957 to 1960. At the beginning of the 1950s, the NIH rapidly emerged as one of the liveliest locales for biomedical research.131 This attracted many aspiring visitors to reside in Bethesda for some time, while the milieu brought Kandel into contact with many leading researchers. Among them were: the émigré neurophysiologist Karl Frank (1916–1993), who pioneered intracellular neuronal recordings; Alden Spencer (1931–1977), who worked on hippocampus physiology; and the prolific Japanese–American biophysicist Ichiji Tasaki (1910–2009).132 Kandel’s scientific pedigree at elite research institutions in America certainly aided in the application and designation processes of the numerous awards, nourishing his outstanding career and leading towards the receipt of the Nobel Prize. These included some of the most outstanding recognitions of excellence for Kandel in the biomedical sciences in the USA: Fellowship of the American Academy of Arts and Sciences in 1976, the Albert Lasker Award for Basic Medical Research in 1983, the Canadian Gairdner Foundation Award in 1987, the National Medal of Science in 1988, and the Ralph W. Gerard Prize in Neuroscience in 1997, which also paved the way for his Nobel Prize in 2000.133

Marshall, as Kandel’s supervisor, was the chief of neurophysiology and was mostly interested in mapping the functional organization of the human cortex. The spirit of biological reductionism in Bethesda proved to be very influential for Kandel too; he began his programme on the study of learning mechanisms and identified Aplysia as his main research model.134 These contingent though beneficial career situations were driven by multiple contextual political developments and they deeply influenced Kandel’s conceptualization of cellular neurophysiology.135 The seemingly sequential continuation of

128 Stahnisch, op. cit. (note 15), pp. 263–265; John P. Reuben, ‘Harry Grundfest 1904–1983’, Biogr. Mems Natl Acad. Sci. USA 65, 150–167 (1995).
129 Reuben, op. cit. (note 128), p. 152.
130 Hollingsworth, op. cit. (note 28), pp. 17–20.
131 Buhm Soon Park, ‘The development of the intramural research program at the National Institutes of Health after World War II’, Persp. Biol. Med. 46, 383–402 (2003).
132 Magoun, op. cit. (note 26), p. 155.
133 Joan Arehart-Treichel, ‘Lasker Award: passport to a Nobel Prize?’, Sci. News 102, 365–366 (1972).
134 Kandel, op. cit. (note 29), pp. 165–178.
135 Eric R. Kandel and James H. Schwartz, Principles of neural science (Elsevier, New York, 1981), pp. 7–10.
his programme of research on investigation of memory in mice would likely not have turned out as well as it did, if the NIH had not emerged as such a catalyst in biomedical research and recognition of excellence. Culturally socialized in Vienna, Kandel’s childhood experiences in his home country gave rise to ‘a fascination with memory, a fascination that focused first on history and psychoanalysis, then on the biology of the brain, and finally on the cellular and molecular processes of memory’.136 His academic life-trajectory, from fin de siècle Vienna to his research into identifiable neurons in Aplysia, also influenced his position towards the powerful community of psychoanalysts in the USA, to which he had been drawn, as he personally emphasizes in his own autobiographical writing.137

After he immigrated to the USA, having received his continuing education at Erasmus Hall High School in Brooklyn, New York, Kandel developed an exceptionally prolific career, which was to a large extent a reflection of the prominence of American research institutions. Certainly, the intensity of scientific exchanges, the culture of political liberalism on campuses in his new host country, and the post-war technological progress helped this transition and offered insight into his own understanding of the varied professional practices he experienced as he moved, each set of protocols marked by their respective contexts of time and culture:

Freud’s theorizing, [Arthur] Schnitzler’s [1862–1931] writings, and the paintings of [Gustav] Klimt [1862–1918], [Egon] Schiele [1890–1918], and [Oskar] Kokoschka [1886–1980] had a common insight into the nature of human instinctual life. During the period of 1890 to 1918, the insights of these five men into the irrationality of everyday life helped Vienna to become the center of modernist thought and culture. We still live in that culture today.138

The culture of home countries exerted a profound effect on émigrés’ scientific lives, and this was quite noticeable to them, whether they were forced to leave Frankfurt, Graz, Leipzig or Vienna. They soon realized, in new places, that forms of research organization, scientific conduct, and new investigative methods overseas could be very different from those they were accustomed to. In Kandel’s specific case, his own academic studies as a young investigator in the USA occurred at a time when the confrontation between psychoanalysis and biological psychiatry was at its height, as both movements were rather strong there.139 Sometimes this engendered open scientific conflicts, such as the one between psychoanalysis and somatic biological paradigms; Kandel first experienced this in the milieu of clinical psychoanalysts in his family and the community of Jewish émigrés in New York, and later in the elite biomedical research institutions in which he worked. Many professional immigrants strove to sustain their families, and it was often necessary for them to accept positions in healthcare and clinical work to guarantee their continued survival.140

It is not possible here to elaborate on the meandering development of Kandel’s work stints at Harvard University, NYU and Columbia.141 Nevertheless, what becomes clear is the deep impact that major political developments had on his work in cellular neurophysiology, from his entering the field through psychoanalysis, through the finding of his main biological

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136 Kandel, op. cit. (note 29), p. xv.
137 Kandel, op. cit. (note 126), pp. 1028–1029; Kandel, op. cit. (note 29), pp. 24–47.
138 Kandel, op. cit. (note 124), p. 11.
139 Schwartz, op. cit. (note 19), pp. 71–74.
140 Stahnisch, op. cit. (note 64), pp. 299–302.
141 Robertson, op. cit. (note 122), pp. 743–745.
model *Aplysia* at French institutes, which later enabled his research programme at the NIH. Certainly, the intensity of collaborations that could be found at leading research campuses in post-war US institutions was what made the Nobel Prize possible for him, when he received it in the year 2000. With respect to his former upbringing in Vienna and its vibrant intellectual context, Kandel upheld his connections with the Austrian culture of excellence through refurbishing exchange programmes for outstanding Jewish students and researchers—in communication with Austrian past-president Thomas Klestil (1932–2004)—and accepting invitations from leading Austrian institutions for the advancement of science, such as his Honorary Membership of the Austrian Academy of Sciences in 2002, as much as Katz did with his respective community in Germany. Kandel won several Austrian awards, and he has since acknowledged his rearing in Vienna and relationship-building with Austria as central to the development of his career. These include for example the Viktor Frankl Award in 2008, his honorary citizenship of the City of Vienna in 2009, and the Grand Decoration of Honour for Services to the Republic of Austria in 2012. The latter, being a political award, can be seen as particularly revealing for the role and use of such prizes in re-establishing Austria and its scientific associations among the social order of the international community. It went beyond the commemoration of Kandel’s school years in Vienna, since it recognized the positive influence on the international perception of Austria’s excellent research culture that Kandel evoked through the perception of his global career.

**DISCUSSION**

As the living and working situation of the émigré neurophysiologists from the post-war Anglo-American scientific community illustrates, émigrés did not simply succumb to new cultural codes, but kept with them much of where they had come from. The general processes of assimilation and experiencing of cultural differences that émigré scientists went through took place in quite difficult environments. As Sigerist noted in his well-received book on *American medicine*: ‘There are still large sections of the population that do not receive the medical attention they need. Splendidly equipped technically, American medicine is still backward socially.’

Viewing the forced migration process from a wider context, which takes the regional knowledge economies in émigrés’ receiving countries into account, allows the development of a more comprehensive account of their role in forming and shaping new situated knowledge communities of brain science and biomedical research, as well as cultures of excellence, as they paved the way for refurbishing recognition and knowledge claims related to new discoveries in neurophysiological research. In their new work contexts,
émigré researchers often discovered that methodological success did not immediately translate into scientific recognition, as in the case of Katz’s neurophysiological research of synapse transmission. He had explored some new venues of research into local responses in nerve and muscle membranes after his emigration, when visiting the Plymouth Marine Biological Laboratory in 1935 and thus pursuing neurophysiology by the sea with access to crabs and his foray into neuromuscular junction work. Scientific recognition also materialized through direct personal exchanges, such as Katz becoming the protégé of no less than Hill after a short period of exile in the UK. He soon became ‘everybody’s scientific darling’, and from the late 1940s was competed for by UCL and the then-burgeoning Australian National University, however, remaining in London after a final counter offer. For Kandel this would mean relinquishing some of his cherished perspectives from clinical psychoanalysis and undertaking new laboratory research into the neuroscience of memory mechanisms. The international network of many of the émigrés can thus provide an excellent example of the regional knowledge economies in neurophysiology that became so visible in émigrés’ contributions to Anglo-American research communities, including the recognition of their developed research practices and excellent scientific results.

The three émigré neurophysiologists discussed in this article provide a viable illustration of this, because in each case considered, the émigrés were themselves aware of the cultural dimensions around their scientific work, especially through frequent questions around the concepts of ‘internationality’, ‘emigration’ and ‘scientific recognition’. In this sense, the culture of their new host countries had a visible impact on their respective careers in neuroscience and formed a large part of their contingent trajectories for winning prestigious prizes, including Nobel awards. The Nobel Prizes bestowed a significant amount of cultural capital upon these outstanding émigré neurophysiologists, since effectively most of the nominations were made by prominent British and American neurophysiologists, which in turn generally stemmed from renowned international scientific institutions and their respective regional knowledge economies. It was obvious to the émigré neurophysiologists Loewi, Katz and Kandel, as well as other émigré physicians, that they were leaving major imprints through the increased formation of research networks in their new host countries. They mobilized methodological, conceptual and biographical resources when setting out to find new jobs, continuing their former research interests, and settling into foreign knowledge economies.

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147 Sakmann, *op. cit.* (note 95), p. 194.
148 Stahnsch, *op. cit.* (note 15), pp. 237–300.
149 Edward Shorter, *A history dictionary of psychiatry* (Oxford University Press, Oxford, 2005), p. 160.
150 Pierre Bourdieu, *Distinction: a social critique of the judgement of taste* (Routledge & Kagan Paul, Cambridge, MA, 1984), pp. 36ff.
151 Even though the increasingly robust and searchable website archive of the Nobel Foundation only lists data from the past seventy years: ‘data until 1963 is included for nominations to all Nobel Prizes except the Nobel Prize in Physiology or Medicine, that only contains data until 1953’, it is a recurrent pattern that Nobel laureates have mostly been nominated by national colleagues—with overwhelmingly high numbers of US American nominations, their respective network of senior trainees, laboratory collaborators, or renowned scientific research institutions. This is reflected in the circumstance that early career experiences at highly ranked research institutions could visibly enhance the likelihood of being recognized with a Nobel Prize during advanced careers, as is represented in the significantly higher number of Ivy League graduates who have received a Nobel Prize since the end of World War II. See Nils Hanson and Thomas Schlich, ‘Performing excellence: Nobel Prize nomination networks in North America’, *Notes Rec. R. Soc. Lond.* 00, pp. 1–27, at pp. 6f.
152 Dewey Heyward Brock and Ann Harward, *The culture of biomedicine: studies of science and culture*, vol. 1 (University of Delaware Press, Newark, 1984), pp. 34–54.
153 Ash and Soellner, *op. cit.* (note 14), pp. 117–138.
In trying to cope with all the new social challenges and the challenge of adapting to Anglo-Saxon styles of research, émigrés began to enrich programmes of investigation in what was then a largely male-dominated research community in neurophysiology. This all happened before the field of neuroscience factually took shape as a massive collaborative area of basic and clinical investigations—and it is here that the emergence of the Neuroscience Research Program in Boston, spearheaded by Francis O. Schmitt (1903–1995), first came into play in the 1960s. This expansion was flanked by the introduction of specialized professorships at many North American universities as well as the emergence of academic associations such as the Society for Neuroscience. All of these variables were also necessary to form new levels of research excellence in the neurosciences that emerged in the post-war period. In this sense, the three Nobel Prizes won by the émigré German-speaking neuroscientists described herein are best conceived of as examples of general developments in science in the twentieth century, emphasizing that each of them made a foundational contribution to the current biomedical field. Furthermore, the discoveries made were rather more difficult to discern owing to the complex research activities now common in group work, and with the changing criteria for attributing merit to individual steps in team research.

The case examples allow us to understand the movements, exchanges and communication across culture, and, taking the influences of bilateral knowledge economies into account, help us to appreciate that cultures of excellence did build on previous achievements that émigré neuroscientists had made in Germany and Austria. This included intricate mechanisms of recognition—or lack thereof, as it was for many of them—closely linked to situated knowledge communities and regional knowledge economies, which relied on acquaintance with national and international elite groups and networks of neurophysiologists who actively promoted their scientific careers even after the time of their refuge in countries abroad was over. This observation is in line with Nils Hansson’s and Thomas Schlich’s introductory article to this Special Issue of Notes and Records, in which they detail how the Nobel Prizes were conventionally awarded to acknowledge specific scientific achievements, with broad consequences, namely that not merely does research excellence lead to awards, but also recognition becomes part of the perceived excellence in science and scholarship.

Furthermore, the UK and USA had their own distinctive cultures of excellence in addition to those of Germany, Austria, Czechoslovakia and Poland. Anglo-Saxon countries contingently received established émigré neuroscientists already decorated with prizes and awards ‘in their travel luggage’ so to speak, while they appeared to have connected productively with established research networks, such as those around the elitist neurophysiologists at Oxford or well-funded laboratories and programmes at the NIH, the

154 An exceptional female émigré neuroscientist was the Italian–American neuroscientist Rita Levi-Montalcini (1909–2012), who was, however, not working within the male-dominated electrophysiological paradigm, but rather in the neuroregeneration field, where more female scientists were active. It may not be too surprising that her Nobel Prize in Physiology or Medicine was only awarded in 1986—shared by another male neurobiologist Stanley Cohen (1922–2020)—for her discovery of nerve growth factor, when it was long ‘overdue’. Jean-Claude Dupont, ‘Rita Levi-Montalcini et les débuts de la neuroembryologie’, Rev. Hist. Sci. 53, 499–519 (2000).

155 Francis O. Schmitt, The never-ceasing search (American Philosophical Society, Washington, DC, 1990), pp. 231–239.

156 This is also visible in the neuroscience field, where the applied and clinical field of neurosurgery, for example, had not received any Nobel prizes through the Nobel Committee before the ‘decade of the brain’ from 1990 to 1999: Gavrus, op. cit. (note 13), pp. 8–9; Hansson and Schlich, op. cit. (note 4), p. 14.

157 Nils Hansson, Thorsten Halling and Heiner Fangerau (eds), Attributing excellence in medicine: the history of the Nobel Prize (Brill, Leiden, 2019), pp. 1–14.
Rockefeller Institute, and Ivy League universities. In the Central European countries, the bestowment of accolades often hinged more on mentorship and personal networks representing younger neuroscientists as *protegées* of established senior academics. The latter group used their impact and power in distinctive cultures of excellence in their conferring of prizes and support of laureates’ careers, as is visible in the case of Katz’s receiving of the Garten Prize with Hund’s support and academic patronage. In short, from the analysed cases it is possible to apprehend that the mechanisms of recognition and acknowledgement in the Anglo-Saxon context centred rather around membership in elite research institutions (*per officium virtus*), while the regional excellence economies in Central Europe focused more on academic lineages (*per patrocinium virtus*). This can in turn also be related back to different forms of the organization of research institutions, namely the horizontal and rather democratic research style in Anglo-American departments *vis-à-vis* the vertical and pyramidal hierarchies in rather feudally organized Central European research institutes.\(^{158}\) Even though this distinction might not appear directly related to the functioning of scientific recognition cultures, it has been pointed out in the literature that departmental structures offered quicker forms of organization and action among groups of like-minded researchers and genealogical trainee networks calling for organized collaborative action, whereas concerted nominations from institute directors often needed to be based on acquaintances in scientific societies and elite associations for the advancement of science, such as the German National Academy of Sciences Leopoldina, to achieve the same goals.\(^{159}\)

In terms of historiographic frames, one can distinguish varying understandings of ‘scientific credit’ in different contexts from the stories of the three émigré scholars discussed in this article, and we may better understand how diverse neuroscientific communities with their respective academic reward mechanisms operated on both sides of the Atlantic. The cases of Loewi’s role as a nominator for Nobel awards for American neuroscientists, of Katz’s mentoring of British and émigré neurophysiologists, as well as Kandel’s role as a supervisor of numerous excellent American postdocs and young investigators as well as a science ambassador to his home county Austria, can be seen as representative of the bilateral knowledge transfer inaugurated by émigré neurophysiologists, while they engaged in the networks of nominators, mentors and reviewers that were involved in the attribution of scientific credit in the neuroscience field. From focusing on the systematic phenomenology of their case examples in the context of forced migration, knowledge exchanges, and communication across cultures throughout the post-war period, this article has clarified some of the factors and trajectories of how they received merit of the highest order for their contributions to science, and it has revealed significant variations in the cultural representation and practice of award cultures in Central Europe and North America. Perhaps most fundamentally, with hindsight, the examples of the émigré scientists examined here can expose émigré neurophysiologists’ contributions to interdisciplinary innovations and cultures of excellence in their new host countries, including the UK and USA, as well as lay bare how local variation impacted the ways and means of the recognition of excellence in international communities, not only in the twentieth century, but also today.\(^{160}\)

158 Stahnisch, *op. cit.* (note 15), p. xvii.
159 Halling *et al.*, *op. cit.* (note 7), pp. 211–214.
160 Stahnisch, *op. cit.* (note 2), pp. 128–145.
DATA ACCESSIBILITY

The archival records are available at the Archives of the NIH in Bethesda, MD, the Rockefeller Archives Center in Sleepy Hollow, NY, the Society for the Protection of Science and Learning Collection at the Bodleian Library in Oxford, UK, and the online nomination archives of the Nobel Prize in Stockholm, Sweden.

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