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Conceptualizing Landscapes Through Language: The Role of Native Language and Expertise in the Representation of Waterbody Related Terms

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Abstract

Landscapes are essential to human life: they provide a multitude of material (food, water, pollination) and nonmaterial (beauty, tranquility, recreation) values. Their importance is enshrined in international conventions and treaties, committing signatories to protecting, monitoring, and managing all landscapes. Yet, relatively little is known about how people conceptualize "landscape" and its constituents. There is emerging evidence that conceptualizations of landscape entities may influence landscape management. This in turn raises the question as to how people speaking different languages, and with differing levels of expertise, may differ in conceptualizing landscape domains as a whole. In this paper, we investigated how people conceptualize landscape-related terms in a specific domain—waterbodies—by comparing German and English-speaking experts and nonexperts. We identified commonly used waterbody terms in sustainability discourses in both languages, and used those terms to collect sensory, motor, and affective ratings from participants. Speakers of all groups appear to conceptualize the domain of waterbody terms in comparable ways. Nevertheless, we uncovered subtle differences across languages for nonexperts. For example, there were differences in which waterbodies were associated with calm happiness in each language. In addition, olfaction seemingly plays a role

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in English speakers' conceptualization of waterbodies, but not German speakers. Taken together, this suggests the ways in which people relate to landscape although shared in many respects may also be shaped in part by their specific language and culture.

Keywords: Waterbodies; Sustainability; Concepts; Sensorimotor norms; Emotional norms

1. Introduction

The diversity of worldviews and knowledge systems held about nature by distinct communities was highlighted by a recent report on values assessment for policymakers, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services report (Pascual et al., 2022). One approach for exploring variation in knowledge systems is through the lens of language—and in particular by exploring similarities and differences in the ways in which landscapes and their elements are conceptualized through language. Studies of indigenous languages have found differences in conceptualization which can have profound consequences for human–environment relations. These differences often have implications for land cover and land use classes (Comber, Fisher, & Wadsworth, 2005) and their definitions in management. For example, experts erroneously relabeled secondary rainforest as primary assuming rainforest had not previously been cultivated (Wartmann & Purves, 2018), and classified areas used for grazing as unproductive which led to the planting of forest on what was, in fact, grazing land (Robbins, 2001). In both cases, differences in terminology relating to landscape—that did not take into consideration indigenous classifications—affected management decisions, with implications for traditional land use. The resulting importance of capturing multiple conceptualizations of our relationship with landscapes for environmental governance has recently gained traction in policy (Coscieme et al., 2020; Pascual et al., 2022).

Despite this, policy and management approaches often appear to take conceptual equivalence for granted. For example, the European Landscape Convention (Council of Europe, 2000)—which commits signatories to protecting, monitoring, and managing landscapes of all types—has two official languages, English and French, and is then translated into 41 additional languages. It ostensibly assumes straightforward equivalence between languages. However, a closer examination of the term "landscape" and presumed translation equivalents in seven European languages found the superordinate concept landscape may not be so similar across languages after all (Van Putten et al., 2020). Similarly, other international policy initiatives, such as the UN's Sustainable Development Goals (UN, 2022), are based around targets and indicators. For example, indicator 15.1.1 aims to measure "Forest area as a proportion of total land area" although in a diverse sample of languages, linguistic terms related to "forest" vary considerably, suggesting that there is no unitary underlying concept (Burenhult et al., 2017; Burenhult, 2023, in this issue). These differences may be one reason why more formal definitions of "forest"—for instance, based on tree cover and tree height—vary with profound consequences for measurements at global scales (Sexton et al., 2016). Related to these issues is a privileging of the English language, and the concepts captured therein, as a dominant language in both science and policy across many countries (Blasi, Henrich, Adamou, Kemmerer, & Majid, 2022), especially as the importance of global initiatives increases.

This raises a series of important challenges for future work in this area. While previous research has highlighted cross-linguistic differences in isolated concepts, such as "landscape" or "forest," it remains unclear whether a more systematic exploration of an entire semantic field would also yield such mismatches across languages. It could be the case that researchers have focused specifically on terms which are vague or ill-defined but these are, in fact, the minority when considering the larger vocabulary in this domain. For example, superordinate concepts, such as *landscape*, are in any case more abstract, and, therefore, potentially less likely to be comparable across languages (Malt, 1995). Moreover, studies reporting substantive differences across languages have often focused on case studies based around introspection and dictionary definitions (e.g., Bromhead, 2017; Mark, 1993), whereas quantitative corpus-based studies are divided over whether semantic domains related to the physical world (such as landscape) show substantive similarities across languages (e.g., Thompson, Roberts, & Lupyan, 2020; Youn et al., 2016). This highlights the need for further empirical study using speaker judgments to clarify the matter.

In this paper, we, therefore, examine multiple terms within a single semantic field related to "waterbodies" in two related languages, English and German, with both lay people and experts. Specifically, we explore how speakers mentally represent the domain of "waterbody" terms through sensory, motor, and emotion associations. In doing so, we assume this provides insight into the meaning of these terms, although we remain agnostic for present purposes as to whether the concepts themselves are stored in neural systems for perception and action (e.g., Barsalou, 1999; Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011) or amodal brain regions (e.g., Bedny & Caramazza, 2011; Mahon, 2015). To illustrate, a concept like *rainbow* is strongly related to visual but not olfactory information; whereas *stairs* conjure motor movements of the legs, but not mouth. Sensory, motor, and emotion ratings explain language use (Winter, 2019; Winter, Perlman, & Majid, 2018), and can predict behavioral responses to words (e.g., Connell & Lynott, 2014; Kuperman, Estes, Brysbaert, & Warriner, 2014; Lynott, Connell, Brysbaert, Brand, & Carney, 2020; Lynott & Connell, 2009; Speed, Papies, & Majid, 2023; Speed & Majid, 2017, 2020; Vergallito, Petilli, & Marelli, 2020). In the current study, we ask whether terms referring to waterbodies have different sensory, motor, and emotional associations in English and German individually and as a domain.

We focus specifically on waterbodies because water is not only essential to life—and thus the subject of a specific Sustainable Development Goal—it is also an important element in many explanations of landscape preference (Wartmann, Tieskens, van Zanten, & Verburg, 2019; Wherrett, 2000). For example, Sustainable Development Goal Indicator 6.3.2 aims to improve water quality by monitoring and increasing the "proportion of bodies of water with good ambient water quality" (United Nations, 2022.). Waterbodies are defined as rivers, lakes, and groundwater, and their technical delineation is described in detail by the United Nations Environment Programme (UNEP, 2018). Communicating this indicator assumes the public shares a conceptualization of waterbodies, as defined by experts, and this shared conceptualization extends across languages. However, there are reasons to question this. For instance, English *lake* typically refers to enclosed fresh waterbodies, but the generally accepted equivalent Gaelic word *loch* encompasses both enclosed waterbodies containing fresh water and those open to the sea. Such differences in meaning have clear implications for the ways in which indicators are understood by local populations, and potentially implemented at national levels.

Our investigation targeted English given the central role of English in previous scientific work and policy documents. As a focus of cross-linguistic comparison, we chose German—which although closely related to English (both being Germanic languages of the Indo-European family)—has been shown to differ from English with respect to word meanings in a number of other domains (e.g., Goddard, Wierzbicka, & Wong, 2016; Kopecka & Narasimhan, 2012; Majid, Gullberg, Staden, & Bowerman, 2007; Newman, 1998). A further advantage of German is that it is a well-documented language with large corpora available, and it is possible to sample demographically comparable participants to our English sample from the UK. Our German-speaking participants were from Germany and Switzerland and have similar educational and cultural backgrounds to the sample from the UK. Critically, the environmental characteristics of the two regions (UK vs. Germany and Switzerland) differ. The UK is an island surrounded by sea, while most of Germany and Switzerland are land-locked, with rivers playing a more important role for transport. These differences could have implications for conceptual representations.

In this study, we also consider the role of expertise and how it may intersect with cross-linguistic differences. Strategic policies around landscape involve experts communicating their knowledge to people with different backgrounds, but expert conceptual representations may differ from lay people in important ways. Previous studies in other domains, such as folk biology, have shown that experts have more alternative knowledge structures to draw upon when making judgments about the structure of a domain (Boster & Johnson, 1989; Wing, Burles, Ryan, & Gilboa, 2022). For example, rather than relying primarily on surface-level perceptual features, experts also use functional information to make judgments. Similarly, studies of wine experts have shown their language use (Croijmans & Majid, 2016), memory (Croijmans, Arshamian, Speed, & Majid, 2021), and imagery (Croijmans, Speed, Arshamian, & Majid, 2020) for wines differ from lay people. Together, these studies suggest that experts can have substantively different mental representations than lay people. So, domain-specific knowledge about waterbodies (as exemplified by those knowledgeable in Geography, Geology, or Environmental Science, for example) may differ from lay people. Therefore, we conducted a comparison of expert and lay people's concepts of waterbodies in order to establish the magnitude of variation across groups.

The number of terms which could fall under the rubric "waterbody" is potentially large and may differ in salience between English and German. We, therefore, began with a corpus study (Section 2) in order to identify relevant terms using newspaper corpora in each language and searched for waterbody terms in conjunction with sustainability discourses. Next, the identified terms were submitted to a rating study (Section 3) with naïve and expert participants in English and German in order to test whether the different groups conceptualized waterbodies in distinct manners across sensory, motor, and emotional dimensions. Since we aim to go beyond the potential (non-)equivalence of individual terms, but explore ways in which waterbodies are conceptualized across these dimensions, we used principal component analysis (PCA) to understand how the waterbody domain is structured within and across languages. From a policy perspective, differences in ways in which the domain as a whole is conceptualized could have implications for the ways in which policy is communicated and implemented.

2. Study 1: Identifying waterbody terms in English and German

2.1. Methods

To compile candidate terms related to waterbodies in English and German, we identified a range of sources, including online encyclopedias, other online resources (e.g., Wikipedia), place name categories from online gazetteers (i.e., GeoNames), and the scientific literature (Mark, 1993). Since we did not presume equivalence between German and English a priori, we sourced terms separately in both languages. Next, we used the frequency of occurrence for individual terms in news media as a proxy for cultural importance. To do this, we first created a corpus of potentially relevant news articles in English and German, retrieving articles published in the 10 years from 2010 to 2019 containing the keywords "sustainability" (*Nachhaltigkeit*), "conservation" (*Naturschutz,* literally "nature protection"), and "biodiversity" (*Biodiversität*).

To create a corpus of English, we relied on the Guardian API (API, 2022), thus exploring a specific newspaper, while in German, we were able to use SwissDox (SwissDox@LiRI, 2022.), a media archive containing material from many Swiss media sources. Duplicate articles were removed for the final analysis. By creating a subset of articles related to our theme of interest, we aimed to reduce the influence of polysemous or metaphorical language, for example, eliminating articles about sport which used waterbody terms in a metaphorical sense. As a final step, we searched candidate terms in the corpora for each language and ranked terms by frequency. Since many terms were still ambiguous at this stage (e.g., *well* can refer to a noun describing a water source or an adjective pertaining to health in English), we carried out a filtering step using dictionary definitions. Dictionaries often rank definitions by frequency of use, so we retained only candidate terms whose first definition referred to waterbodies explicitly, working our way through the list of terms using the Oxford English Dictionary (OED) and *Digitales Wörterbuch der deutschen Sprache* (DWDS) to remove highly ambiguous terms until we had a list of 25 relevant terms in each language selected according to frequency, an oft-used proxy for cultural interest (Michel et al., 2011).

2.2. Results

The initial search for terms pertaining to "waterbody" identified 121 unique terms in German and 114 in English. German terms, perhaps because of the common use of compound words, such as *Stausee* ("reservoir," literally "dammed lake" from *Stau* "dam" and *See* "lake"), were less prone to ambiguity, so only nine terms were removed during the initial dictionary-based vetting process. English terms were more often polysemous, with 36 of

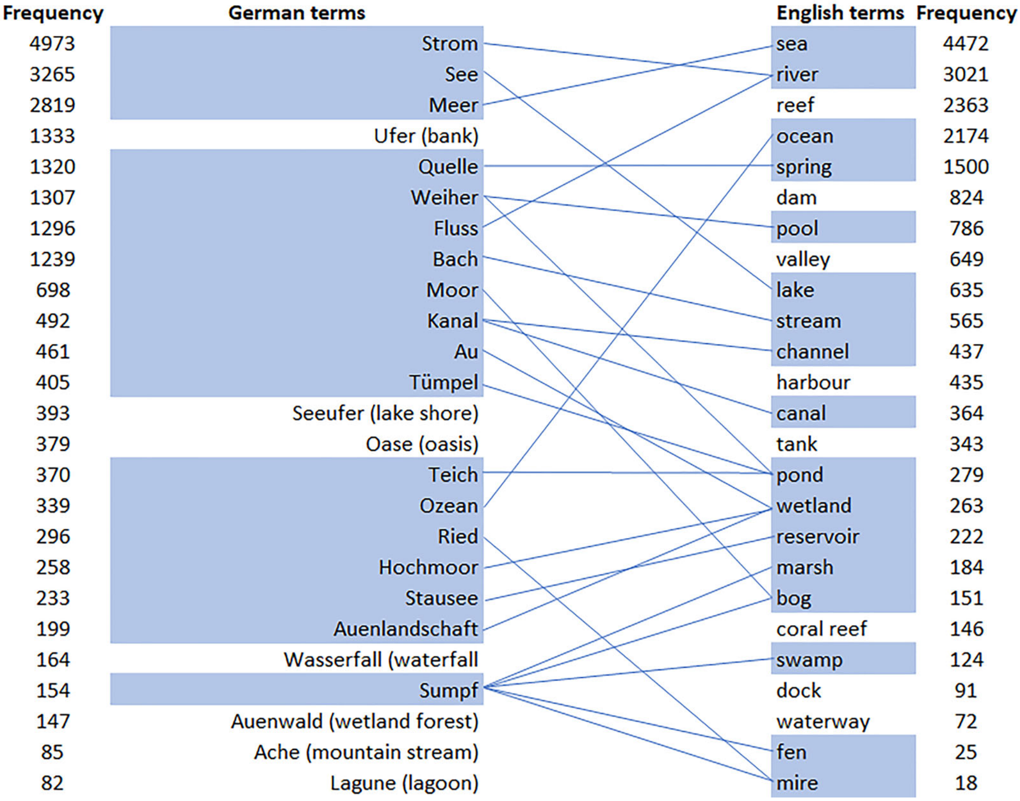

Fig. 1. German and English terms, ordered by rank frequency from most frequent (top) to least frequent (bottom), according to Swissdox (German) and Guardian's API (English). Terms highlighted in blue were judged to be presumed translation equivalents, lines connect related forms (e.g., German *Strom* is equivalent to English *river*; note, German *Fluss* is also a presumed translation equivalent of *river*).

the first 61 candidate waterbody terms eliminated before a final list of 25 was identified. For example, words whose meanings could be interpreted in different ways, such as *well*, *bank*, and so on, were removed because of their potential ambiguity. The most frequently retained German term, *Strom* (which can be "a river flowing into the sea" or "an electrical current") occurred 4973 times in the Swissdox collection of articles, whereas the least frequent term (*Lagune* "lagoon") occurred only 82 times. The most common term in English, *sea,* occurred 4472 times in the Guardian collection, while the least frequent term *mire* occurred 18 times. The 25 initially identified unambiguous terms related to waterbody in both languages are illustrated in Fig. 1 along with presumed translation equivalents as identified by two of the authors proficient in German and English.

As Fig. 1 illustrates, media articles in English and German (at least in these sources) refer to similar waterbodies in discussions of sustainability and conservation—around 60% of the top-ranked German terms had presumed English translation equivalents, and vice versa. Translation equivalents include, for example, *sea* (*Meer*), *spring* (*Quelle*), *river* (*Fluss*), and *bog* (*Moor*), with 18 of the 25 German terms having English equivalents and 17 of the 25 English terms potentially matching German terms. Where there are no identified translation equivalents, this could be because there are genuine lexical gaps, but gaps can also be explained by a number of other factors, including: (1) the initial search of waterbody-related terms conducted independently in each language failed to generate entities (e.g., waterbody-related infrastructure, such as *dock* and *harbour*, elicited in the English search process did not appear in German). (2) A term polysemous in one language was removed from its list (e.g., *bank* in English is polysemous between *river-bank* and *money-bank*, but its equivalent in German *Ufer* was unambiguous and, therefore, retained). (3) The term was specialized in one of the languages and did not have a direct presumed translation equivalent in the other (e.g., *Auenwald* "wetland forest" and *Ache* "mountain stream"). (4) The term had low ranks in one language. For example, *oasis* and *waterfall* occurred in English, but were very low frequency and so ranked lower than in German and, therefore, do not appear in the top 25 terms using the search procedure described above.

2.3. Summary

Using comparable newspaper sources in English and German, we identified commonly used terms related to waterbodies for use in Study 2. Taking frequency as a proxy for cultural interest (Michel et al., 2011), we note there is a comparable orientation toward waterbodies in relation to sustainability, as reflected in the fact that many of the same terms appear in the top 25 most frequent waterbodies. Nevertheless, even in these closely related languages, we find a handful of terms that appear uniquely in each language that are perhaps suggestive of misalignments of cultural interest, something that could be explored in future studies.

3. Study 2: Comparing conceptualizations of the waterbody domain in English and German

Having identified commonly used terms in the waterbody domain in English and German, we then carried out a rating study probing sensory perception, motor activity, and emotional value associated with terms. To qualitatively explore similarities and differences in the ways in which individual waterbody terms were used, we visualized them using radial plots. To investigate the domains as a whole, we used PCA to assess ratings further.

3.1. Participants

In total, 75 participants participated in this study. Sixty-eight participants were initially recruited using Prolific, with the criteria of first-language English speakers from the UK and first-language German speakers from Germany and Switzerland. We initially considered experts to be people who answered affirmatively to the question: "Do you have a degree or expertise in Geography, Geology, Environmental Science or a related field?" Only a small number of Prolific participants answered this expertise question positively, and so we recruited an additional seven expert participants using social media and emails sent to hydrologists. Participants were paid £9 for taking part. The study was approved by the Ethics Committee of the University of Zurich (Faculty of Arts and Social Sciences).

Data of three participants were excluded from the final analyses because they were not familiar with one of the five control items included in the study as performance checks (see Procedure). The remaining 72 participants consisted of 56 nonexperts, 27 English (14 women, 13 men; $M_{age} = 40$, range 19–68 years) and 29 German speakers (8 women, 20 men, 1 non-binary; $M_{age} = 32$, range 18–71 years), and 16 experts, 8 with English as a first language (5 women, 3 men; $M_{age} = 39$, range 21–58) and 8 with German as their first language (3 women, 5 men; $M_{age} = 43$, range 30–70). None of the English speakers indicated that they spoke German proficiently, whereas 35 of the German speakers spoke English.

3.2. Materials and procedure

The lists of 25 terms collated in German and English through Study 1 served as stimuli (Fig. 1). We used Limesurvey (Limesurvey GmbH) to implement the study in both languages. A professional translation agency translated materials from English to German and the translation was checked by a second translator. Participants took part in either the English or German questionnaire.

Each target word was presented in one of the three blocks querying associations of sensory perception, motor activity, and emotional value. Block order was counterbalanced across participants with term order randomized within each block. For sensory and motor ratings, we based the questionnaire on Lynott et al. (2020), while emotion ratings were modeled after (Warriner, Kuperman, & Brysbaert, 2013). For sensory ratings, participants were asked to rate to what extent they experienced each target concept from 0 (not at all) to 5 (greatly) for each of the following senses: by feeling through touch, tasting, smelling, sensations inside the body (interoception), hearing, and seeing, in that order. For motor ratings, participants likewise indicated if they experienced the target concept by performing an action with the head excluding mouth, foot/leg, hand/arm, mouth/throat, and torso, again using the same Likert scale. Finally, for emotion ratings, participants indicated how they felt on a 6-point scale (0–5) when they read each target for three dimensions ranging from: unhappy to happy (valence), calm to excited (arousal), and in control to controlled (dominance).

At the beginning of each rating block, participants received instructions along with a calibration word to familiarize them with the nature of the task. We used calibration words from (Lynott et al., 2020) to make sure participants understood the task: participants saw *Echo/echo*[1] before they began the sensory ratings; *Tourismus/tourism* for motor ratings; and *Statue/statue* for emotional ratings. In addition, five items also taken from Lynott et al. (2020):1276) served as control items: *lachend/laughing*, *Honig/honey*, *Republik/republic*, *hungrig/hungry*, *laut/noisy*. Participants ($n = 3$) who indicated that they did not know one of these widely known concepts were excluded from the final data analysis.

The study was self-paced and participants had the option of indicating "Don't know the meaning of this word" if it applied. Every participant completed all three blocks for all 25 items, as well as the three calibrator and five control items. After rating all items, participants were asked to fill in a demographic questionnaire. Participants completed the survey in around 30–40 min.

3.3. Results

We initially examined the rating data for all 25 terms in both languages. We excluded terms with poor response rates (i.e., where more than half the participants answered "Don't know the meaning of this word"): in German, this led to the removal of *Ache*, *Au,* and *Ried*, while in English *fen* and *mire* were removed. One unexpectedly highly ambiguous term (*Strom* in German) was also removed after a number of participants explicitly left comments on its potential ambiguity with respect to "energy," "electrical current," and "waterbodies," all of which were relevant meanings in our sustainably related corpus. We were thus left with 21 terms for further analysis in German and 23 in English.

We visualized the data using radial plots (examples for three concepts are in Fig. 2) to explore qualitative differences across concepts (following Lynott et al., 2020). As examples, we chose *Meer/sea, Stausee/reservoir* and *Sumpf/swamp* which refer to different sorts of waterbodies, including the sea (often associated with holidays and recreation), reservoirs (which are part of the built-environment and provide water to humans), and swamps or wetland areas (which are hard to access and travel through).

Fig. 2 (top) shows mean ratings from all lay participants for *Meer/sea*, indicating this concept is highly multimodal. For both English and German speakers, there was an association with all the senses. English appeared to show stronger associations than German with the haptic sense perhaps in association with activities, such as paddling or swimming. *Meer/sea* also showed high positive valence in both languages. In contrast, the still freshwaters of *Stausee/reservoir* (Fig. 2, middle) was strongly unimodal in both languages with an association primarily to vision. It was also rated as being positive in valence. Meanwhile, *Sumpf/swamp* (Fig. 2, bottom) was more negatively valenced in both languages than the other two examples, and had a reversal of dominance. So, while participants judged themselves to be more in control of *Stausee/reservoir* and *Meer/sea,* they felt less control over *Sumpf/swamp*. In both languages, *Sumpf/swamp* also had a relatively strong association with smell and a high association with foot/leg in the motor domain.

3.3.1. PCA of sensory, motor, and emotion ratings of waterbodies by lay people in German and English

To explore the conceptualization of waterbody terms in German and English in more detail, we conducted PCA which extracts information from multidimensional data by successively fitting components minimizing variance in the original data. By reducing the number of dimensions necessary to describe the data, it is possible to visually identify associations between data points—our concepts—and their ratings across dimensions. One important limitation of PCA is that decisions about how many dimensions to plot and the significance of attribute values in weighting components are often based on heuristics. However, it is possible to empirically estimate the statistical significance of both component and attribute contributions by using the original data and rearranging values, retaining their original distributions

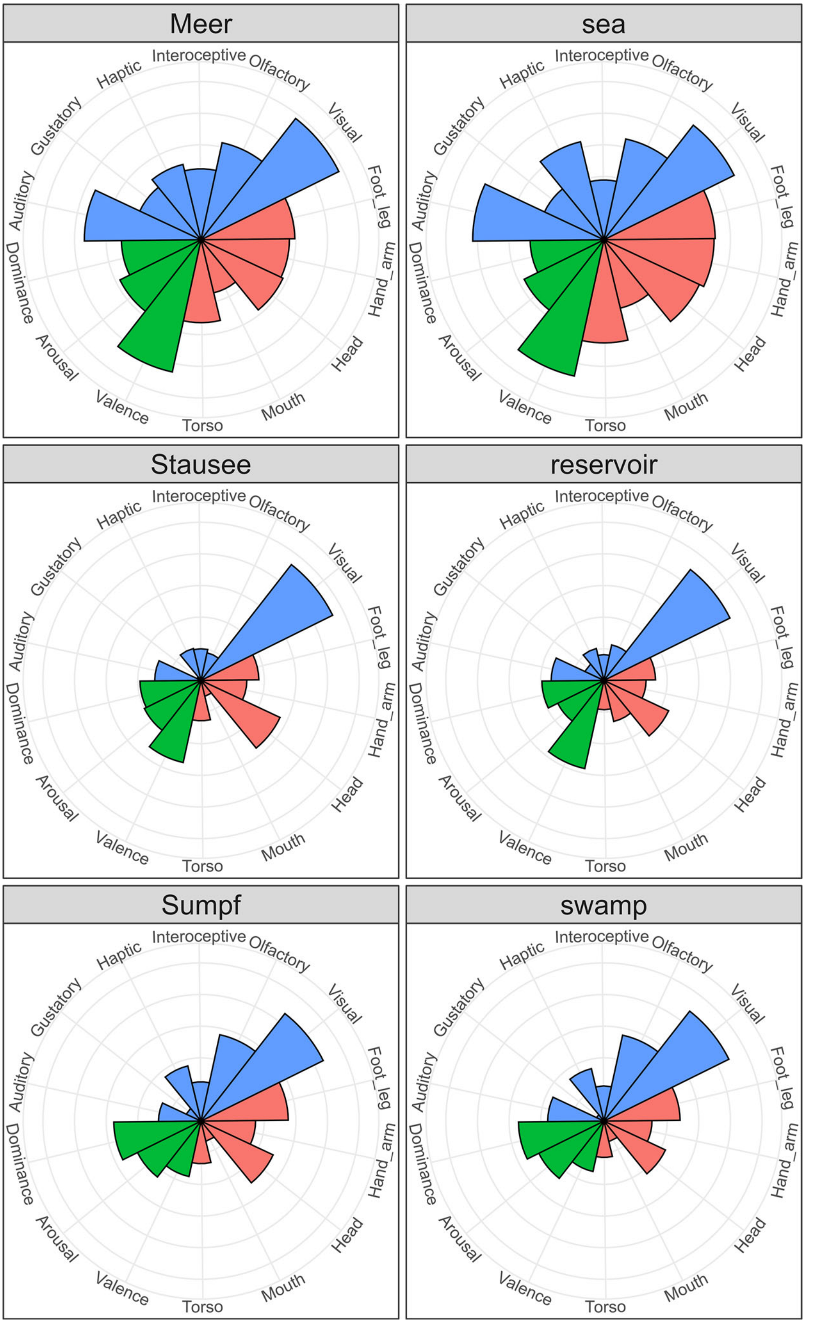

Fig. 2. Mean ratings from lay participants in German (left) and English (right) for three examples of presumed translation equivalent terms, *Meer/sea* (top), *Stausee/reservoir* (middle), *Sumpf/swamp* (bottom). Blue indicates sensory ratings, red motor ratings, and green emotion ratings.

while removing correlations. Such an approach leads to a data-driven null hypothesis, and in turn, can be used to assess whether the structure found in the input describes meaningful variation. That is the approach we used here. For each language separately, we explored how speakers assign sensory, motor, and emotion ratings to waterbodies as a domain. Similar conceptual representations between languages would be indicated if ratings pattern in the same way across language groups.

We used PCATest (Camargo, 2022a) in R (R Core Team, 2021) to calculate significance values, using 1000 random permutations and 1000 bootstrap replicates of our rating data. PCATest reports four test statistics which we used in our analysis: ψ and φ are global measures for the PCA capturing the strength of the eigenvalues and the relationship between eigenvalues and attributes, respectively (Camargo, 2022b; Vasco, 2012). If these are significant, it is possible to meaningfully interpret the principal components, which in turn are each also assigned a significance value. Finally, individual variables may also be tested as to whether they make a statistically significant contribution to each component. For example, we can establish whether each sensory modality separately is associated with waterbodies by looking at its significance value in relation to identified components. For all analyses, we treated values of $p < .05$ as significant. We conducted PCA analyses for each language and each attribute (i.e., individual ratings for sensory, motor, and emotion tasks) separately, resulting in a total of six analyses (Table 1).

In both German and English, only one component was significant for sensory and motor ratings, with the variation explained ranging between 53.9% and 83.4%. The sensory analyses revealed the senses mostly all contribute to the overall fit of the PCA, although visual ratings did not explain variation between terms (since visual ratings were consistently high across the board; and for all terms, the dominant modality was vision), and olfactory ratings were only significant in English but not German (see Table 1). For motor ratings, all five motor ratings were relevant for English, but only four of the five were significant in German with no variation in the German data explained by foot/leg. Finally, for emotion ratings, two principal components were significant in German and English, explaining 97.2% of the variation in both cases. However, the interpretation of the axes differed across languages: in German, arousal and dominance loaded significantly on the first component and valence on the second; in English, valence and dominance loaded significantly on the first component and arousal on the second.

All in all, the analyses point to commonalities across language groups, as indicated by the fact that the number of components extracted in each rating task was the same and many of the same variables were significantly associated with those components. However, there were points of discrepancy too which we discuss further below.

We examined sensory associations using the single component for German and English uncovered in the PCA (Table 1) and plotted waterbody terms on one axis (Fig. 3). In both languages, terms related to open water are plotted to the right (e.g., *Ozean, Meer; sea*, *ocean*). These concepts are multimodal and have high ratings for all the senses (see also Fig. 2). Moving from the right to left, we find other terms associated with open water (*Lagune, See*; *pool, lake*) and running water (*Wasserfall*, *Quelle*, *Bach Fluss; spring, river, stream*). As we approach a loading of zero, we find terms related more to vegetated, still waterbodies (e.g.,

Table 1
PCATest results for sensory, motor, and emotion ratings for German and English

German sensory		**English sensory**	
Empirical $\Psi = 8.10$ Max null $\Psi = 4.43$ Min null $\Psi = 0.38$ $p < .05$	PC 1 is significant and accounts for 56.8% (95% CI: 44.5–71.8) of the total variation	Empirical $\Psi = 11.05$ Max null $\Psi = 3.57$ Min null $\Psi = 0.36$ $p < .05$	PC 1 is significant and accounts for 66.3% (95% CI: 41.9–78.8) of the total variation
Empirical $\varphi = 0.52$ Max null $\varphi = 0.38$ Min null $\varphi = 0.11$ $p < .05$	**Variable PC1 loading** 1: Auditory 0.43* 2: Gustatory 0.46* 3: Haptic 0.48*	Empirical $\varphi = 0.61$ Max null $\varphi = 0.34$ Min null $\varphi = 0.11$ $p < .05$	**Variable PC1 loading** 1: Auditory 0.40* 2: Gustatory 0.47* 3: Haptic 0.43*
Empirical eigenvalue #1 = 3.41 Max null eigenvalue = 2.76 $p < .05$	4: Interoceptive 0.49* 5: Olfactory 0.18 6: Visual 0.32	Empirical eigenvalue #1 = 3.98 Max null eigenvalue = 2.53 $p < .05$	4: Interoceptive 0.47* 5: Olfactory 0.40* 6: Visual 0.22
Empirical eigenvalue #2 = 1.46 Max null eigenvalue = 1.89 $p = .26$		Empirical eigenvalue #2 = 0.92 Max null eigenvalue = 1.97 $p = 1.00$	
German motor		**English motor**	
Empirical $\Psi = 4.32$ Max null $\Psi = 2.89$ Min null $\Psi = 0.25$ $p < .05$	PC 1 is significant and accounts for 53.9% (95% CI: 40.6–73.1) of the total variation	Empirical $\Psi = 12.66$ Max null $\Psi = 2.85$ Min null $\Psi = 0.11$ $p < .05$	PC 1 is significant and accounts for 83.4% (95% CI: 64.7–91.2) of the total variation
Empirical $\varphi = 0.46$ Max null $\varphi = 0.38$ Min null $\varphi = 0.11$ $p < .05$	**Variable PC1 loading** 1: Foot/leg 0.20 2: Hand/arm 0.53* 3: Head 0.46*	Empirical $\varphi = 0.80$ Max null $\varphi = 0.38$ Min null $\varphi = 0.08$ $p < .05$	**Variable PC1 loading** 1: Foot/leg 0.40* 2: Hand/arm 0.47* 3: Head 0.44*
Empirical eigenvalue #1 = 2.69 Max null eigenvalue = 2.43 $p < .05$	4: Mouth 0.44* 5: Torso 0.52*	Empirical eigenvalue #1 = 4.17 Max null eigenvalue = 2.37 $p < .05$	4: Mouth 0.46* 5: Torso 0.47*
Empirical eigenvalue #2 = 1.29 Max null eigenvalue = 1.70 $p = .35$		Empirical eigenvalue #2 = 0.50 Max null eigenvalue = 1.63 $p = 1.00$	

(*Continued*)

Table 1
(Continued)

German emotion		**English emotion**	
Empirical $\Psi = 1.45$ Max null $\Psi = 1.27$ Min null $\Psi = 0.00$ $p < .05$	PC 1 is significant and accounts for 59% (95% CI: 53.7–71.4) of the total variation	Empirical $\Psi = 1.30$ Max null $\Psi = 1.13$ Min null $\Psi = 0.01$ $p < .05$	PC 1 is significant and accounts for 53.6% (95% CI: 50.2–66.2) of the total variation
Empirical $\varphi = 0.49$ Max null $\varphi = 0.46$ Min null $\varphi = 0.01$ $p < .05$	PC 2 is significant and accounts for 38.2% (95% CI: 26.9–43) of the total variation	Empirical $\varphi = 0.47$ Max null $\varphi = 0.43$ Min null $\varphi = 0.03$ $p < .05$	PC 2 is significant and accounts for 43.7% (95% CI: 31.3–47.2) of the total variation
Empirical eigenvalue #1 = 1.77 Max null eigenvalue = 1.92 $p < .05$	The first two PC axes are significant and account for 97.2% of the total variation	Empirical eigenvalue #1 = 1.61 Max null eigenvalue = 1.86 $p < .05$	The first two PC axes are significant and account for 97.2% of the total variation
Empirical eigenvalue #2 = 1.15 Max null eigenvalue = 1.25 $p < .05$	**Variable PC1 loading** 1: Valence 0.07 2: Arousal –0.69* 3: Dominance –0.72* **Variable PC2 loading** 1: Valence 0.92* 2: Arousal 0.32 3: Dominance –0.21	Empirical eigenvalue #2 = 1.31 Max null eigenvalue = 1.28 $p < .05$	**Variable PC1 loading** 1: Valence –0.74* 2: Arousal –0.14 3: Dominance 0.65* **Variable PC2 loading** 1: Valence 0.25 2: Arousal 0.85* 3: Dominance 0.46

Note: ψ and φ are global measures of the strength of the eigenvalues and the relationship between eigenvalues and attributes. Where significant, interpretation of principal components and variable loadings on principal components can be carried out. For all PCAs ψ and φ were significant, and we report significance of the first two principal components and the loading of each variable on significant principal components. For all analysis, we take $p < .05$ as significant (indicated with a * for variable loadings).

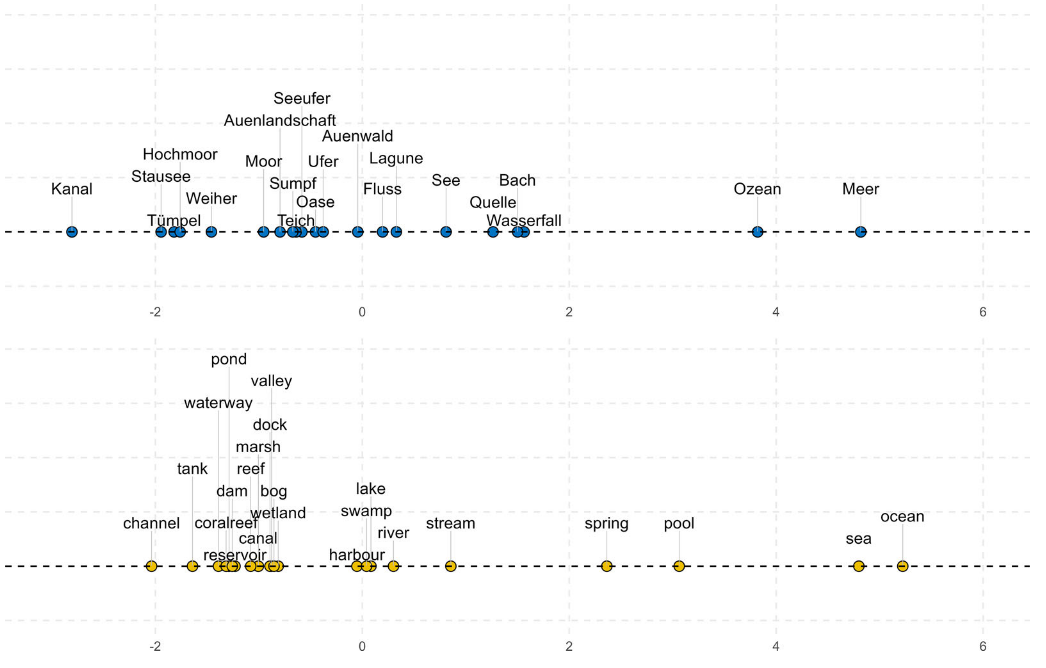

Fig. 3. Sensory ratings of waterbodies plotted according to their loading on the first principal component in German (top, blue) and English (bottom, yellow).

Auenwald; swamp). In German, we find a range of terms related to smaller waterbodies (*Teich*, *Weiher*, *Tumpel*), wetlands (*Hochmoor*, *Sumpf*), banks of lakes and rivers (*Seeufer* and *Ufer*), and finally the built environment (*Kanal* and *Stausee*). In English, built elements are also found on the extreme left (*channel, tank*), with a number of wetland and other terms related to natural and built environments clustered close together (e.g., *reservoir, coral reef, dock, dam, wetland, bog*).

Despite the fact that terms in these analyses do not completely overlap, we nevertheless find the sensory associations German and English speakers have for waterbodies share a broad organizing principle. Open or running water appears to be multimodal (generally receiving higher ratings on all the senses) and appears on one end of PC1 (right side of plots in German and English, Fig. 3), whereas waterbody concepts relating to vegetation or the built environment are generally associated less strongly with the senses (apart from the vision which is implicated in all waterbodies), and are found on the other side of PC1 (left Fig. 3). Notably, within waterbody terms, there was differentiation by the senses: for example, while *Meer/sea* and *Ozean/ocean* received relatively high ratings for both audition and olfaction, *stream, river,* and *Wasserfall* received high ratings for audition but relatively low ratings for olfaction, whereas *bog, Tümpel, Moor,* and *Hochmoor* all received high ratings for olfaction, but lower ratings for audition. This illustrates how sensory information is meaningfully linked to conceptual distinctions in this domain.

We next examined motor ratings, again projected onto a single dimension for German and English (Fig. 4). Broadly speaking, the plots were similar to those found for sensory ratings,

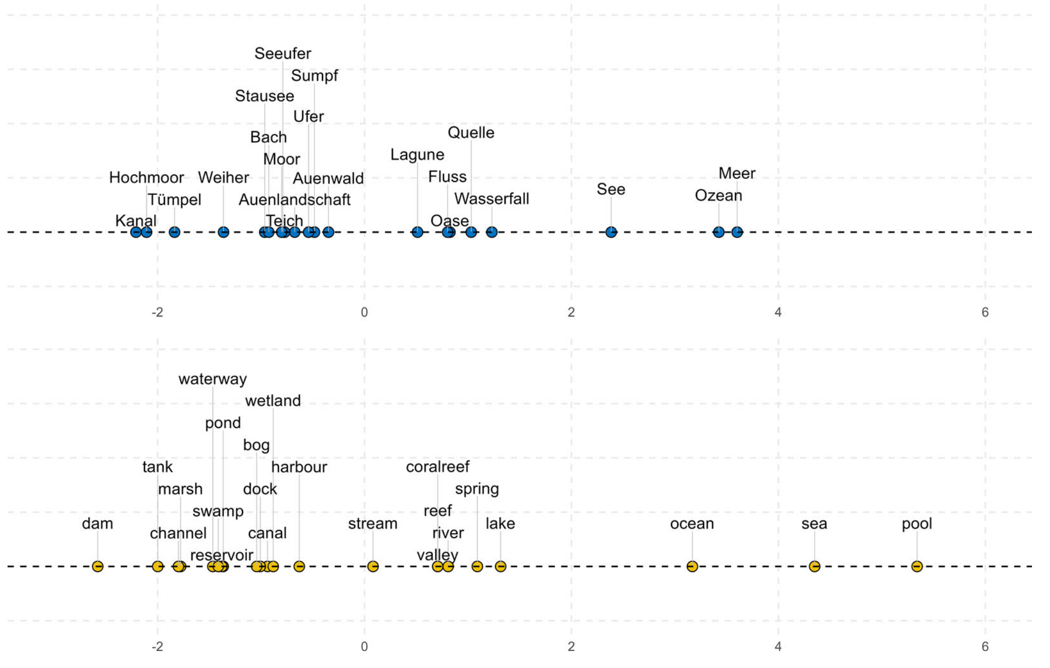

Fig. 4. Motor ratings of terms plotted according to their loading on the first principal component in German (top, blue) and English (bottom, yellow).

although *pool* was shifted to the right in English. Although there is some rearrangement of terms (e.g., *coral reef* and *reef* in English), waterbodies with strong sensory loadings also appear to be those for which motor associations are deemed important.

Finally, we turn to emotional ratings plotted according to the first two principal components in German and English. Since the loadings differ more substantively for emotion than sensory or motor information, we plotted the magnitude and direction of each rating dimension to facilitate interpretation (Fig. 5). Although valence loads onto different principal components in German and English, there were broad similarities in the emotional profiles of terms. In German, for example, *Wasserfall*, *Meer,* and *Ozean* are all places associated with happiness and excitement, and where participants felt they were controlled by their surroundings. Potentially calmer, but still positively associated locations where participants were in control included *Quelle*, *Auenlandschaft*, and *See*. Smaller waterbodies were less positively rated (e.g., *Teich*, *Weiher,* and *Tümpel*), while wetlands were rated as controlling the behavior of participants (*Hochmoor*, *Sumpf*, *Moor*), perhaps because in such environments an individual is no longer a free-agent (e.g., you cannot travel so easily).

In English, the most exciting, happy places were similar to those found in German (i.e., *coral reef, sea, ocean, river*), although *pool* was also in this cluster for English but not German speakers. A second cluster of more tranquil, positive locations included smaller waterbodies and some built environments (e.g., *pond, canal, spring, lake*). Less positive intrusions in the landscape were also often associated with the built environment where participants feel

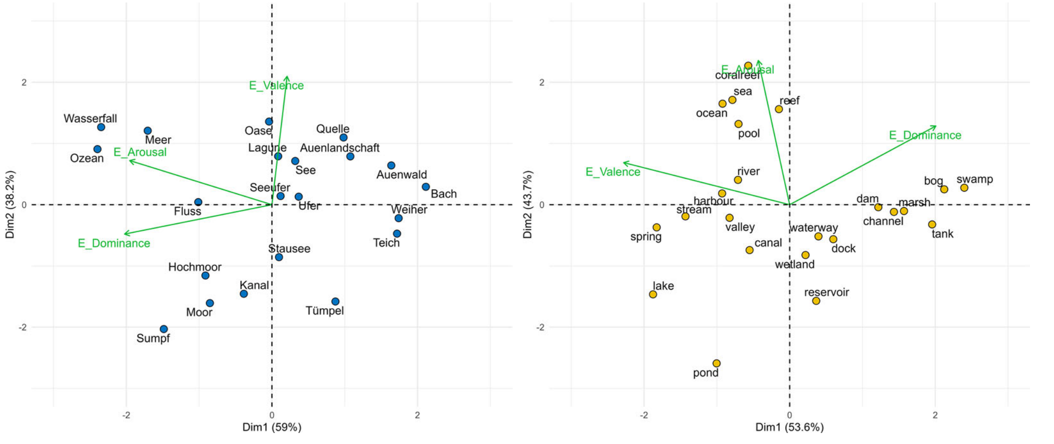

Fig. 5. Emotion ratings plotted in German (left, blue) and English (right, yellow). Arrows (green) indicate the magnitude and direction of each rating dimension.

Note: German PC1 arousal and dominance versus PC2 valence; English PC1 valence and dominance versus PC2 arousal.

increasingly controlled (e.g., *waterway, dock, channel, reservoir*). Overall, then, although positive, exciting places (which also imply a loss of control) were similar in both languages, but more calm (or tranquil) settings seemed to differ—in particular for smaller waterbodies and some elements of the built environment.

3.3.2. Comparing experts to lay participants

Having established how German and English lay people represent waterbodies, we next examined the similarity between lay and expert conceptualizations. We compared experts to lay people from their own language only, since our primary interest was to establish within-language communication ease across expertise as indicated by shared versus differing conceptualizations of landscape terms. To do this, we calculated Spearman rank correlations comparing the rank order of mean ratings assigned to each term for each rating dimension. In other words, we explored whether experts and lay people ranked concepts similarly according to individual rating dimensions.

Fig. 6 shows the correlation values for each subscale of sensory, motor, and emotion ratings for German and English expert and lay people. Overall, there was high consensus, and all ratings, with one exception, were significantly positively correlated. Only the visual dimension between expert and lay people in German did not correlate significantly, $\rho(19) = .31$, $p = .18$. Although English did show a significant association for visual ratings, it was relatively weaker, $\rho(21) = .56$, $p < .05$, in comparison to other sensory ratings (see Fig. 6). This may seem surprising since all terms loaded high on vision. However, this apparent discrepancy can be accounted for by the low variance in visual ratings. In contrast, the highest correlations were found for olfactory ratings in both German, $\rho(19) = .87$, $p < .05$, and English, $\rho(21) = .95$, $p < .05$, suggesting that there is consensus between experts and lay

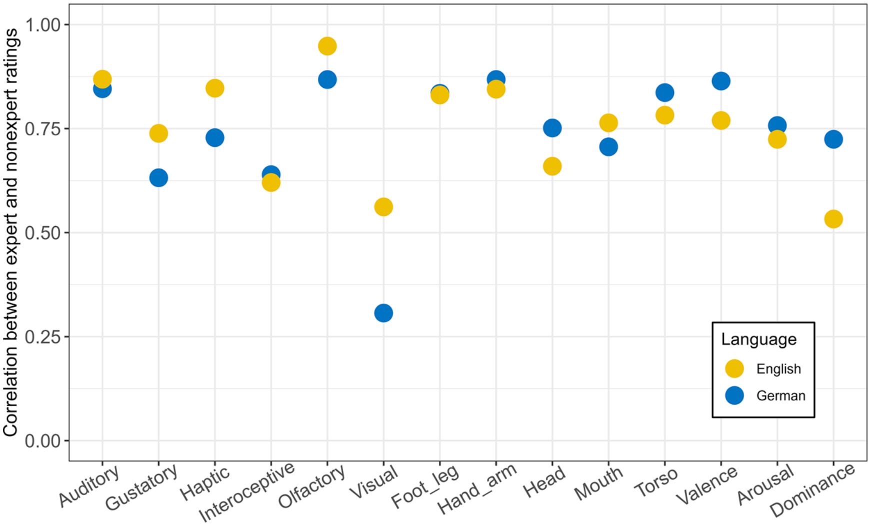

Fig. 6. Spearman rank correlations values for ratings assigned by expert and lay participants in English and German for sensory, motor, and emotion ratings. All values are significantly positively correlated ($p < .05$) with the exception of visual ratings in German.

people within-language groups in how waterbodies relate to the sense of smell. Correlations in the motor domain were robust (varying between $\rho = .66$ and $\rho = .87$), as were correlations for emotion ratings (although dominance in English was lower $\rho(21) = .53$, $p < .05$). Overall, these results suggest that experts and lay participants in our study conceptualized terms in similar ways.

4. General discussion

Research and policy development related to sustainability appears to implicitly assume that concepts are equivalent across languages and cultures, despite increasing recognition of the importance of differing value systems, worldviews, and knowledge systems. There is ample evidence from the cognitive sciences, however, that culture, language, and expertise can influence the conceptualization of diverse domains. In this study, we investigated how waterbodies in landscapes are conceptualized by different groups of people who differ in the languages they speak, the environments they live, and the expertise they have. We found notable points of convergence across groups, as well as some points of divergence, both of which we discuss here.

4.1. *Conceptualizations of waterbodies across language and expertise*

Speakers of English and German appear to have largely shared conceptualizations of waterbodies in terms of their sensory, motor, and to some extent emotion associations. This was revealed in particular by the fact that both sensory and motor ratings in the two languages collapsed onto a single dimension, where large open water bodies (e.g., *Meer*, *Ozean*; *sea, ocean*) had the highest sensorimotor ratings, whereas non-natural features (e.g., *Kanal*, *Stausee*; *dam, reservoir*), smaller enclosed waterbodies (e.g., *Tümpel*, *Weiher*; *pond*), and wetlands (e.g., *Moor*, *Sumpf*; *bog, marsh*) generally had lower ratings.

Despite the overarching similarity in both languages, there were some differences too. For example, olfactory ratings loaded significantly on the first principal component of the sensory PCA in English but not German, suggesting that English speakers considered smell to be of more relevance to waterbodies than German speakers. This highlights the importance of asking people about each sensory modality explicitly, as prior work has also demonstrated the perceptual content of a representation is not judged accurately unless attention is drawn to each modality individually (Connell & Lynott, 2016).

With respect to emotional associations, the picture was more complex. Unlike the sensory and motor ratings where only a single significant component emerged in the PCA analyses, emotion ratings were best characterized by two components, and valence contributed in different ways to each component across languages. There also appeared to be differences between English and German with respect to the sorts of locations associated with positive sentiment, and those potentially deemed tranquil. Current theory in landscape research (e.g., Wartmann et al., 2019) would predict that waterbodies are often associated with tranquility (calm, happiness) and this was indeed the case in our English data, where we found *spring, stream, canal, lake, pond,* and *valley* associated with positive valence and low arousal. However, in German presumed translation, equivalent terms (*Quelle*, *Bach,* and *See*) and smaller waterbodies (*Weiher*, *Teich*, *Tümpel*) did not seem to be associated with positive sentiment. This suggests that landscape researchers need to pay closer attention to cross-linguistic and cross-cultural data to establish whether theories are universally applicable.

Our final comparison focused on expert and lay people's conceptualizations of waterbodies. Again, we found substantive similarities, as indicated by medium to high correlations between expert and lay groups for all variables except visual, whose exceptional behavior was likely the result of ceiling effects—across the board, everyone rated all waterbodies as highly associated with vision. This suggests strong similarities across groups, irrespective of expertise. This seems to depart from previous work which found differences in conceptualizations as a result of expertise (e.g., Boster & Johnson, 1989; Croijmans & Majid, 2016; Croijmans et al., 2020, 2021). One possible explanation for this is that the terms we investigated were familiar to all participants, and so could be considered basic level with respect to waterbodies (Mark, Freksa, Hirtle, Lloyd, & Tversky, 1999). Another possibility is that sensory, motor, and emotion grounding for landscape concepts is the same for experts and lay people, it is only higher-order conceptual organization that changes with acquired knowledge. Note, however, changes in representations are seen in sensory systems for wine experts, in line with the expertise they develop (e.g., Croijmans & Majid, 2016; Croijmans et al., 2020, 2021). Characterizing precisely which aspects of conceptualization change as a function of expertise is something that requires future exploration. For example, a priori it could have been the case that hydrologists had differential motor or sensory experience as a result of their particular interactions with waterbodies.

4.2. Sensory grounding and the nature of concepts

We focused on sensory, motor, and emotion associations to waterbodies, assuming that such data provide information about the conceptual representations of waterbody terms. Since our primary interest was whether different groups—varying in language background and expertise—differ in a way that might affect policy communication, we selected a method that could be used for a large number of items and participants regardless of native language or background knowledge. Sensorimotor and emotion ratings have been shown to be important for explaining language use (Winter, 2019; Winter et al., 2018), and behavioral responses to words (e.g., Connell, 2014; Lynott et al., 2020; Speed et al., 2023), in different languages (e.g., Chen, Zhao, Long, Lu, & Huang, 2019; Filipovic Durdevic, Popović Stijačić, & Karapandžić, 2016; Lynott et al., 2020; Miklashevsky, 2018; Morucci, Bottini, & Crepaldi, 2019; Speed & Majid, 2017; Vergallito et al., 2020), and so their validity and utility are well attested.

However, there is more to conceptual representation than revealed by these ratings alone. Despite the shared structures found for sensory, motor, and emotion grounding, other aspects of conceptual representations could differ. For example, there could be differences in the overall organization of the domain and how terms relate to one another. There remain a number of open questions here: is landscape, or the subdomain of waterbodies specifically, organized in a taxonomic or partonomic manner? If there is a hierarchy, how many levels does it have? In the domain of the body, for example, it has been proposed that there are no more than six levels in any language (Andersen, 1978; Brown, 1976) but whether similar constraints hold for landscape is not known. Asking speakers to do pile-sorting with terms or probing linguistic judgments (e.g., *Is a marsh a type of wetland?*) could help elucidate how this conceptual domain is organized.

Sensory, motor, and emotion associations while clearly relevant to conceptual representations are also limited in the extent to which they shed light on deeper knowledge people have about waterbodies. Groups could differ in what they take to be the set of defining, characteristic, or commonly drawn-upon features to categorize waterbodies of different types. People could have also different judgments about prototypes or exemplars for specific waterbodies, particularly when relying on expert knowledge. These and many related questions remain to be addressed. Future studies should clarify the conceptual foundations of landscape knowledge across communities.

4.3. Broader implications of our study

Our study focused on a comparison of two closely related languages—English and German—spoken in a circumscribed geographic region. The English speakers we tested were from the UK, an island surrounded by sea, whereas the German speakers were from Germany and Switzerland, that is, in the main landlocked regions. Despite the differences in geography, we nevertheless uncovered key similarities in how terms relating to the sea and rivers were conceptualized, particularly with respect to their sensorimotor associations. This could be taken to mean that local habitats do not make a difference to how people conceptualize landscapes. However, this conclusion may be premature.

English and German are closely related languages with a history of contact and whose speakers (at least as tested in this study) share many demographic characteristics. Any of these factors could explain common patterns. It is important to note that shared conceptualizations of landscape between related languages should not be taken as a given, as previous studies have found differences between English and German in a number of other domains (e.g., Goddard et al., 2016; Kopecka & Narasimhan, 2012; Majid et al., 2007; Newman, 1998). Finding similarities between two closely related languages is a minimal threshold toward establishing universality. To truly conclude whether something is a psychological universal, a large-scale study of many unrelated linguistic communities that differ on as many cultural and demographic parameters as possible is required (Majid, 2023). A more tractable research strategy might be to consider which cultural or experiential factors may theoretically give rise to variation in the conceptualization of waterbodies in light of this exploratory study, and specifically target those in future work.

For now, the overarching similarities uncovered between both English and German, as well as expert and lay people, suggest that policymakers communicating with these audiences need not fear their messages will go too far awry. Where caution may be required is in the potential emotions evoked by different waterbodies, especially those considered to be tranquil. This issue deserves further scrutiny.

4.4. Limitations

Our work has a number of limitations. First, we selected terms based on internal criteria from each language (i.e., frequency measured in independently constructed corpora rather than parallel corpora). As such, not all terms found in one language had presumed translation equivalents in the other. Where we did assign terms as presumed translation equivalents, this could also be debated. An alternative would be to take a data-driven approach to identifying equivalent terms, but this would still require the creation of an initial list of seed terms. Second, despite the fact that the majority of terms were familiar to participants, a few were not, perhaps reflecting a difference between the discourse of newspapers and that of everyday language. Third, recruiting experts was difficult, and indeed, defining expertise is not trivial. We recruited experts through a question about academic background and by targeted recruitment of self-identified hydrologists. It may be that the lack of difference we found between experts and lay participants reflects the breadth of knowledge of these two groups, and future studies should use more stringent criteria, for example, by specifically asking questions that require expert knowledge related to waterbodies. Fourth, our study only collected sensory, motor, and emotion ratings as a way of exploring similarities and differences between terms. Collecting data about, for example, values related to sustainability or nature (cf. Bouman, Steg, & Perlaviciute, 2021) might also be important to understand how individuals and groups think about and value concepts like the sea, rivers, and moors. Finally, our work was carried out on two closely related languages, so similarities across communities must be interpreted with caution, especially since many of the German speakers had knowledge of English. It certainly does not imply that more distantly related languages will have the same patterns.

5. Conclusions

To conclude, speakers of English and German, both experts and lay people, broadly share conceptualizations of waterbodies—especially as they relate to their sensory and motor grounding. This is consistent with what has previously been reported in some corpus studies (e.g., Thompson et al., 2020), and challenges more extreme forms of relativity proposed in this domain. Some tentative evidence in favor of differences were found such that English speakers judged olfaction to be significantly associated with waterbodies, but German speakers did not.

The most substantive differences between languages could be found in the affective associations speakers had with waterbodies, suggesting the ways people relate to landscape may in part be shaped by culture. These differences in affective associations may in turn have policy implications—in English, we find a clear link between a cluster of waterbody terms and calming happiness which we associate with the extensive literature on tranquility in English, while this cluster appears to be missing in German. Since preserving the tranquility of natural areas is sometimes a policy goal, operationalizing models of tranquility or peacefulness in non-English speaking communities should, therefore, not simply transfer existing models, but begin by exploring how tranquility is conceptualized in other cultures.

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Note

1 The first word is in German and the second in English. Note in German, all nouns are always written with a capital letter.

References

Andersen, E. S. (1978). Lexical universals of body-part terminology. In J. H. Greenberg, & E. A. Moravcsik (Eds.), *Universals of human language* (Vol. 3, pp. 335–368). Stanford University Press.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, *22*(4), 577–660.

Bedny, M., & Caramazza, A. (2011). Perception, action, and word meanings in the human brain: The case from action verbs. *Annals of the New York Academy of Sciences*, *1224*(1), 81–95.

Blasi, D. E., Henrich, J., Adamou, E., Kemmerer, D., & Majid, A. (2022). Over-reliance on English hinders cognitive science. *Trends in Cognitive Sciences*, *26*(12), 1153–1170.

Boster, J. S., & Johnson, J. C. (1989). Form or function: A comparison of expert and novice judgments of similarity among fish. *American Anthropologist*, *91*(4), 866–889.

Bouman, T., Steg, L., & Perlaviciute, G. (2021). From values to climate action. *Current Opinion in Psychology*, *42*, 102–107.

Bromhead, H. (2017). The semantics of standing-water places in English, French, and Pitjantjatjara/Yankunytjatjara. In Zhengdao Y. (Ed.), *Semantics of Nouns*, Oxford, Oxford Academic.

Brown, C. H. (1976). General principles of human anatomical partonomy and speculations on the growth of partonomic nomenclature. *American Ethnologist*, *3*(3), 400–424.

Burenhult, N. (2023). Sustainability and semantic diversity: A view from the Malayan rainforest. *Topics in Cognitive Science*, *15*, 546–559.

Burenhult, N., Hill, C., Huber, J., Van Putten, S., Rybka, K., & San Roque, L. (2017). Forests: The cross-linguistic perspective. *Geographica Helvetica*, *72*(4), 455–464.

Camargo, A. (2022a). PCAtest: Statistical significance of PCA.

Camargo, A. (2022b). PCAtest: Testing the statistical significance of principal component analysis in R. *PeerJ*, *10*, e12967.

Chen, I.-H., Zhao, Q., Long, Y., Lu, Q., & Huang, C.-R. (2019). Mandarin Chinese modality exclusivity norms. *PLoS One*, *14*(2), e0211336.

Comber, A., Fisher, P., & Wadsworth, R. (2005). What is land cover? *Environment and Planning B: Planning and Design*, *32*(2), 199–209.

Connell, D., & Lynott, L. (2014). I see/hear what you mean: Semantic activation in visual word recognition depends on perceptual attention. *Journal of Experimental Psychology: General*, *143*(2), 527.

Connell, L., & Lynott, D. (2016). Do we know what we're simulating? Information loss on transferring unconscious perceptual simulation to conscious imagery. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(8), 1218.

Coscieme, L., daSilva Hyldmo, H., Fernández-Llamazares, Á., Palomo, I., Mwampamba, T. H., Selomane, O., Nadia, S., Pedro, J., Yasuo, T., Michelle, L., Barral M. P., Farinaci J. S., Julio, D-J., Sonali, G., Ojino, J., Alassaf, A., Baatuuwie, B. N., Lenke, B. … Zeenatul, B. (2020). Multiple conceptualizations of nature are key to inclusivity and legitimacy in global environmental governance. *Environmental Science & Policy*, *104*, 36–42.

Council of Europe. (2000). European Landscape Convention. *Report and Convention Florence*, *ETS No. 17*(176), 8.

Croijmans, I., Arshamian, A., Speed, L. J., & Majid, A. (2021). Wine experts' recognition of wine odors is not verbally mediated. *Journal of Experimental Psychology: General*, *150*(3), 545.

Croijmans, I., & Majid, A. (2016). Not all flavor expertise is equal: The language of wine and coffee experts. *PLoS One*, *11*(6), e0155845.

Croijmans, I., Speed, L. J., Arshamian, A., & Majid, A. (2020). Expertise shapes multimodal imagery for wine. *Cognitive Science*, *44*(5), e12842.

Filipovic Durdevic, D., Popović Stijačić, M., & Karapandžić, J. (2016). *A quest for sources of perceptual richness: Several candidates*. Filozofski fakultet u Novom Sadu.

Goddard, C., Wierzbicka, A., & Wong, J. (2016). "Walking" and "running" in English and German: The conceptual semantics of verbs of human locomotion. *Review of Cognitive Linguistics*, *14*(2), 303–336.

Guardi API. (2022). The Guardian Open Platform. Retrieved from https://open-platform.theguardian.com/

Kopecka, A., & Narasimhan, B. (2012). *Events of putting and taking: A crosslinguistic perspective*. John Benjamins Publishing Company.

Kousta, S. T., Vigliocco, G., Vinson, D. P., Andrews, M., & Del Campo, E. (2011). The representation of abstract words: Why emotion matters. *Journal of Experimental Psychology: General*, *140*(1), 14.

Kuperman, V., Estes, Z., & Brysbaert, A. B., & Warriner, M. (2014). Emotion and language: Valence and arousal affect word recognition. *Journal of Experimental Psychology: General*, *143*(3), 1065–1081.

Lynott, D., & Connell, L. (2009). Modality exclusivity norms for 423 object properties. *Behavior Research Methods*, *41*(2), 558–564.

Lynott, D., Connell, L., Brysbaert, M., Brand, J., & Carney, J. (2020). The Lancaster Sensorimotor Norms: Multidimensional measures of perceptual and action strength for 40,000 English words. *Behavior Research*, *52*(3), 1271–1291.

Mahon, B. Z. (2015). What is embodied about cognition? *Language, Cognition and Neuroscience*, *30*(4), 420–429.

Majid, A. (2023). Establishing psychological universals. *Nature Reviews Psychology*, *2*, 199–200.

Majid, A., Gullberg, M., Staden, M. v., & Bowerman, M. (2007). How similar are semantic categories in closely related languages? A comparison of cutting and breaking in four Germanic languages. *Cognitive Linguistics*, *18*(2), 179–194.

Malt, B. C. (1995). Category coherence in cross-cultural perspective. *Cognitive Psychology*, *29*(2), 85–148.

Mark, D. M. (1993). Toward a theoretical framework for geographic entity types. In *European Conference on Spatial Information Theory* (pp. 270–283).

Mark, D. M., Freksa, C., Hirtle, S. C., Lloyd, R., & Tversky, B. (1999). Cognitive models of geographical space. *International Journal of Geographical Information Science*, *13*(8), 747–774.

Michel, J.-B., Shen, Y. K., Aiden, A. P., Veres, A., Gray, M. K., Pickett, J. P., Hoiberg, D., Clancy, D., Norvig, P., Orwant, J., Pinker, S., Nowak, M. A., & Aiden, E. L. (2011). Quantitative analysis of culture using millions of digitized books. *Science*, *331*(6014), 176–182.

Miklashevsky, A. (2018). Perceptual experience norms for 506 Russian nouns: Modality rating, spatial localization, manipulability, imageability and other variables. *Journal of Psycholinguistic Research*, *47*(3), 641–661.

Morucci, P., Bottini, R., & Crepaldi, D. (2019). Augmented modality exclusivity norms for concrete and abstract Italian property words. *Journal of Cognition*, *2*(1)

Newman, J. (1998). *The linguistics of giving*. John Benjamins Publishing Company.

R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Robbins, P. (2001). Fixed categories in a portable landscape: The causes and consequences of land-cover categorization. *Environment and Planning A*, *33*(1), 161–179.

Sexton, J. O., Noojipady, P., Song, X. P., Feng, M., Song, D. X., Kim, D. H., Anupam A., Chengquan H., Saurabh C., Pimm S. L., & Townshend John R. (2016). Conservation policy and the measurement of forests. *Nature Climate Change*, *6*(2), 192–196.

Speed, L. J., & Majid, A. (2017). Dutch modality exclusivity norms: Simulating perceptual modality in space. *Behavior Research Methods*, *49*(6), 2204–2218.

Speed, L. J., & Majid, A. (2020). Grounding language in the neglected senses of touch, taste, and smell. *Cognitive Neuropsychology*, *37*(5–6), 363–392.

Speed, L. J., Papies, E. K., & Majid, A. (2023). Mental simulation across sensory modalities predicts attractiveness of food concepts. *Journal of Experimental Psychology: Applied*.

SwissDox@LiRI. (2022). Retrieved from https://www.liri.uzh.ch/en/services/swissdox.html

Thompson, B., Roberts, S. G., & Lupyan, G. (2020). Cultural influences on word meanings revealed through large-scale semantic alignment. *Nature Human Behaviour*, *4*(10), 1029–1038.

Pascual, U., Balvanera, P., Christie, M., Baptiste, B., González-Jiménez, D., Anderson, C. B., Athayde, S., Barton, D. N., Chaplin-Kramer, R., Jacobs, S., Kelemen, E., Kumar, R., Lazos, E., Martin, A., Mwampamba, T. H., Nakangu, B., O'Farrell, P., Raymond, C. M., Subramanian, S. M. … Termansen, M.. (2022). Summary for policymakers of the methodological assessment of the diverse values and valuation of nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat.

UN. (2022). Sustainable Development Goals. United Nations. Retrieved from https://sdgs.un.org/

UNEP. (2018). Step-by step monitoring methodology for indicator 6.3.2. United Nations Environment Programme. Retrieved from https://wesr.unep.org/media/docs/projects/step_by_step_methodology_632_revision_final.pdf

United Nations. (2022). SDG Indicators: Metadata repository. Retrieved from https://unstats.un.org/sdgs/metadata/

Van Putten, S., O'Meara, C., Wartmann, F., Yager, J., Villette, J., Mazzuca, C., Bieling, C., Burenhult, N., Purves, R., & Majid, A. (2020). Conceptualisations of landscape differ across European languages. *PLoS One*, *15*(10), e0239858.

Vasco, M. N. C. S. (2012). Permutation tests to estimate significances on principal components analysis. *Computational Ecology and Software*, *2*(2), 103.

Vergallito, A., Petilli, M. A., & Marelli, M. (2020). Perceptual modality norms for 1,121 Italian words: A comparison with concreteness and imageability scores and an analysis of their impact in word processing tasks. *Behavior Research Methods*, *52*(4), 1599–1616.

Warriner, A. B., Kuperman, V., & Brysbaert, M. (2013). Norms of valence, arousal, and dominance for 13,915 English lemmas. *Behavior Research*, *45*(4), 1191–1207.

Wartmann, F. M., & Purves, R. S. (2018). 'This is not the jungle, this is my barbecho': Semantics of ethnoecological landscape categories in the Bolivian Amazon. *Landscape Research*, *43*(1), 77–94.

Wartmann, F. M., Tieskens, K. F., van Zanten, B. T., & Verburg, P. H. (2019). Exploring tranquillity experienced in landscapes based on social media. *Applied Geography*, *113*, 102112.

Wherrett, J. R. (2000). Creating landscape preference models using internet survey techniques. *Landscape Research*, *25*(1), 79–96.

Wing, E. A., Burles, F., Ryan, J. D., & Gilboa, A. (2022). The structure of prior knowledge enhances memory in experts by reducing interference. *Proceedings of the National Academy of Sciences*, *119*(26), e2204172119.

Winter, B. (2019). *Sensory linguistics*. Benjamins.

Winter, B., Perlman, M., & Majid, A. (2018). Vision dominates in perceptual language: English sensory vocabulary is optimized for usage. *Cognition*, *179*, 213–220.

Youn, H., Sutton, L., Smith, E., Moore, C., Wilkins, J. F., Maddieson, I., Croft, W., & Bhattacharya, T. (2016). On the universal structure of human lexical semantics. *Proceedings of the National Academy of Sciences*, *113*(7), 1766–1771.