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## Helping students see eye to eye: Diversifying teaching of sensation and perception in higher education

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### ABSTRACT

There is current interest in diversifying teaching curricula across many disciplines in university teaching. Sensation and perception is often considered difficult to diversify. Current challenges include diversity of the topics and teaching tools/materials, and the diversity that characterizes both the student and the teacher populations. We start by describing the diversity present in student and teacher groups, with a UK focus, and discuss how inclusive and diverse teaching materials can impact participation and engagement of broad student groups. We next consider how teaching content can be broadened by teaching on topics that consider differences between participant groups with different characteristics (including gender, ethnicity, disability and culture). Finally, we suggest resources that can be used to diversify sensation and perception teaching. We include example topics where diversity features in perception research, aimed at engaging teachers and students in the process of diversifying the teaching of sensation and perception.

### ARTICLE HISTORY

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### KEYWORDS

Diversity; equality; perception; teach; inclusion

When we teach Sensation and Perception in Higher Education (HE) we are, in large part, presenting the history (up to the present day) of our subject, and that history tends to be focused on studies carried out in specific geographical areas by the people who have ruled or governed them. We tend not to acknowledge the global history of our subject and the work of minority scientists (wherever they work) is often not showcased. Nor do we often consider the characteristics of our study groups, including diversity across gender, socioeconomic class, sexual orientation, disability, neurodiversity, ethnicity and geography. Instead, participant groups *tend* to be Western, educated, industrialized, rich and democratic (which can be abbreviated to WEIRD; Henrich et al., 2010).

This matters because our world boasts a diversity of people and cultures, our universities host a diversity of students, and WEIRD populations are by definition not suitable to be representative of such diversity (Henrich et al., 2010; see also Muthukrishna

et al., 2020, for methods to measure distance between cultures). For example, Henrich et al. (2010) have noted that 96% of participants across a wide range of studies published in top psychology journals come from countries hosting 12% of the world's population. Of course there are resource and language issues here: including both academic funding opportunities being much greater in specific regions (notably Europe, North America and parts of East Asia), and to the English language dominating research dissemination (Petersen, 2021). Reviewers and editors of journal articles are also predominantly WEIRD (Nishikawa-Pacher et al., 2022; Palser et al., 2022). This bias is potentially to the detriment of the progress of science, which relies on creativity and innovation, both of which are boosted by diversity of the teams taking part. For example, the ethnic diversity of research teams has been shown to correlate with scientific impact (AlShebli et al., 2018), and teams with more female participants have been shown to have more equal participation

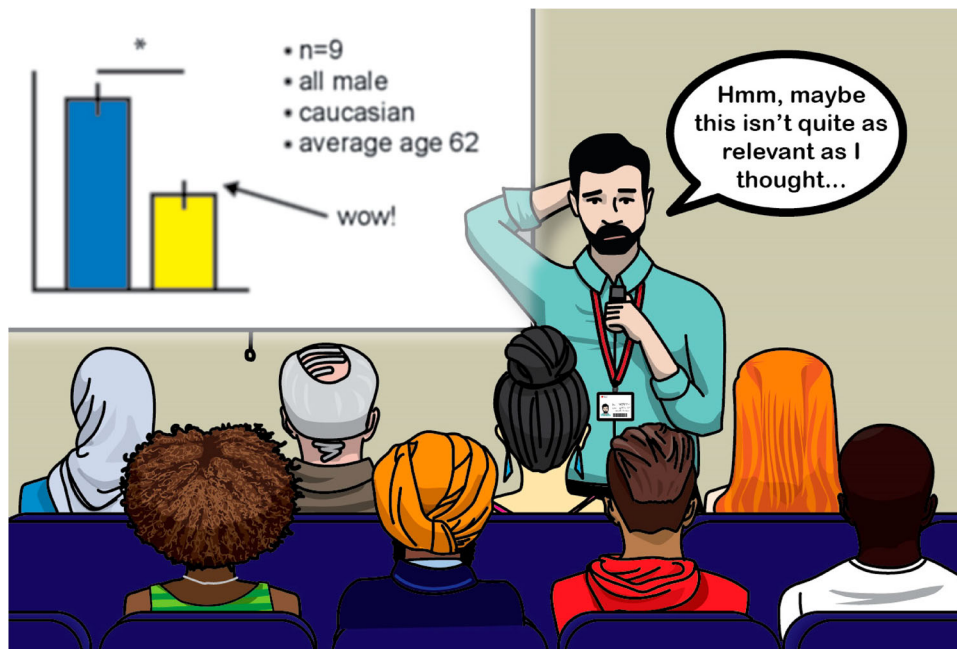
(Nielsen et al., 2017). It is also known that consideration of diversity across the syllabus can academically empower students from diverse backgrounds (see Lee et al., 2012; Smith, 2020). Therefore, if we want to improve our science, the way we teach it, and who engages with it, we need to actively incorporate opportunities to teach about diversity in our discipline, both of the science itself and the people doing it. It is also important to ensure that this is achieved in an *integrated* way, as opposed to being considered an “add-on” (see Smith, 2020).

You might be thinking, “why me?”, or, “I will not be able to contribute to diversifying Sensation and Perception teaching because I am WEIRD and I work in a WEIRD environment” (see Figure 1). However, opportunities arise because our universities are now hugely diverse in their student bodies. For example, in the UK, while 84% of undergraduate students are from the UK, the remaining 16% come from 201 different countries; with 10% coming from 172 countries outside the European Union. Within students from the UK, white ethnicity accounted for 74% of the group (Higher Education Statistics Agency, 2022b). Everyone who teaches can contribute to improving diversity by thinking about the relationship between their student cohort and their course content (Armstrong, 2011). You do not need to be a member of a disadvantaged group to make

a difference. Indeed, we know that those from under-represented groups contribute more to diversity and inclusion activities. Indeed, this endeavour often comes at their own cost: for example, a recent study from the USA showed that academics’ efforts in this area were not considered important for tenure (Jimenez et al., 2019). Yet many others do not contribute at all.

You may also be thinking “I don’t have time to discuss these topics: there’s already too much to cover”. We hope to persuade you that diversity can be an integral part of sensation and perception teaching, and that in many cases, increasing the diversity of your teaching examples will involve minor changes. In addition, engaging with these topics may have broader benefits in terms of encouraging students to engage critically with questions around research rigour and design.

Who are we, the authors? Sensation and Perception is a topic taught primarily in the disciplines of Psychology, Neuroscience and Optometry in UK Higher Education. We are four academic teachers and researchers in this area, coming from a range of UK universities, from ancient to modern, and from large to small. Three of us are based in departments of Psychology (one includes Neuroscience), and one in Optometry. In this article we offer an incomplete survey of the issues, alongside a range of suggestions for materials



**Figure 1.** A light-hearted illustration showing a lecturer realizing his class is more diverse than the data example he’s provided.

and ideas with which to engage student groups. Our aim is to encourage interest and provide resources to help to diversify the teaching of our discipline. Note that, when quoting demographic data, we use the UK environment as an example, because that is our own HE context and we have easy access to national-level data, as ours is mostly a government-funded HE system. Of course, many of the issues we discuss are truly international, as is the evidence we use to back up our arguments. Some of the details about the ethnicity of cohorts and ratios of international students may be country-specific, but HE is now an international endeavour, and we feel that most of this review will offer something for everyone, particularly if they work in an environment where research is published or taught in the English language. This paper is not offered as a definitive review, but rather offers some starting points to allow the teacher of sensation and perception to add the value to their teaching that increasing diversity can provide.

We outline our argument in two main sections. We begin by reviewing the breadth of diversity amongst teachers and students. Next, we discuss the importance of widening research in our area to include more diversity in the research questions being asked, the people asking them, and their study populations; and offer examples of where both excellent research, and that which is less well designed, can be used to teach core concepts in sensation and perception. We finish the article with a more practical focus: with a section suggesting a range of resources to include diversity in the teaching of Sensation and Perception, from textbook content, through activities to include students, to individual research papers that cover specific topics.

### **Diversity of teachers and those taught**

In this section we outline the current state of diversity of teachers and students, with a UK focus (because the UK has a state-run university system, national statistics are available).

#### ***Gender diversity***

Typically, social and life sciences, including psychology, have more equal (or even women dominated) gender representation in the student body compared to more mathematically intensive fields, such as

engineering or physics, where men typically make up the majority of the cohort (UK Higher Education Statistics Agency, 2021a). There is evidence that gender bias directing women away from maths-heavy disciplines occurs well before university education begins (Ceci et al., 2014). However, Sensation and Perception, despite often being taught within women-dominated courses, can give the impression of being more man-focused, perhaps at least partly because of its relatively high computational and mathematical slant. Certainly, research in Sensation and Perception is still dominated by men. For example, a recent survey of the attendees of the International Vision Sciences Society Annual Meeting found that the majority of the scientists at all career levels were men, and the imbalance was most pronounced for senior scientists (Cooper & Radonjic, 2016). In scientific events, men tend to be the majority presenting (sometimes resulting in “manels”; Penfold et al., 2019) and in participation (Jarvis et al., 2022). Those researchers often are, or become, teachers too. Thus, universities may often find themselves in the situation where the gender diversity of the teaching staff on Sensation and Perception courses does not represent that of their student body (which is over 80% women for psychology in the UK: Higher Education Statistics Agency, 2021a). This may have important consequences: for example, there is evidence that having a woman instructor increases the likelihood of women students taking further courses in that area of research, or is generally more inspiring for women students (Bettinger & Long, 2005; Lockwood, 2006; Porter & Serra, 2020). However, the authors also recognize that ensuring gender-balance in Sensation and Perception fields is a challenge that will not be remedied overnight due to a lower proportion of women being interested in STEM in general (STEM Women, 2022), and so in the meantime it will be important to reflect on admissions procedures to ensure that they are inclusive (see CIPD, 2022), and to consider highlighting female role models in other ways in any areas where there are fewer women employed. For example, this can be achieved through inviting external speakers and utilizing research studies that are led by women in teaching materials. It may also be appropriate to link with local secondary level schools to perform outreach activities to help showcase these career paths to young, aspiring minds.

## Ethnic diversity

Diversity is of course not just about gender (e.g., Blasi et al., 2022; Hassan, 2008; Medin et al., 2017; Pells, 2022). While it is difficult to get information on individual disciplines, like Psychology, or sub-disciplines, like Sensation and Perception, UK universities are becoming increasingly ethnically diverse in terms of their student body, with the percentage of entrants from Asian, Black, Mixed and Other ethnic groups increasing in the 5 years to July 2020 from 24% to 27.4% (UK Higher Education Statistics Agency, 2022a). This trend is likely to continue as the UK as a whole also becomes more ethnically diverse (Rees et al., 2016). Overall, around 75% of academic staff in UK universities identify as white. However, there is good evidence for underrepresentation of ethnic minority staff at higher levels of the academy. For example, only 1% of UK full Professors are black (Coughlan, 2021). Thus, it seems likely that there are differences in the ethnic diversity of students and teachers in our courses, and this may again have consequences for mentoring and career take-up (Chemers et al., 2011). We highlight the importance of ethnic diversity in Sensation and Perception teaching and research in the “Diversity of Research” section below, where we discuss how failing to take into account ethnic diversity in our research populations may lead to misleading scientific conclusions. And unfortunately, as with gender, low ethnic diversity is a difficult issue to resolve, as it relates partly to career interest from a young age, but it also relates to employment practices and perceived work environments, which may be more challenging to remedy in the short-term. This is why it is important to continue this conversation and embed discussion of diversity into our everyday culture in higher education through inclusive practices, EDI committees, and initiatives that promote healthy and proactive reflection on our practices, like the UK Advance HE’s Race Equality Charter (see Advance HE, 2023).

## Disability and neurodiversity

A perhaps less often-considered aspect of diversity is disability and neurodiversity, despite approximately 20% of UK undergraduates reporting at least one disability, impairment, or medical condition (UK Higher

Education Statistics Agency, 2021b). Note that data specifically focused on cohorts who are taught sensation and perception are not available. Some aspects of neurodiversity are highly relevant to Sensation and Perception courses and are often taught as core content: for example, colour blindness, deafness, and synaesthesia are all frequently covered in introductory textbooks (see Table 1). However, much of this material uses a “medical model” of disability, which traditionally focuses on individuals’ deficits and functional limitations. In recent years there has been a shift within the research world toward considering neurodiverse conditions as a natural variation within the ample range of human experience. Such a framework challenges the traditional ableist view which penetrates our society, where those who deviate from the statistical norm should be considered as impaired or defective and, as such, should work toward conforming to the majority’s standards (Astle & Fletcher-Watson, 2020; Azevedo et al., 2022; Pellicano & den Houting, 2022). We suggest it is important to avoid ableist and non-inclusive language where possible, and better yet, to use the student’s preferred words, in the same

**Table 1.** Examples of diversity across perception from textbooks.

Textbook	Diversity related content
Sensation and Perception (11th edition) Goldstein and Caciomani (2021)	Perception across cultures, e.g., music Experience dependent plasticity in wayfinding Sensory substitution, e.g., echolocation
Sensation and Perception (6th edition) Wolfe et al. (2020)	Perception across cultures, e.g., colour categorization, music Genetic variation in colour vision Perception of taste and smell, e.g., supertasters, odour hedonics
Foundations of Sensation and Perception (3rd edition) Mather (2016)	Perception across cultures, e.g., “carpentered world hypothesis” and illusions Individual differences in perception across all senses, e.g., differences between sexes, differences as a result of expertise
Sensation and Perception (2nd edition) Harris and Smith (2022)	Perception across the lifespan Pathologies of perception, e.g., agnosias, hemispatial neglect, perception in autism spectrum disorder
Basic Vision (revised edition) Snowden et al. (2012)	Perception across the lifespan Pathologies of perception, e.g., agnosias, ataxia, prosopagnosia
Sensation and Perception (5th edition) Foley and Matlin (2015)	Pathologies of perception, e.g., phantom limbs and pain
Perception: A multisensory perspective Bruno and Pavani (2018)	Sensory substitution Synaesthesia
Introduction to Sensation and Perception (co-created with students) Psy, 3031 and Olman (2022)	Sensory variation, e.g., supertasters, synaesthesia Pathologies of perception, e.g., prosthetic limbs, colour deficiency, sensory loss



way we have learnt to do when addressing people's sexual identity.

Obtaining information about personal preference is of crucial importance, as there is variability in the way different communities choose to refer to their disability or impairment. Some people see their disability as an essential part of who they are and prefer to be identified with their disability first (Identity-First Language; e.g., autistic person), others to have their disability as a descriptor (Person-First Language; e.g., person with autism; Klentz, 2020; Liebowitz, 2015). Sometimes groups of disabled people make their own consensus choices: for example, people with hearing loss who share a common culture and preferentially use sign language (often their first language) define themselves as "Deaf", while the "lowercase d" deaf is used to refer to the physical condition of having hearing loss, and it is preferred by people who don't always have a strong connection to the Deaf community, don't always use sign language, and who may prefer to communicate with speech (Butler et al., 2001).

In higher education, the movement away from the medical model emphasizes the importance of accommodating and supporting non-typical learning experiences. It also advocates for the adaptation of standard teaching practices and materials to the students' needs (Nieminen & Pesonen, 2022). Research with neurodiverse populations has additionally highlighted the importance of understanding and awareness, as well as avoiding "othering" during our teaching (Sarrett, 2018). "Othering" here is defined as a phenomenon in which individuals or groups are considered "not to fit in" with other groups, which can lead to negative associations. In the UK, guidelines have been developed to ensure a fair learning experience for the whole student population, including neurodiverse students and those with sensory impairment (UK Department for Education, 2017).

Practices concerning Sensation and Perception teaching could be improved by reflecting on how accessible our content is for neurodiverse students: do we provide compelling explanations of visual illusions for students with visual impairments? Do students with sensory processing issues find Sensation and Perception demonstrations uncomfortable? If we focus on vision as a major sense, how do we adapt our teaching for those with visual impairment?

We highlight some specific suggestions for how to make our Sensation and Perception teaching more accessible in the "recommendations of resources" section (below). However, we do note that some of the issues surrounding the lack of diversity of the student population in academia are structural (e.g., there may be greater financial costs for a neurodiverse student; there may be little support for teachers to support students) and that individual lecturers will clearly not be able to overcome all accessibility barriers.

To sum up this section, once the extent of diversity of the student body is understood, it can become easier to consider how to make one's teaching more inclusive and diverse, to attract and retain a broader range of people to become interested in the area that we love.

### **Diversity of research: Questions asked, who by, and study populations**

Psychology research has traditionally relied on WEIRD participants, with data suggesting that the majority of psychology papers rely on participants from Western nations, and psychology undergraduates (Arnett, 2008). In perception research and cognitive psychology research more generally, ethnicity is very rarely mentioned in publications (Roberts et al., 2020). One should also consider who succeeds as researchers, and who are excluded, an area that can provide fruitful discussion with groups of students. For example, there is evidence showing that fewer women, and fewer people from non-Western nations are primary authors and peer reviewers at some high profile journals (Murray et al., 2018; Nature Editorial Board, 2018). An interesting example comes from Primatology, which has suffered less from gender bias than other areas, but still favours researchers from the Global north. In this area there is an ongoing debate and discussion about how to improve the publishing situation via journal editorial practice (Setchell & Gordon, 2018). Similarly, and part of the same problem, we rarely even allude to the fact that nearly all modern research articles are written in English, although this is of course not true historically: for example, the Stroop Effect was first written about in German (Jaensch, 1929; Jensen & Rohwer, 1966; MacLeod, 1991). As educators, we are unlikely to be comfortable teaching and assigning papers written

in languages that we cannot read ourselves, but we should consider the possible biases and inequalities that the dominance of English may create. This is currently an area of interest in the field of Ecology, where much research involves collaboration between researchers across continents. One recent suggestion involves inviting peers to aid with English-language proof-reading via journal pre-print repositories (Khelifa et al., 2022).

### ***Cultural effects on sensation and perception processes***

Researchers have often assumed that the relatively “lower level” cognitive processes we often study in Sensation and Perception areas will be more generalizable across (for example) different cultures compared to other subfields of psychology, such as social psychology. This is supported to an extent by evidence suggesting cognitive science studies replicate more often than social science studies (Open Science Collaboration, 2015). In addition, techniques common in human sensation and perception research, such as psychophysics, have historically focused on representing participant data individually, allowing (at least in theory) variance across people to be studied more explicitly than many other areas of psychology, which have often focused on aggregated, averaged data. These types of “individual differences” based studies are one way in which we can explore diversity within sensation and perception research (e.g., see Nefs et al., 2010).

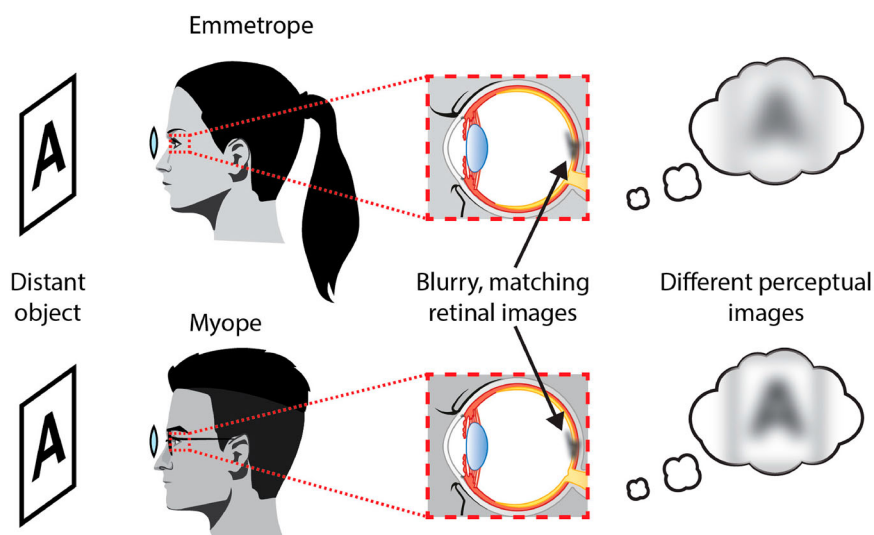
A second way in which diversity has been studied is through the use of “cross-cultural” studies, comparing different groups with different experiences. For example, culture can influence perceptual processes via differences explained by cognitive styles (Kitayama et al., 2003) and spatial cognition, for example by use of different frames of reference for spatial cognition (Adamou & Shen, 2017; Haun et al., 2011). A plethora of studies have investigated how language affects the way people process and interpret sensory information (see Lupyan et al., 2020, for a review). For example, Russian participants have been shown to make faster colour discrimination judgements when the colours fall into different linguistic categories compared to when they fall into the same category (Winawer et al., 2007). Similarly, sound discrimination in infants is shaped by their native

language (Pons et al., 2009). However, there are also important examples where culture seems to be less critical: for example, there seem to be strong commonalities in colour naming boundaries across different languages, supporting the idea that there are similar mechanisms for guiding lexical partitioning of colour space across cultures (Lindsey & Brown, 2006).

Diversity of perceptual experience across cultures, ethnicities, and gender is not restricted to the environment in which a person is raised. Genetic factors that influence the structure and function of the eye can also matter. It is known, for example, that pigment of the iris varies across ethnicities (Edwards et al., 2016), and iris pigment is linked to melatonin suppression by light (Higuchi et al., 2007), which is also linked to pupil size (Higuchi et al., 2008). We also know that average pupil size (in bright environments) decreases as we age (Winn et al., 1994). Further, there is evidence of differences in higher-order aberrations within the eye across different ethnicities (Cerviño et al., 2008). All of these factors have physiological consequences on the light arriving at the retina, which could influence the perceptual experience of the individual to some degree. Sign-posting studies like these will be important for any cohort that may move on to clinical practice or other people-facing vision-related roles.

Further, even within studies that aim to test a single population, there can be differences in the ability to utilize visual information, as shown in the ability of myopic (short-sighted) participants to be better able to “see” through a blurring lens than emmetropic (no prescription) participants (see Khan et al., 2013, and Figure 2). This phenomenon is thought to be related to the greater amount of exposure to blur over the lifetime of the myope. However, at the point of being tested in the lab, all participants are receiving the same optical experience, suggesting differences in how they *perceive* the input. Figure 2 shows an illustrative example of how a myopic person might be able to obtain more information from a retinal image than someone with emmetropia, as was reported in Khan et al. (2013).

Neurodiversity should also be considered when thinking about perception. A classic example is the adaptation that occurs following sensory loss.



**Figure 2.** Illustration showing two people, an emmetrope (typical vision without needing corrective lenses) and a corrected myope (short-sighted without corrective lenses) viewing a letter “A” through a +1D blurring lens, as described in Khan et al. (2013). In this example, the emmetrope and corrected myope have the same image arriving at the retinal level, but the myope will be better at adapting to the blur and so will be able to get more information from the scene than the emmetrope – this indicates a difference in perception or perceptual image.

For example, blind and deaf individuals are known to show remarkable plasticity in other senses (Voss et al., 2010). There are also many examples of less obviously “sensory” neurodiversity that can affect perception. Certain conditions, for instance Down syndrome, are known to be related to specific vision deficits, such as low visual acuity threshold, contrast sensitivity (John et al., 2004), reduced stereopsis, anomalies in colour discrimination (Krinsky-McHale et al., 2014), suggesting aberrations in the visual and oculomotor systems development in this population (Watt et al., 2015). Another example is that of Autism spectrum disorders (ASD). In addition to ASD being commonly associated with difference in specific sensory processing mechanisms (Robertson & Baron-Cohen, 2017; Simmons et al., 2009), people in these populations have been found to show an unusual visual functional and optometric profile, including atypical eye movements, increased prevalence of strabismus and astigmatism, and possible impairments of retinal structure and functions (Little, 2018). Recent research suggests that even some of the most basic aspects of perception, such as Weber’s Law (a just noticeable change in a stimulus property tends to be a constant ratio of that property), can be different in an autistic population (Hadad & Schwartz, 2019). This can result in greater precision and accuracy of some perceptual tasks for ASD populations, compared with typical populations.

### *Methodological issues to consider*

Physiological differences across cultures is an important consideration, not only for perception, but also in measurement of vision. For example, there are reports that eye tracking devices might produce less accurate data when used with certain ethnic groups, with some proposed solutions being that “participants should preferably be recruited from a homogenous ethnicity” (Blignaut & Wium, 2014, p. 79). Whilst this suggestion would certainly control for confounding variables in data acquisition, we suggest that it does not promote an inclusive approach to the data collection itself (but could provide a good example to engage students in debate). We consider it might be more appropriate to consider the potential impact of ethnicity on the data, and think carefully about whether it is possible to account for this in power calculations and expected variation accordingly. This would allow for discussions of differences across cultures, and might lead to improvements in software which prevent these artefacts from occurring in the first place. Even within supposedly highly homogeneous groups, such as people living in the same city, differences exist based on the photic environment they have been exposed to in the early postnatal life, impacting their sensitivity to colour spectrum differences (Laeng et al., 2007). Recent evidence also shows a variety of environmental factors,



including air quality, impact visual cognition (Spencer et al., 2023).

Another famous (though contentious) example is the research claiming that susceptibility to visual illusions may vary depending upon one's cultural upbringing ("the carpentered world hypothesis", Segall et al., 1963). This research has been heavily critiqued, demonstrating some of the challenges in conducting this type of cross-cultural research. For example, as detailed in a well-known Perception textbook (Mather, 2016) it is not always clear that the instructions in cross-cultural studies, such as this one, are understood similarly in different languages, and in these types of illusion tasks, there is evidence that instructions or expectations can lead to response bias. Mather used other examples to demonstrate it can also be tricky to ensure that matched samples are obtained from different populations. For example, it may not be known whether every person in every group can see stimuli well: the incidence of uncorrected refractive errors is likely higher in the non-industrialized, rural groups (yet this is not routinely measured).

Finally, and perhaps particularly challenging for modern studies, participants may not easily fall into discrete categories (e.g., they may live in country A, but grew up in country B) (Larsen et al., 2013). Rather than these difficulties being a reason to avoid teaching about such topics, we would like to suggest that they provide an avenue for explaining why the details of experiment design and methods are crucially important.

### **Implications for research design**

The danger, however, of trying to be diverse in one's participant recruitment strategy is that it might lead to inadvertent segregation of the population that one is trying to study. There must be a balance then, between deliberately segregating populations because there is a precedence, and recruiting in a diverse way in order to gain a more realistic representation of measured effects across a diverse population. The fundamental question, therefore, has to be in considering the role that cultural or other differences have on the research questions being asked, and outcomes. Researchers must consider whether cultural differences are a key component of their research question, or whether they are not interested

in cultural differences per se, but still must consider potential diversity within the study population in order to obtain meaningful and generalizable results. Engaging students in discussions of what questions should be a priority, and why, can offer opportunities for deep engagement with our science at several levels, and works towards empowering our students with a sensitive and inclusive approach to research.

Taken together, the studies we have highlighted here, and many others, suggest that there is a biological and medical precedence for considering diversity within our study populations when discussing sensation and perception. This point is crucial to convey to students, particularly those who may be taught perception as part of a clinical qualification (e.g., orthoptics, optometry, ophthalmology).

### **Recommendations of resources**

How to apply general suggestions to Sensation and Perception teaching presents a moving goalpost (perhaps as it should). In the UK, for example, the Quality Assurance Agency for Higher Education (a charity who work to enhance HE quality across the UK) are currently consulting on revised benchmarking statements that define a range of disciplines taught by UK HE institutions (including Psychology), and these changes include a clearer steer towards diversity and inclusion (UK Quality Assurance Agency, 2021). Thus, it is likely that many of us will be asked to not only think about how we already incorporate diversity and inclusion material into our teaching, but may also be asked to update our resources to meet new requirements in the future. In this section, we provide some suggestions and recommendations to assist teachers of Sensation and Perception with this task. Our aim is not to provide comprehensive coverage of all possible resources, but to offer some suggestions that we (or other colleagues) have found useful or interesting.

When we teach Sensation and Perception, what are we trying to inspire in the minds of our students? Most instructors (and learning outcomes) would likely indicate that they want their students to understand the physiological processes underpinning sensation and perception, along with an appreciation of how perception occurs, though the level of this may vary depending on the stage of the programme. It is

unlikely though, that we are able to cover the entire spectrum of research in sensation and perception within a single module, and so by the nature of our course design, we will choose studies and theories that we think are interesting and relevant (or specified by the accrediting body). This means that within reason, we have some control over the questions we ask and the topics we present to our students, and this can be an active and thoughtful decision, although many of us may feel restricted to the content that exists within the textbooks we recommend. In order to diversify our teaching of these topics, we either need to utilize resources that cover diverse questions, or we need to be comfortable to step away, slightly, from the confines of the traditional

textbook approach, in order to better serve the needs of our diverse population of students. Below, we have highlighted topics covered by popular Sensation and Perception textbooks that cover aspects of diversity (Table 1), we suggest activities that could be incorporated into classes (Table 2), as well as research articles that could be used in teaching (Table 3).

### Textbooks

Many of us teaching Sensation and Perception will recommend one or two textbooks as part of our courses, and therefore it is useful to consider how they approach diversity-related content. In this section, we point the reader towards some of the

**Table 2.** Ideas for diversifying content and student inclusion and collaboration.

General areas	Topic details
Introducing ourselves at the beginning of the course	Introductory activity aiming to replace the question “Where are you from?” with the question “Where do you know from?”, helping students and instructors to recognize each other as interlocutors ( <a href="https://maifeminism.com/where-do-you-know-from-an-exercise-in-placing-ourselves-together-in-the-classroom/">https://maifeminism.com/where-do-you-know-from-an-exercise-in-placing-ourselves-together-in-the-classroom/</a> ). Eugenia Zuroski, McMaster University.
Diversifying the course syllabus	Some thoughts on diversifying the syllabus for psychology in general, rather than sensation and perception in particular (Fuentes et al., 2021).
Who does the science? Activity	Offer groups of students the chance to research who might have contributed to the study of perception, from non-Western cultures. Groups can be asked to offer a poster or slide illustrating their findings. Paul Gardner, University of St. Andrews.
Who does the science: resources	Several papers offer reviews that include contributions to psychology from women and other minority groups (Alvarez et al., 2020; Henrickson et al., 2020; Moradi & Townsend, 2006; Russo & Denmark, 1987; Rutherford & Davis, 2008; Wills et al., 2023).
Create an e-book	Students could work together to create an e-book (e.g., as a Wiki, or using Google documents) with small groups taking charge of different chapters, both as a revision aid (e.g., summarizing lectures) and to encourage them to incorporate extra material, e.g., studies that reflect their own interests. (Psy, 3031 & Olman, 2022).
Research proposal	Students invited to plan/write a research proposal or preregistration (i.e., introduction, hypothesis, methods, predicted results) for perception-based research. As part of this, they could identify gaps in the literature that may be based on a lack of diversity in previous studies.
Course Readings	Teachers are encouraged to examine their course readings and use examples that include authors from minority groups. Including photos of some of the authors. Places to find examples: <a href="https://en.wikipedia.org/wiki/List_of_women_neuroscientists">https://en.wikipedia.org/wiki/List_of_women_neuroscientists</a> <a href="https://en.wikipedia.org/wiki/List_of_women_psychologists">https://en.wikipedia.org/wiki/List_of_women_psychologists</a> Steve Engel's (University of Minnesota) google page on “Acknowledging the contributions of Black researchers and engineers in perception”: <a href="https://docs.google.com/document/d/1SnxasZmtNaxs1lillbUrgQ4LZl27UMyshxfU5sHaBqM/edit">https://docs.google.com/document/d/1SnxasZmtNaxs1lillbUrgQ4LZl27UMyshxfU5sHaBqM/edit</a>
Accessibility	Students could be asked to design accessible materials (or to discuss how they could make materials more accessible) e.g., a poster for their student society, lecture notes etc., with reference to what they have learned in their perception courses. While creating materials and delivering contents, it is crucial to do so in a way they can be accessible to all students, e.g., people with colour blindness (cf. Geissbuehler & Lasser, 2013), with visual impairment or dyslexia (e.g., accessible via text-to-speech aids; see also British Dyslexia Association, 2022; Equality Challenge Unit, 2009 for further recommendations).
Reflective discussions	Students can be encouraged to consider how what they are learning might be relevant to their lives or to current events through discussions (e.g., in a quick “pair and share” format during a lecture, or via free text contributions through software such as PollEverywhere or on Virtual Learning Environments).
Hidden figures in Psychology podcast	A podcast that illustrates how some psychologists are missed from history of psychology texts. Includes tips on incorporating less known pioneers into psychology teaching: <a href="https://psychsessionspodcast.libsyn.com/sotl002-invisible-pioneers-adding-forgotten-psychologists-to-psychology-course-content-with-leslie-cramblet-alvarez-and-nikki-jones">https://psychsessionspodcast.libsyn.com/sotl002-invisible-pioneers-adding-forgotten-psychologists-to-psychology-course-content-with-leslie-cramblet-alvarez-and-nikki-jones</a> Leslie Cramblet Alvarez (Denver) & Nikki Jones (Colorado Mesa).
Hands-on Vision Science	A web site dedicated to offering hands-on demonstrations of key concepts in perception, that could allow deeper understanding across diverse groups with different learning styles and neurodiversity. <a href="https://sites.google.com/view/hands-on-vision-science/home">https://sites.google.com/view/hands-on-vision-science/home</a> Ben Balas (North Dakota State).
Increasing student diversity in research labs	Many of us host students in our labs, to conduct formal projects as part of their course, or to engage in voluntary or paid research. This article offers strategies to increase the diversity of students who get selected for such activities (Ahmad et al., 2019).
Diversity in assessment	Many courses will utilize fairly traditional forms of assessment, e.g., timed essays, presentations. Introducing more diversity in assessment (e.g., webposts, podcasts, videos) or perhaps offering assessment choice if possible, could help to make courses more accessible for a range of students (Sokhanvar et al., 2021 for a review). Also, ensuring a fair evaluation process implies that alternative assessment methods and procedures are made available to any students in the class, to minimize the risk of “othering” (see main text).

**Table 3.** Suggested research areas and topics that could be used in teachingsensation and perception, including research references.

General areas	Topic details	References
Optics and the eye Nature/nurture in perception	Underwater vision in an isolated population is superior to that of typical “western” population, due to the ability to accommodate the eye. Follow up paper shows that improved ability can be learned.	Gislén et al. (2003)
Geometric illusions	Geometric illusions across cultures were studied in the 1960s with isolated groups in Africa. Some core methodological problems emerge, could be useful to motivate understanding of good Methods.	Mather (2016); Segall et al. (1963)
Sensory illusions	Using auditory or tactile illusions in addition to visual ones could be a way to introduce a more inclusive (and possibly more novel) approach to the study of perception.	Goldstein (2021); Hayward (2008); Tichko and Loui (2020)
Cultural differences	More recent work looking at cultural differences between Western participants and participants from a remote culture (Himba) in a range of visual illusions (e.g., lightness perception, geometric illusions).	Bremner et al. (2016); Davidoff, Fonteneau, and Fagot (2008); Davidoff, Fonteneau, and Goldstein (2008); Linnell et al. (2018)
Colour perception	Culture, location and timing of birth impact colour perception and discrimination.	Josserand et al. (2021); Laeng et al. (2007); Martinovic et al. (2020); Winawer et al. (2007)
Hearing	There are differences in pitch and musical interval perception across cultures (example is of an Amazonian tribe).	McDermott et al. (2016)
Hearing	Conductors, trained to monitor different portions of space simultaneously, show a broader tuning in their auditory skills. Auditory localization skills can thus be improved with practice.	Münste et al. (2001)
Olfactory perception	Most variation in the perception of odour pleasantness is found across individuals, and not across cultures.	Arshamian et al. (2022)
Applied vision: driving	There are cross-cultural differences in behaviour in a road hazard task that asked people from several European cultures to view hazard videos and perform a braking task. Eye movements were also recorded.	Di Stasi et al. (2020)
The moving observer: wayfinding	London taxi drivers have enhanced landmark recognition, and higher hippocampal volume than bus drivers, suggesting evidence for experience-dependent brain plasticity.	Maguire et al. (2006)
The moving observer: wayfinding	Cross-cultural differences may affect self-estimates of wayfinding ability, with gender stereotypes playing a role in mediating these patterns. The paper also considers how self-judgements relate to real performance.	Walkowiak et al. (2022)
Echolocation	Some people with visual deficits can use echolocation for spatial navigation. These skills can be learned, to some extent, by those with normal sight.	Dodsworth et al. (2020); Thaler and Goodale (2016)
Sensory substitution	Sensory substitution devices can provide auditory or tactile representations of visual information, e.g., musical notes can provide basic shape and colour information for blind individuals.	Abboud et al. (2014); Striem-Amit et al. (2018)
Olfactory perception	There are racial disparities in olfactory perception within older adults in the US, with African American and Hispanic populations having worse olfactory perception.	Pinto et al. (2014)
Pain perception	False beliefs about biological differences between different racial groups may affect medical judgements, potentially contributing to racial disparities in pain assessment and treatment.	Hoffman et al. (2016)
Marginalized scientists	Discussion of the life of Eleanor Gibson (inventor of the “visual cliff”) and the challenges she faced as a marginalized scientist.	Rodkey and Rodkey (2020)
Tactile perception	While Wilder Penfield mapped patients of both sexes, the iconic illustration of somatosensory map is clearly male. This paper discusses what is known about the map of the female body in the brain (i.e., the “hermunculus”).	Di Noto et al. (2013)
Sensory perception in congenital amputees	Compensatory plasticity processes, usually explored in people with blindness and deafness, can similarly be explored in people who are born without limb(s).	Hahamy et al. (2017); Liu et al. (2020); Striem-Amit et al. (2018)
Vision and Art: visual dysfunction and artistic representation	El Greco fallacy. The elongated forms painted by El Greco have previously been attributed to his having severe astigmatism. The fallacy is that all forms should be elongated to someone with astigmatism, including the canvas and hence forms as-painted should have correct geometry.	Firestone (2013)
Synesthesia and artistic experience	A number of visual artists and musicians have been reported to be syntheses. Does this condition affect the way they create art? Are synesthesia and creativity ultimately linked?	Safran and Sanda (2015); Just (2017)
Visual imagery	Some people lack the ability to show difficulties at creating a quasi-perceptual visual image in their mind’s eye (i.e., aphantasia).	Dance et al. (2022)
“Professional” perceivers	Intensive training and refined perceptual skills reflect in plastic changes in key cerebral areas. Evidence from sommeliers and super smellers.	Wabnegger et al. (2019); Filiz et al. (2022)

(Continued)

**Table 3.** Continued.

General areas	Topic details	References
Pitch and language	Thought to be universal, height-pitch associations might not be so. Farsi and Turkish speakers show weaker space-pitch associations, indicating the language might affect perceptual features mapping.	Holler et al. (2022); Dolscheid et al. (2020)
Vision in autism: Weber's Law	Weber's Law is one of the classic, basic laws established in early psychophysics. It states that sensitivity to a stimulus property is a constant ratio of the property. This research, using several tasks across sensory modalities, suggests the law may not hold in autistic populations.	Hadad and Schwartz (2019)
Smell naming	Unlike English speakers, hunter-gatherer Jahai find odours as easy to name as colours.	Majid and Kruspe (2018)
Sensory deprivation	A review of how blind and deaf individuals are able to adapt to changes in sensory input by enhancing other sensory processing.	Voss et al. (2010)

textbooks that the authors are familiar with: we make no claims that this is an exhaustive review of the relevant content in all of the Sensation and Perception textbooks currently available.

In general, most textbooks focus on the building blocks of perception. Some use diverse populations to illustrate general principles, and this is one straightforward way to increase diversity in ones content in an integrated way. Others have specific chapters treating diverse populations as special cases. Some examples are given in Table 1. We expect that many introductory perception courses will already cover lots of these topics: however, it may be useful (and very straightforward to implement) to explicitly highlight them to students as examples of diverse content.

### **Diversifying content and inclusion**

We have explored informally how our own institutions are moving towards enhancing equality and diversity in teaching, and we have consulted colleagues to begin to survey practices that are current. What follows below are a series of suggestions, we apologize to those who might have wonderful ideas and practises that we have missed. Table 2 suggests activities that could be undertaken with groups of students across many levels of study.

### **Some useful journal articles**

In this final sub-section, we present a range of areas and topics, with some suggested references, in Table 3. Again, this is not an exhaustive list, but is meant to offer somewhere to start to diversify your teaching content.

## **Conclusions**

The value of diversifying academic teaching, in the face of an increasing array of professional tasks and demands, can sometimes feel demanding, of secondary importance, or “someone else’s job”. We hope that our short review has provided motivation for thinking about how to combat the mismatch between student and teacher diversity, how diversity of sensation and perception is becoming a better researched area, and how you might go about diversifying your teaching styles and materials, to engage and inspire the next generation of scientists and clinicians.

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