Patterns of iconicity across sign languages and gestures

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Introductory remarks

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Examiners:

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- Dr. Gerardo Ortega

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Chapter 1

Introduction

Human communication is richer and more complex than just spoken or written words. It is inherently multimodal. We don't just talk. We also gesture and sign to convey expressive meaning by visually displaying properties of the intended meaning through iconicity: resemblance-based relationships between a form and its referent (Dingemanse et al., 2020; Holler & Levinson, 2019; Perniss, 2018; Perniss et al., 2010; Winter, Woodin, & Perlman, 2023). While spoken language, or its written representation, is often seen as the default in linguistics, sign languages used by deaf communities show that language adapts to the most accessible modality for its users (Goldin-Meadow & Brentari, 2017). Manual gestures, using the same modality as sign languages, are employed by language users from all communities (Kita, 2009; Liszkowski et al., 2012) and even congenitally blind individuals, who have never seen other people gesture (Iverson & Goldin-Meadow, 1997; Karadöller et al., 2024; Mamus et al., 2023; Özçalışkan et al., 2016). They play a crucial role for both the receiver, by providing additional information (Drijvers & Özyürek, 2017), and the sender, by structuring thought, aiding recall, and supporting language planning (Chu & Kita, 2011; Hagoort & Özyürek, 2024; Kita et al., 2017). Throughout history, different modalities have been strategically used for different communicative needs. Particularly gestures and signs represent notable examples of how the body itself is a powerful tool for language and meaning-making in the visuo-manual modality (Ferrara & Hodge, 2018; Holler & Levinson, 2019; Kusters & De Meulder, 2019; Vigliocco et al., 2014).

Gestures and signs, though different in fundamental ways, share their ability to exploit the visuo-manual modality for depiction. Both can directly use the body and manual articulators to depict embodied actions and spatial layouts in a highly intuitive way. An example is the concept EAT. For ease of reference and comparison purposes, I will use this example at several points throughout this dissertation. In both signs and gestures, this concept is depicted iconically through the action of bringing food to the mouth, depicting a visually salient and fundamental feature of the process of eating food (see Figure 1.1). Note that this may not be the most salient part of the experience of eating food, which is presumably related to the actual process of eating. Instead, it represents the part is visually accessible to an observer and involves the hands, which serve as the main articulators for gestures and signs.

This example shows a typical occurrence, where signs and gestures from different signed and spoken language contexts select similar iconic depictions in order to represent concepts, resulting in similar forms. The affordances of the visuo-manual modality for iconicity are therefore taken to drive high lexical similarities across sign languages, even in the absence of historical relationships (Guerra Currie et al., 2002; Wittmann, 1991; Woll, 1984). However, not just any two iconic signs are likely to show high form overlap. Instead, the specific aspects of the referent that are depicted and the way they get mapped

Figure 1.1: EAT signed by a BSL signer (left) and gestured by a hearing non-signer from Germany (right). In both forms, the hand moves from neutral space towards the mouth. The forms differ in handshape and the specific movement path.

neutral

onto the manual articulators, i.e. the iconic relationship between form and meaning, needs to align for lexical similarities to emerge across languages.

This dissertation explores the ways in which the body is used in the depiction of referents in hearing people's gestures and lexical signs in two established sign languages. Lexical signs were selected from a semantic elicitation task conducted with deaf signers of British Sign Language (BSL) in Birmingham, UK, and of German Sign Language (Deutsche Gebärdensprache) (DGS) in Cologne, Germany (see Chapter 2). The two sign languages are established sign languages that are recognised as the official languages of the deaf communities in the two countries. These signs were compared to each other and to gestures elicited from non-signers in both countries.

The BSL and DGS signs compared in this dissertation are lexical signs, that are used within the deaf communities of the two research sites. As such, they have a conventionalised form and meaning, and while iconic mappings in these signs can be identified by the signer and by observers, they are not created on the spot and are likely to not always come to the forefront in linguistic production and processing (Gimeno-Martínez & Baus, 2022). Meanwhile, the gestures elicited for this research are spontaneous productions, created by hearing speakers of English and German, with no knowledge of a sign language. As such, they are likely to be highly variable and reflect an online mapping process, in which the gesturer has to actively consider the concept and how to best represent it. Differences between gesturers thus reflect different perspectives on how to approach a given concept, what characteristics are salient, and a range of possibilities for depiction. This means that the lexical comparison between the two sign languages provides us with insights into cross-linguistic similarities and differences, while the comparison with gesturers gives us insights into the potential for iconicity that is intrinsic to these concepts.

1.1 Iconicity in gestures and signs

In sign languages and gestures, iconicity typically depicts the shape, size, and handling of referents, spatial layouts or movements through space. Because the manual articulators move through the space in front of our bodies, this type of information is particularly easy to depict (Dingemanse et al., 2015; Perniss & Vigliocco, 2014). To understand how these mappings might be constructed, Taub (2001) proposes the *analogue-building model*, which provides a step by step process of deriving the articulatory form from specific construals of the referent. Following Gentner (1983), iconic mappings can also be understood as structure-preserving mappings building on analogies between conceptualisations and articulatory forms. For example, the action of eating can be depicted by enacting the action with the hands, thereby creating an iconic sign or gesture (Emmorey, 2014; Taub, 2001). This direct link between form and meaning can ground gestures, signs, and even spoken words in sensori-motor experiences with bodily actions and visual percepts (Flaksman, 2020; Perniss & Vigliocco, 2014).

Different theoretical approaches have been proposed to categorise and measure iconic form-meaning relationships across language modalities. Dingemanse et al. (2020) distinguishes categorical approaches, which describe iconicity at the level of the individual item, and approaches capturing the strength of iconic relationships, typically pooling ratings from a group of observers. Classification systems are by their very nature more specific to the particular types of mappings available in a given modality, while quantifying the degree of iconicity is a fairly modality agnostic approach. This is because classification systems specify the relationship between form and meaning in terms of the types of features selected and how they are depicted. Meanwhile, quantifying the strength of the relationship between a form and its referent requires a more holistic perception, in which all sorts of mappings could be considered.

This dissertation focuses on a categorical classification of iconic mappings in the visuo-manual modality, building on the classification system proposed by Müller (2009). This system has been further modified and applied to both gestures and signs of different sign languages in prior research, facilitating comparisons between the findings in this dissertation and prior work. In the system used in this dissertation, we distinguish mappings in which the signer's or gesturer's body stands in for the body performing the target action or acting on a referent (*acting*), from those in which the hand depicts some aspect of the size or shape of the referent embedded in action (*representing*) or as a detached entity (*entity*). We also consider items in which a non-human body is mapped onto the body of the signer or gesturer (*personification*) and those in which the hands trace the outline of the referent (*tracing*). Finally, we accounted for pointing signs (*deictic*) and included a category for signs which did not fit into our categorisation scheme (*other*, for more details on the coding scheme see Subsection 3.1.1 and Subsection 4.2.3). The set of categorisations of iconic mappings will be referred to as "iconic strategies" throughout this dissertation.

1.2 Iconicity in concrete concepts

The description of iconic mappings in the visuo-manual modality above links it to depictions of bodily actions and spatial layouts. This implies a strong embodiment and a grounding of iconic strategies in concrete experiences. In this dissertation, concrete concepts are defined as accessible to direct perception through personal, embodied and sensory experience, while the understanding of abstract concepts is mediated through language. Concepts are understood to exist on a continuum between those two extremes and individuals may differ in their perception of the degree of concreteness of a given concept (Borghi, 2023; Brysbaert et al., 2014).

Prior studies have indeed largely focused on highly concrete, often easily visualisable concepts, excluding abstract concepts. Past research into the use of iconic strategies in sign languages and gestures has indeed typically been confined to concrete concepts, exploring semantic domains such as everyday actions, tools, or animals (e.g., Hou, 2018; Hwang et al., 2017; Ortega & Özyürek, 2020b; Padden et al., 2013; van Nispen et al., 2017). This focus highlights the assumption that iconicity is most suitable for representing concrete concepts, a suggestion made explicit in Lupyan and Winter (2018) as an explanation of why (spoken) languages are not more iconic. However, other studies have not been able to confirm this suggested link between concreteness and iconicity even in spoken languages (Perlman et al., 2018). Considering the strong affordances of the visuo-manual modality for iconicity, it would thus be surprising, if we found no traces of iconicity in signs and gestural representations of abstract concepts. Therefore, this dissertation sets out to explore the use of iconicity not only in concrete but also abstract domains.

1.3 Iconicity in abstract concepts

Sign languages, however, are known to use iconicity to ground even highly abstract concepts. Meir and Cohen (2018) explores these more complex representations in more detail, showing that iconic mappings can be combined with metonymic or metaphorical representations to create a *double mapping* capable of representing even highly abstract concepts. This dissertation understands metaphorical mappings to involve "understanding one thing in terms of another" (Cienki & Müller, 2008, p. 486) and uses it as an umbrella term that includes what might be more precisely defined as a metonymic relationship, in which the whole is understood in terms of its parts. Both iconicity and metaphor thus build on mappings that combine two domains. In the case of iconicity, the mapping is between form and meaning, and in the case of metaphors it relates the source and target domains (Meir & Cohen, 2018, p. 865). In this way, gestures and signs for both concrete and abstract concepts can be considered iconic in this dissertation. According to (Cienki & Müller, 2008), concrete iconic signs directly depict aspects of the referent itself, while abstract iconic signs depict "aspects of the entity, action, or relation in terms of which the referent is characterized (metaphoric [abstract] reference)" (2008, 485, square brackets in the original).

We thus have an understanding of how iconic mappings can be linked to metaphorical representations, to refer to abstract concepts in the visuo-manual modality. However, previous research has not systematically explored how iconic strategies may be used across abstract concepts and whether there are differences between strategies in their ability to refer to abstract concepts. Specifically for silent gestures, no prior research has charted how non-signers use iconic strategies to represent abstract concepts across semantic domains. This dissertation addresses this gap, exploring how iconicity can be used to depict abstract referents both in sign languages and gestures of hearing non-signers.

1.4 Overview of studies in this dissertation

This dissertation sets out to explore how iconicity shapes form-meaning mappings in the visuo-manual modality and shapes the lexicon for both concrete and abstract concepts. Data will be drawn from two sign languages, BSL and DGS, and silent gestures of hearing people in Germany and the UK. This introduces several dimensions through which this study advances our understanding of how iconicity is used as a strategy for meaning making across the lexicon. The first is the role of concreteness and its interaction with iconicity. The second stems from the cross-linguistic comparison of two sign languages, potentially allowing for the identification of language-specific characteristics. And finally, the comparison between signs and silent gesture allows for an investigation into how iconicity may be a resource available for depiction in the visuo-manual modality more generally and the identification of elements that may be specific to the context of a fully fledged linguistic system.

Chapter 2 provides additional background information on how the concepts were selected, which then serve as the basis for analyses in the subsequent chapters. In addition, the chapter provides details about the concreteness ratings collected from multiple groups of raters for these concepts. The chapter does not answer a specific research question but rather provides methodological background information supporting the subsequent research studies.

Chapter 3 explores form-meaning mappings in concrete and abstract concepts. While it is fairly well understood that iconic mappings are available to create abstract references in sign languages through iconic-metaphoric or iconic-metonymic double mappings, it has not been studied how these mappings interact with perceived concreteness. In the domain of sign languages, we thus explore the suitability of different iconic strategies for abstraction, comparing their use for abstract and concrete concepts in BSL and DGS and how the use of iconic strategies relates to form overlap between the two languages. The study thus specifically seeks to answer two research questions:

RQ 1: How are iconic strategies distributed in BSL and DGS, and does the distribution differ by language?

RQ 2: What is the relationship between iconic strategies, degree of concreteness, and form overlap?

Chapter 4 investigates the impact of iconicity and concreteness on the production of gestures in hearing adults from Germany and the UK. While previous studies have shown consistency in the productions of gestures for concrete concepts in non-signers across multiple countries, similar studies are not available in the domain of abstract concepts. Studying how non-signers use iconicity to produce depictions of abstract concepts will provide a valuable baseline for understanding how iconicity operates outside the realm of linguistic structure. The study will explore to what extent gesturers, who do not know a sign language, are able to represent abstract concepts in the visuo-manual modality and how difficulties that may emerge in creating such mappings express themselves. We ask to what extent variation of gestural representations can show the expressive potential and the uncertainties involved in creating abstract and concrete references with their hands. Finally, we compare gestural productions to signs from BSL and DGS, in order to gain a better understanding of the influence of the dimensions of concreteness and conventionalisation of the linguistic system in which a sign is situated. The study thus specifically seeks to answer three research questions:

RQ 3: How does the (supposed) greater suitability of iconicity for representing concrete concepts manifest in gestures?

RQ 4: How is iconicity used in gestural depictions of abstract concepts?

RQ 5: Does the role of iconicity in silent gesture also manifest in lexical items in sign languages?

Chapter 2

Concept selection, signs, and concreteness ratings

The data for this dissertation was collected in the context of a larger research project. This chapter provides background on how the list of concepts for the studies presented in Chapters 3 and 4 was derived and how different groups of raters perceived the concreteness of these items. Elements from this section will be repeated in the main studies presented in chapters 3 and 4, where they are relevant to the individual analyses.

2.1 Sign elicitation

Lexical comparisons are often conducted using word lists originally developed for eliciting supposedly culturally-neutral concepts in spoken languages. Often, these are based on different adaptations of Swadesh lists (Swadesh, 1955), comprising varying numbers of items, and follow methods from the lexicostatistics of spoken languages, e.g. computing Levenshtein distances based on overlap between form constituents in sign pairs across languages. However, as Woll (1984) already pointed out, such lists, even when adapted to sign languages, are inadequate for the study of modern, urban deaf populations, as many items are culturally irrelevant to those populations. Some more recent studies therefore developed their own lists. These, however, frequently used written materials as a point of departure which introduces problems of accurate translations, where the original glosses might suggest a translation equivalence that does not reflect the true relationship between the gloss and the sign (Langer et al., 2014).

As this project is focused on the use of iconicity in the visuo-manual modality, all data collection was driven by considerations from a sign language perspective. This included the selection of concepts that would serve as a basis for all further data collection. By using BSL and DGS as points of departure, we mitigate the issues laid out above and are able to select concepts that are relevant to the sign language communities in question and select signs that were produced by signers from these communities. We collected concepts from a wide range of semantic domains and levels of concreteness and abstraction. Of course, with just over 200 concepts, this selection cannot be representative of the whole lexicon of either sign language, nor are we able to show lexical variation within BSL and DGS. We conducted a semantic elicitation task with deaf signers from Germany and the UK to create a list of signs that would be relevant to the respective deaf communities.

2.1.1 Participants and recruitment

Deaf informants were invited to participate in what was initially intended to be a pilot phase for a larger semantic elicitation study. However, due to the Covid-19 pandemic and lockdown regulations at German and British universities, data acquisition had to be stopped and we decided to proceed by analysing the pilot data. All pilot participants in Germany were employees at the university, who were not involved in the project otherwise and thus naive as to the specific research aims. All participants gave their informed consent for data analysis and further processing. The German informants participated on work time, while the British informants received individual monetary compensation for their time.

A total of 5 Deaf signers of DGS in Germany (mean age = 38.2, range: [25, 54]; gender: 1 woman, 4 men) and a total of 4 Deaf signers of BSL in the UK (mean age = 42, range: [37, 47]; gender: 2 women, 2 men) participated in the semantic elicitation task. All participants reported using the respective sign language as their preferred means of communication.

2.1.2 Stimulus materials

The list of semantic domains was inspired by existing word lists, such as the Intercontinental Dictionary Series (Key & Comrie, 2015), Concepticon (List et al., 2021) and the concepts included in Kimmelman et al. (2018b). Some semantic domains proved unsuitable for elicitation in sign languages. For example, the semantic domains possession and quantity were judged to be both difficult to present and unproductive, as they essentially only contain pointing and gestures of specific quantities in sign languages. However, we added a number of semantic domains, mainly to attempt to elicit a substantial number of abstract concepts.

The stimulus items consisted of videos of individual signs, compounds or short phrases, which served as semantic prompts to the participants. They were produced by a deaf native user of German Sign Language (DGS) and British Sign Language (BSL) respectively. These signers, unlike the participants in the experiment, were involved in the research project as research assistants and played an active role in developing appropriate translations for each semantic domain to the two sign languages. While neither of them knew the respective other sign language, the team worked together to ensure that translations in the two sign languages remained conceptually equivalent. Signs were recorded against a blue screen backdrop.

2.1.3 Paradigm

The experiment was presented in psychopy, using a structurally identical procedure for all participants. Each trial consisted of a fixation cross, present for 500ms, followed by a sign language video of the target item. The video played as a loop until the participant had exhausted the concepts they associated with the semantic category and moved to the next trial by pressing the space bar.

As the German recordings were designed to pilot the materials, including a selection of optimal representations of semantic domains, the number of items differed between informants. Participants 1 and 2 were presented with the initial 112 items, split into two separate lists and containing both variants of a number of semantic domains that had more than one possible translation. Participants 3 to 5 were presented with a reduced list of 31 items, shortened to only include single variants of each semantic category and with some semantic domains combined into more basic categories. The British participants were then presented with the translation equivalents of the 31 items selected for the second half of the German participants, with some additions to assess possible alternative translations (see Appendix D for the lists of semantic domains presented to the different sets of participants).

2.1.4 Procedure

Participants were seated across from an addressee and filmed by a camera situated behind the experimenter. In the task, participants were asked to come up with as many individual signs as they could for each semantic domain. The domains were presented as short signed category labels, such as THINGS-TO-DO-OUTSIDE or TIME. Instructional materials and semantic domains labels were presented as videos in the respective sign language on a laptop, placed next to the participant, using Psychopy (PsychopyPy3 Experiment Builder, v2020.1.2, Peirce et al., 2019). The semantic domain labels played in a loop until the participant chose to advance to the next item by pressing the space bar. Participants could interact with the experimenter throughout the data elicitation, including to ask clarification questions on the task or individual semantic domain labels. They were encouraged by the experimenter to produce more signs, including in cases where they were unsure whether the signs matched the semantic category. The experimenter also asked them to condense sentences into a single lexical item, if possible.

2.1.5 Annotation and concept selection

Responses were glossed in English for both DGS and BSL data and subsequently annotated for iconic strategy in a first coding round. The task resulted in a total of 6902 tokens in Germany and 2940 tokens in the UK[1]. From these, we selected concepts to serve as our reference list for all studies in the project.

Concepts were only chosen if a sign for the concept had been produced in both countries, providing us with an authentic selection of signs as produced by signers from Birmingham and Cologne, respectively. Wherever several lexical variants could refer to the same concept, we chose the most frequently named variant or asked deaf team members for their input on the most frequent variant in the local deaf community. This allowed for a direct lexical comparison across BSL and DGS. The concepts came from a total of 24 semantic domains and included both concrete and abstract concepts. The aim was to collect 10 concepts per semantic domain, though this was not always feasible. Categories were retained only if they could be filled and or if we could find an almost sufficient number of concepts. Other categories had to be excluded because we could not find a sufficient number of concepts that had been produced in both languages, e.g.

[1] The difference in response numbers is at least partially due to the much longer experiments with participants 1 and 2 in Germany, though German participants also appeared more verbose overall.

locations in space, or combined in order to include a sufficient number of concepts, e.g. "childhood" and "toys". This accounts for the lower number of semantic domains in the final list, compared to the labels presented in the semantic elicitation task. The final selection comprised 234 concepts, which were then translated to English and German (for the full list, see Appendix C). The distribution of iconic strategies of the selected concepts approximates the distribution found in the overall dataset. The signs were subsequently refilmed under studio conditions for further analysis and use as stimulus materials in the rating tasks (accessible through the virtual appendix, see Appendix A).

2.2 Concreteness ratings

Two rating studies were conducted in the context of this project, compiling subjective, holistic, and impressionistic ratings of individual items. The ratings were collected in an online-study, using a university hosted LimeSurvey instance (Limesurvey GmbH, n.d.). Participants in the rating studies were randomly assigned to one of the two rating tasks: iconicity or concreteness. They first responded to demographic and linguistic background questions and then advanced to the rating task. Participants in both studies were compensated for their time using online vouchers. In this dissertation, only the concreteness ratings will be included, as they are directly relevant to the studies discussed in Chapters 3 and 4.

2.2.0.1 Participants

In order to investigate the role of concreteness with regards to the use of iconic strategies in a sign language lexicon, we asked signers who had not participated in the semantic elicitation task to rate the 234 concepts for concreteness in DGS and BSL in an online rating task. In addition, hearing non-signers rated the translation equivalents of the same concepts for concreteness in English and German. Ratings should be considered as holistic and impressionistic, as participants were asked to follow their subjective impressions of the items presented.

A total of ninety-nine participants took part in the concreteness rating task (mean age = 28.3, SD = 9.6, range: $[18, 57]$; gender: 74 women, 22 men, 3 non-binary; sign language knowledge: 44 non-signers, 55 signers; hearing status: 36 deaf, 6 hard of hearing, 57 hearing; country: 56 Germany, 43 UK). They were recruited through personal social networks of the researchers in the project and on the social media channels of the research groups in Germany and the UK. They were compensated for their time by means of online vouchers.

2.2.0.2 Procedure

Participants who were assigned to the concreteness rating task, rated the degree of concreteness for each concept on a scale from 100 to 700, with 100 labelled as concrete and

700 as abstract. This scale was chosen to easily map onto 7-point Likert scales frequently used in the literature, while maintaining a wide spread that would allow treating the data as interval-scaled. The concept measured here is labelled as *concreteness*, throughout this dissertation. However, on the rating scale, the upper extreme is labelled as *abstract* and the lower extreme as *concrete*. This is, because in piloting the rating scale, placing abstract on the lower end of the scale felt highly unintuitive. This mapping will be used throughout this dissertation, placing concrete at the lower (left or bottom) end of the scale and abstract at the higher (right or top) end of the scale.

The instructions were adapted to BSL and DGS from Brysbaert et al. (2014) and back-translated to English and German to closely match the signed versions. Highly concrete concepts were defined by being subject to experience through sensory input, e.g. the concept SOFA, a thing people can see, touch and experience the feeling of sitting on it. HOPE was used as an example for abstract concepts, the understanding of which depends on context and explanation through language, and is not available to direct sensory experience.

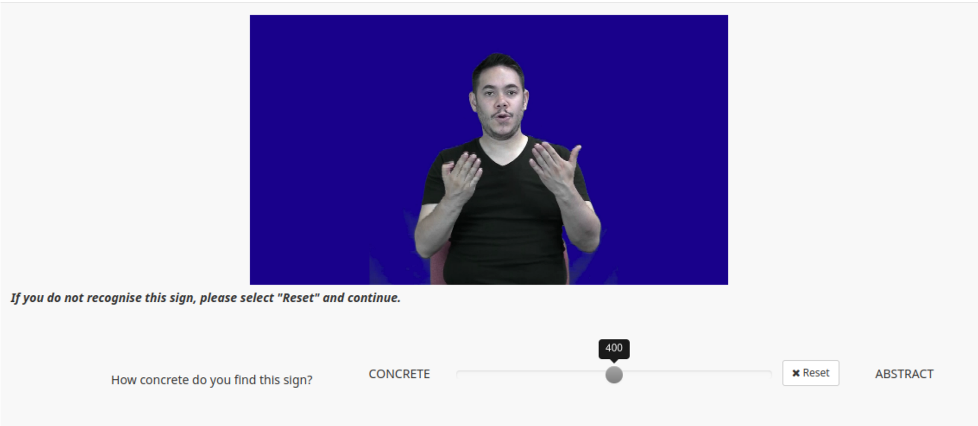
After recording their response, participants advanced to the next trial by pressing "next". Signers first rated a set of signs and were subsequently asked to translate the signs into English or German. This served as a comprehension check, to ensure participants knew and rated the intended signs. Ratings for signs for which signers gave translations that did not match the intended meanings were excluded from the analysis (excluded = 719, included = 81145). Non-signers were shown only the translation equivalents in English or German and asked to rate the concreteness of each concept.

The task was implemented using a university hosted LimeSurvey instance. Instructions were presented in BSL and/or English for British participants and DGS and/or German for German participants. For the rating task, the individual sign or word was presented in the middle of the screen, with the instructions and rating scale at the bottom of the screen. Videos played in a loop and words remained visible until the participant had recorded their response and continued to the next item. Participants were allowed to skip items if they were unfamiliar with the sign or uncertain about their response.

2.2.1 Analysis

Analyses were conducted using the R statistical language (version 4.4.1, R Core Team, 2022)[2] on Windows 11 x64 (build 26100). The following section shows correlations between ratings provided in the two countries, as well as between signers and non-signers within each country, using Pearson's product moment correlation, providing statistical details and visualisations. For analysis and visualisation purposes, the rating responses are centred around the mid-point of the scale, such that negative numbers (min. = −300)

[2] A full list of packages is available in the virtual appendix, see Appendix A.



(a) Signers

(b) Non-signers

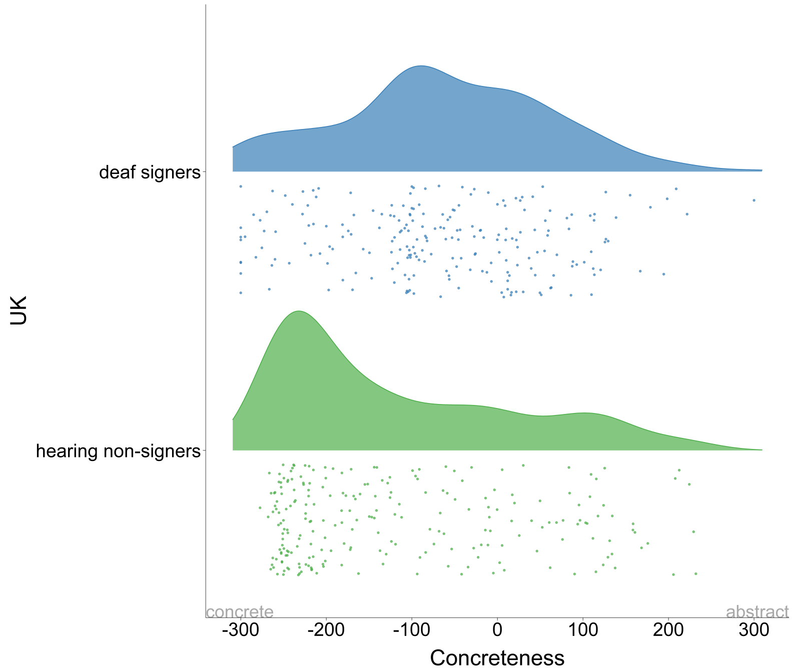
Figure 2.1: Screenshots of the concreteness rating tasks as presented to signers (top) and non-signers (bottom).

indicate a bias toward concrete and positive numbers towards abstract (max. = 300). In addition, descriptive information is provided about the distribution of raters across items, giving insights into the how many ratings are available by groups of raters as well as when pooling results.

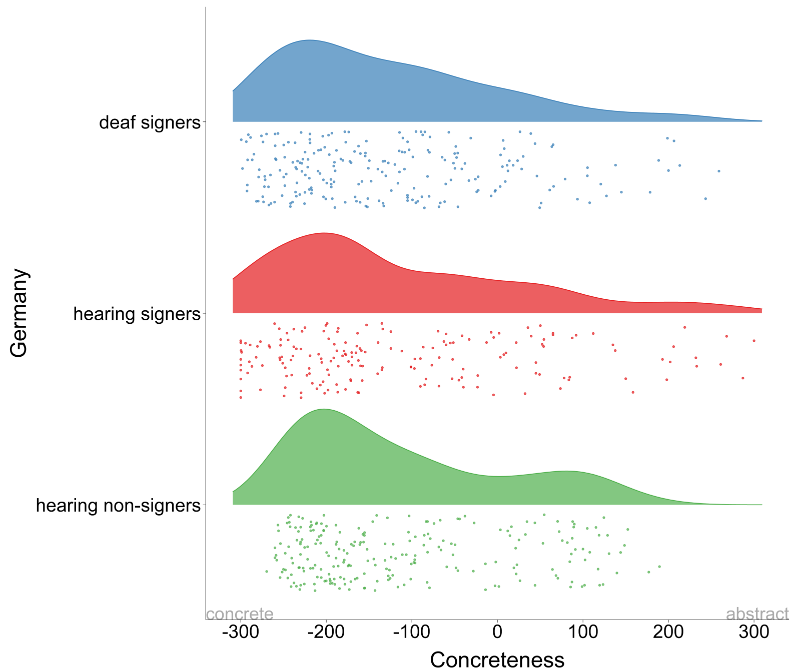
2.2.2 Results

Comparing the distribution of concreteness ratings between groups in the two countries shows a high positive correlation between signers and non-signers in Germany ($r = .585$, $t = 10.832$, $df = 225$, $p < .001$) and a medium-sized positive correlation in the UK ($r = .478$, $t = 8.0765$, $df = 220$, $p < .001$). Figure 2.2 shows the distributions differentiated by group. Interestingly, particularly the deaf raters in the UK seem to be rating signs as more abstract than the other groups. This trend is not as clearly visible in the deaf raters in Germany. Here, ratings were available from both hearing and deaf signers, though the figures suggest that the hearing signers group more with the hearing non-signers than the deaf signers. This might indicate that even though they were rating signs from DGS, their ratings might have been more strongly influenced by German conceptualisations than those of the deaf signers.

Finally, as raters were able to skip individual items and ratings from signers were only counted if they interpreted the sign in the intended way, not all concepts received the same number of ratings. Considering the low number of ratings available within some



(a) British raters



(b) German raters

Figure 2.2: Distribution of concreteness ratings by group of participants in the UK (top) and Germany (bottom). The groups of raters consist of deaf signers (top, blue), hearing signers (middle, red), and hearing non-signers (bottom, green). All curves show a bias towards the concrete end of the rating scale. Only deaf BSL signers show a more centralised distribution, with only a small bias towards the concrete half of the scale.

of these groups in combination with the correlations between groups, pooling items may provide more reliable assessments of concreteness (see Table 2.1).

Table 2.1: Number of concreteness ratings provided by group.

Language	Sign knowledge	Hearing status	median	min.	max.	Q1	Q3
BSL	signer	deaf	6	1	14	3	7
	non-signer	hearing	26	23	27	26	27
		Overall:	30	23	41	29	33
DGS	signer	deaf	7	2	18	6	8
	signer	hearing	3	1	13	2	3.75
	non-signer	hearing	16	14	17	16	17
		Overall:	25	14	46	23	27

These overall concreteness ratings, just like those of all individual groups or raters, were clustered towards the lower end of the scale in both Germany and the UK (see Figure 2.3), showing that most items were perceived as rather concrete with only fairly few items rated as strongly abstract. The median rating for BSL signs (−198) was marginally lower than for DGS signs (−190). Examples of highly abstract concepts in both countries are COMMBREAK ("communication breakdown"), FUTURE, and HOBBIES. Overall, concreteness ratings were highly correlated between Germany and the UK ($r = .887$, $t = 29.242$, $df = 232$, $p < .001$). This suggests that raters in both countries did not substantially differ in their perceptions of how concrete items were.

2.3 Interim summary

The signs selected for the project allow for direct lexical comparisons, representing translation equivalents of a total of 234 concepts. Unlike the rating distributions for English words in Brysbaert et al. (2014), our concepts show a fairly strong bias towards the concrete end of the rating scale. This may be influenced by the selection process. Even though our semantic fluency task included categories that would be expected to elicit more abstract concepts, e.g. "law", "time", or "politics", concrete concepts may simply be more readily available to recall and production in such an open semantic task. As such, participants may have provided more concrete than abstract items, making it difficult to balance concreteness in the item selection prior to conducting the rating task.

Ratings between the two countries were highly correlated and even ratings provided by signers and non-signers showed medium correlations, in line with findings of high semantic alignment across languages in similar cultural contexts (B. Thompson et al., 2020). Comparing the ratings between signers and non-signers suggests that, if anything, signers might perceive concepts as more abstract than non-signers. This seems to be true

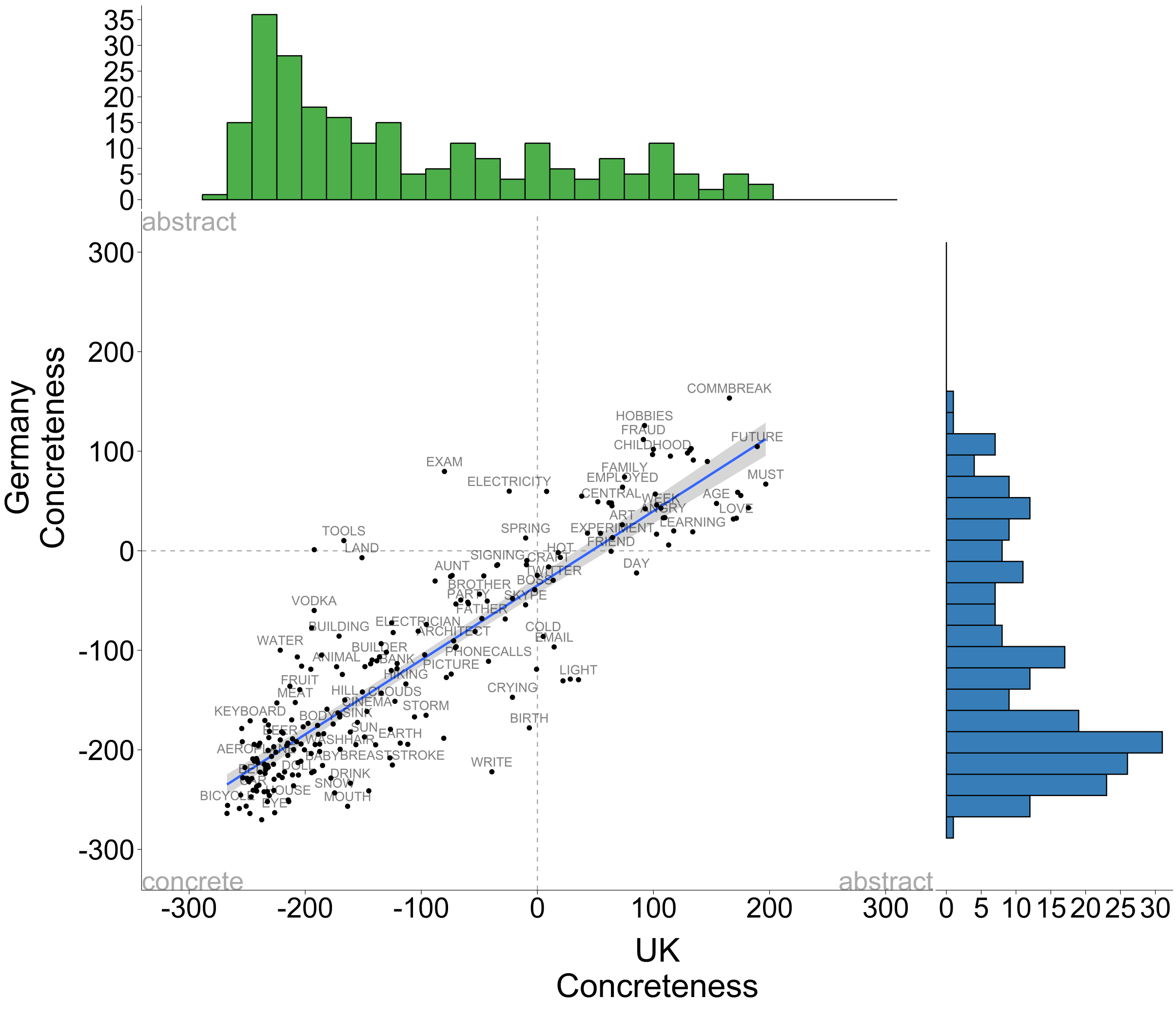


Figure 2.3: Correlation of concreteness ratings in the UK (x-axis, green) and Germany (y-axis, blue). Rating values indicated are mean ratings across all groups of raters within each country. The ratings show a strong, positive correlation.

for the BSL signers but is not evident for the DGS signers. Considering that concreteness ratings are clearly correlated across all groups, the ratings from different groups will be pooled in the following chapters. This will increase the number of ratings that contribute to each concept's concreteness score, increasing the reliability of the measurement.

Chapter 3

Iconicity shapes lexical similarity: The case of British and German Sign Language

3.1 Introduction

One of the striking characteristics of sign languages is the prevalence of iconicity, which we define broadly as a resemblance-based relationship between linguistic form and referent (Dingemanse et al., 2020; Perniss et al., 2010; Winter, Woodin, & Perlman, 2023). Due to the affordances of the manual-visual modality, sign languages frequently employ similar iconic strategies to represent concrete concepts, leading to lexical similarities even in historically unrelated languages (Guerra Currie et al., 2002; Wittmann, 1991; Woll, 1984). A typical example are the signs for the concept EAT[1] in BSL and DGS (Figure 3.1). This raises an important question: to what extent does iconicity shape lexical overlap, and does this effect extend beyond concrete meanings? To address this, we investigate how different types of iconic depictions are used in the lexicon of British Sign Language (BSL) and German Sign Language (DGS). By examining the distribution of iconic strategies across concrete and abstract concepts, we assess how shared iconic strategies contribute to lexical similarity between these two unrelated languages.

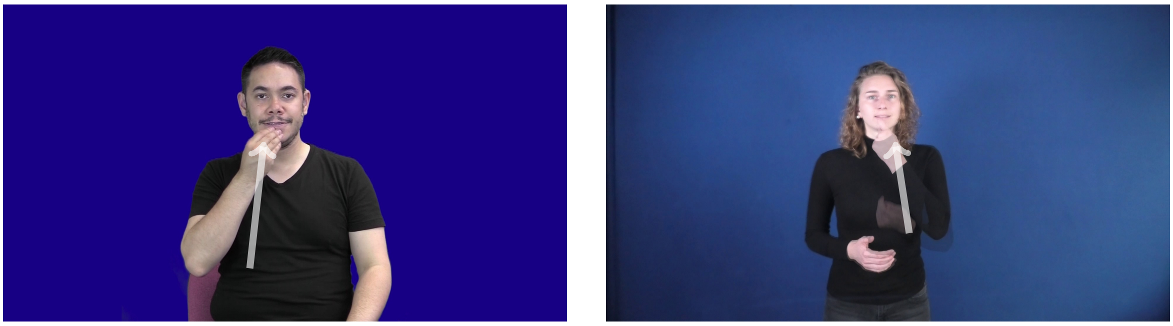


Figure 3.1: EAT in BSL (left) and DGS (right). In both signs, the hand moves from neutral space towards the mouth. The signs differ in handshape, with the BSL sign using a flat grip handshape, while the DGS sign uses a handshape where the index finger lies over the tip of the thumb. Handedness is non-distinctive in both sign languages.

The signs for EAT (Figure 3.1) show strong similarities in BSL and DGS, because they are iconic. The iconicity of BSL and DGS EAT can be discerned in the three main *constituents* of signs (handshape, location, movement) as depicting the action of eating. The grasp-like handshapes are related to holding the food, the location on the mouth is motivated by where we ingest the food, and the movement depicts how we bring food to the mouth. However, despite the shared iconic motivation, we see subtle differences in the phonological form of the BSL and DGS signs, which are not explained by iconicity. In the present study, we investigate how iconicity motivates lexical similarity across unrelated

[1] Glosses are chosen to identify sign forms, following the initial sign elicitation context. They should not be taken as context-sensitive translations, but rather as approximations of meaning. For example, the sign form in BSL and DGS could also be glossed as FOOD without additional context. All videos are available for reference through Appendix A.

sign languages and how this similarity manifests in sign pairs and their form overlap or differences. Relating a comparison of iconic representations in the two unrelated sign languages to the degree of form overlap shows us how iconicity interacts with the linguistic system, e.g. phonological characteristics of the two sign languages. This means that we will compare the use of iconic strategies in BSL and DGS, establishing whether signs depicting the same concept use the same iconic strategy to depict the same concept and how this relates to the degree of form overlap of these sign pairs. Further, we go beyond previous studies which have only focused on the use of iconicity in concrete concepts and investigate whether iconicity is deployed in similar ways for abstract concepts, thus bringing into focus the interplay between iconicity and concreteness in shaping lexical similarities.

3.1.1 Iconicity and iconic strategies in sign languages

In sign languages, iconicity typically represents information about the shape and size of referents, handling of referents, spatial layouts, and movements through space, as this type of information is easy to map onto the manual articulators (Dingemanse et al., 2015; Perniss & Vigliocco, 2014). Particular characteristics of meaning are mapped onto the linguistic form, realised through the formational constituents of signs. For example, in the signs for EAT (Figure 3.1), the three constituents contribute to a depiction of the action of eating. Iconic signs are described as structure-preserving mappings between conceptualisations of the referent (the iconic instantiation) and the articulatory form through a clearly defined mapping process, in which semantic features are directly mapped onto the constituents in articulation (Gentner, 1983; Taub, 2001). It is possible that unrelated sign languages converge in the selection of these structures and this could explain lexical similarity, a notion that is addressed empirically in this study.

Researchers have investigated iconicity in different ways (Dingemanse et al., 2020; Perniss et al., 2010). These differences include approaches to studying iconicity in the vocal and visual modality. The present study only focuses on research of iconicity in the visual modality. However, even within modalities, methodological differences can be observed, highlighting different perspectives on the nature of iconicity. Many studies have looked at the degree of iconicity of words and signs in order to explore how they become more or less iconic over time or how perceptions of iconicity may differ across groups (for ratings of DGS and BSL signs and hearing people's gestures, see for example Ortega et al., 2019; Spruijt et al., 2023; Trettenbrein et al., 2021; Vinson et al., 2008). They do so by relying on iconicity ratings, which provides a quantitative measure of iconicity but does not tell us about the iconic motivation of individual signs. Another approach is exploring different types of iconicity (e.g. Müller, 2009; Ortega & Özyürek, 2020a; Padden et al., 2013), which moves the focus to the different ways in which semantic features of the referent are mapped onto the linguistic form (Müller, 2014).

Past studies differ in the specific typologies of iconic strategies, yet common distinctions emerge. In the *acting* strategy, the signer re-enacts bodily actions or actions associated with the referent, e.g., moving the arms and hands as if swimming in the sign BREASTSTROKE in DGS. In the *representing* and *entity* strategies, the hand depicts the form of the referent, with the former incorporating aspects of movement associated with object manipulation or handling, whereas in the latter strategy the signers' body is semiotically backgrounded. The *representing* strategy is employed, for example, in the BSL sign for DRILL, where a pistol-shaped handshape moves towards an imagined wall. In the sign AEROPLANE in BSL, the *entity* strategy is used, as the hand represents the plane which moves through the air with the extended thumb and pinky as wings. In the *personification* strategy, an animal or entity is mapped onto the human body, e.g., representing a cow's head with horns by placing the hands on the forehead in the sign COW in DGS. The *tracing* strategy outlines the shape or surface of a referent, e.g., the DGS sign HOUSE traces the pointy roof and walls of a prototypically shaped house. Rather than focusing on degree of iconicity, these strategies centre around the ways to represent a referent which may shed light on why different sign languages converge on similar lexical forms.

Distinguishing between types of iconic strategies is important because they have been observed to systematically align with different semantic domains in the lexicon of different sign languages, as well as in gestures of hearing people. Eliciting signs and gestures for different types of actions or objects, studies find a strong association of *acting* with the depiction of actions and *representing* and *entity* with the representation of objects (Hou, 2018[2]; Hwang et al., 2017[3]; Padden et al., 2015 for ASL; Ortega and Özyürek, 2020b[4]; van Nispen et al., 2017[5]). Animals are typically represented using either the *personification* as well as the *entity* strategy (Hou, 2018; Hwang et al., 2017; Masson-Carro et al., 2015[6]; Padden et al., 2013). The *tracing* strategy, in turn, is frequently recruited to represent non-manipulable objects, e.g. houses or pyramids (Masson-Carro et al., 2015; Ortega and Özyürek, 2020a[7]). In a large cross-linguistic comparison including 31 sign languages, Kimmelman et al. (2018b) also found a considerable degree of systematicity in the association of iconic strategies with specific semantic domains. For example, the

[2]for San Juan Quiahije Chatino Sign Language (CSL)

[3]for American Sign Language (ASL), Al-Sayyid Bedouin Sign Language (ABSL), Central Taurus Sign Language (CTSL), DGS, Ha Noi Sign Language (HNSL), Israeli Sign Language (ISL), Japanese Sign Language (JSL), Kenyan Sign Language (KSL), and gestures produced by American hearing non-signers

[4]for gestures of Dutch and Mexican

[5]for gestures of Dutch hearing non-signers

[6]for Dutch co-speech gesture

[7]for gestures of Dutch hearing non-signers

authors show an overall preference for vehicles to be depicted using the *entity* strategy across 15 sign languages, with only the Greek Sign Language diverging from this pattern with a preference for *acting*. Importantly and relevant to the present study, research has found that the *acting* strategy is the most prevalent overall in spontaneous silent gestures, a finding often explained by our strong embodied experiences with the world (Ortega & Özyürek, 2020a; Padden et al., 2013; van Nispen et al., 2017).

These studies show that iconicity is used systematically across semantic domains and across sign languages (as well as in the silent gestures of hearing non-signers), regardless of language relatedness. However, previous research has been restricted to a few concrete domains (e.g., tools, actions, animals, and fruit), as these studies were interested in the alignment of iconic strategies with specific semantic distinctions, such as marking the difference between nouns and verbs (Padden et al., 2015) or actions and objects (Ortega & Özyürek, 2020a; Padden et al., 2013), a phenomenon Padden et al. (2013) call "patterned iconicity". This research has linked the high degree of overlap in the use of iconicity in concrete domains to direct mappings of conceptualisations of the referent and iconic representations. That is, iconic strategies are used in systematic ways given our embodied conceptual representations and construals of referents across cultures (Occhino et al., 2017). In our study, we investigate this overall perspective, looking at the distribution of strategies in BSL and DGS.

Some researchers have argued that abstract concepts are further detached from sensory experience and therefore less amenable to iconic representation in spoken languages (Lupyan & Winter, 2018). The studies discussed above do not consider abstract concepts, limiting their comparisons to a limited range of semantic domains, all of which are highly concrete. If different sign languages exhibit similar iconic representations for concrete concepts, an important empirical question is whether such similarities extend to abstract concepts or whether similar arguments hold for spoken and signed languages. This is taken up in this study, extending the investigation across concrete and abstract concepts.

3.1.2 Iconicity and abstract concepts

The intense focus in linguistics on spoken/written languages in WEIRD[8] societies has resulted in the generalised notion that iconicity has very limited prevalence in the vocabularies of the world. In sign languages, however, iconicity plays an important role in representing abstract concepts (Perniss & Vigliocco, 2014). For example, the BSL sign COURT (Figure 3.2, left) depicts a wig because the barristers in the UK wear wigs in court settings, so the BSL sign reflects this practice. The DGS sign COURT (right), in turn, represents bringing scales into balance. These examples show that iconicity is amenable

[8]Western, Educated, Industrialised, Rich, and Democratic is an acronym to describe the well-researched groups in the social sciences (Henrich et al., 2010)

to the depiction of abstract concepts, albeit through metaphorical mappings, which are here defined as "understanding one thing in terms of another" (Cienki & Müller, 2008, pp. 485–486). In these types of metaphorical manual forms, the specific relationship between source and target domain can take on different specific characteristics, including a metonymic relationship. The use of iconicity in abstract concepts in sign languages is realised through what Meir and Cohen (2018) calls a double mapping, where the abstraction comes from a metaphorical extension of a fundamentally concrete concept (Emmorey, 2014; Gentner & Asmuth, 2017; Perniss & Vigliocco, 2014; Taub, 2001). The first mapping happens in the concrete domain, where the target referent is mapped onto a lexical form through iconicity (e.g., depicting a wig or a scale; Meir & Cohen, 2018; Taub, 2001). In the second mapping, the concrete concept becomes the source domain for a metaphorical mapping to extend its meaning to an abstract target domain (e.g., the metonymic extension from a wig to the meaning court; Gentner & Asmuth, 2017; Meir & Cohen, 2018; Taub, 2001). This double mapping reconciles the suggestion that iconicity may be less suitable for abstract concepts (Lupyan & Winter, 2018) and the observation that it plays a role in this domain in sign languages.

Figure 3.2: COURT in BSL (left) and DGS (right). The BSL sign traces the shape of the curly wig worn in British courts. The DGS sign uses an alternating movement to represent the scales of justice being brought into balance with a V-handshape. The signs differ in handshape, location, and movement.

There are a handful of cross-linguistic studies looking at the use of iconicity in abstract domains. Lepic et al. (2016) showed a link between handedness and plurality in four unrelated sign languages, where plural concepts were more likely to be executed as two-handed signs, while singular concepts were articulated with one hand. Östling et al. (2018) showed systematic places of articulation for signs related to sensory information in 31 sign languages, such as signs for THINK being articulated at the forehead or SAY at the mouth. Signers have also been shown to be receptive to iconic associations in their processing of signs and pseudosigns, e.g. showing a facilitatory effect of iconic mappings in handshapes for a handshape monitoring task in ASL signs (Occhino et al., 2020) and a bias towards using iconicity to identify associations between semantic features and form components in Sign Language of the Netherlands (Nederlandse Gebarentaal) (NGT) signers (Schiefner, 2019). These studies suggest that sign languages systematically exploit iconicity to realise abstract conceptualisations throughout the lexicon. However, they have been limited to very specific domains and have investigated the effects of iconicity at the phonological level, rather than the lexical level of individual signs. This differs from our approach, which investigates whether and how iconic strategies are deployed in the signs for concrete and abstract concepts in BSL and DGS.

To our knowledge, only Keränen (2021, 2023) has directly investigated the use of iconic strategies in abstract concepts in a sign language. Keränen (2021) finds that the same iconic strategies identified for concrete concepts are used in sensory and emotion signs in Finnish Sign Language (FinSL). While sensory and emotion concepts are directly experienced, they are are subject to introspection and are typically rated as low in concreteness (Altarriba et al., 1999). For example, in the sign SMELL in FinSL the hand represents the invisible gas that flows into the nose using the *entity* strategy. Keränen's (2021) study thus shows how concrete and grounded iconic strategies can refer to invisible sensations and percepts, expanding their use to more abstract domains. In identifying the same iconic strategies to represent abstract concepts in FinSL that have been reported for concrete concepts, these findings suggest that iconic strategies may be used in similar ways in abstract and concrete concepts. Even here, however, only highly embodied concepts are investigated in a single sign language, leaving open the question to which extent iconic strategies are also used for a broader range of abstract concepts and whether different sign languages are likely to converge on similar representations in abstract semantic domains.

In the present study, we investigate the interaction of iconic strategies and concreteness in shaping lexical similarity across BSL and DGS. On the one hand, two sign languages might use different iconic strategies because the culturally appropriate metaphor calls for highlighting different aspects of the referent. For example, two sign languages may use different metaphorical mappings, even though both signs are highly iconic within their respective context, as illustrated in Figure 3.2. The combination of the iconic mapping with a metaphorical mapping would then lead to increased variation in how abstract concepts are iconically depicted. On the other hand, conceptualisations may be shared across languages, including cultural metaphors for abstract concepts. In that case, we would expect concrete and abstract concepts to be expressed iconically in similar ways, resulting in similar iconic manual forms. This would result in high levels of cross-linguistic overlap in the use of iconic strategies. The present study explores this interaction between iconic strategy use and concreteness.

3.1.3 Form overlap and iconicity

One aspect that has received limited attention in the literature is the extent to which signs with the same iconic motivation share the same formational parameters, i.e. show form overlap. Even where signs are based on the same iconic motivation in two sign languages, they may show differences in specific structure. For instance, even in the highly iconic example of EAT in BSL and DGS, where the signs share an iconic motivation, the signs differ in the specific handshape used.

Past research has investigated form similarities to gain a greater understanding of sign language relations, identifying language families and differentiating the form variation of dialects from that of distinct sign languages (for a review, see Ebling et al., 2015). In these studies, lexical items from dictionary sources or elicitation data are compared with respect to their formational parameters and proportions of overlap are calculated. They are frequently based on adaptations of Swadesh lists (Swadesh, 1955) and follow methods from the lexicostatistics of spoken languages, computing Levenshtein distances based on overlap between form constituents in sign pairs from the languages compared in each study.

Iconic signs were quickly identified as a barrier to such comparisons, as similarities between even unrelated sign languages far exceeded the levels found in spoken languages (Bickford, 1991; Woll, 1984), producing ceiling effects that made it virtually impossible to find sensible thresholds to differentiate the overlap associated with dialects vs. distinct sign languages. In response, these studies frequently excluded iconic signs from comparisons. Other studies treated iconic signs differently from non-iconic signs (Xu, 2006), thus directly removing the option of investigating the specific characteristics of form overlap across iconic and non-iconic signs.

However, as seen above, iconic signs, i.e. signs in which a relationship between meaning and form can be construed, are an integral part of the signed lexicon and may well differ in the degree of form overlap. Excluding them, therefore, results in samples that are not representative of a typical sign language lexicon. Further, investigating the influence of iconicity is critical to understanding the nature of form similarity and shedding light on the processes of lexical creation. While borrowing methodological tools from these lexical comparison studies, we go beyond their findings by combining lexical form and the iconic motivation of signs in our comparison of signs in BSL and DGS. By treating iconicity and form overlap as separate factors in our comparison, we can explicitly investigate their relationship in the lexicon.

3.1.4 The present study

In this study, we investigate factors that influence form similarity in the lexicon of two unrelated sign languages – BSL and DGS. We bring together iconic strategy, concreteness, and form overlap in order to gain a broader understanding of how these factors interact in the lexicon. This leads us to ask the following questions:

RQ 1: How are iconic strategies distributed in BSL and DGS, and does the distribution differ by language?

RQ 2: What is the relationship between iconic strategies, degree of concreteness, and form overlap?

The comparison of iconic strategies will reveal if strategies are used to similar proportions or whether different strategies are favoured across two languages or within a single language. The investigation of the interplay between iconic strategies, concreteness, and form overlap will show to what extent iconicity and concreteness drive cross-linguistic similarity in iconic depictions. Together, the results of our analysis will explain factors that influence the expression of conceptual representations in concrete and abstract domains (e.g. EAT vs. COURT).

If indeed iconic signs are direct representations of our conceptual representations, we expect that BSL and DGS will exhibit a similar distribution of iconic strategies in concrete (Hou, 2018; Hwang et al., 2017; Kimmelman et al., 2018a; Padden et al., 2013, 2015) as well as abstract concepts (Keränen, 2021), at least for the similar cultural contexts provided by the UK and Germany. Based on studies on silent gesture (Ortega & Özyürek, 2020a; Padden et al., 2013; van Nispen et al., 2017), we also expect a strong preference for the *acting* strategy. Considering that abstract concepts require a double mapping combining an iconic and a metaphoric mapping (Meir & Cohen, 2018), they may show less similar iconic representations, even if iconic strategies are used to depict abstract as well as concrete concepts. As such, abstract concepts may show less similarity compared to concrete concepts.

3.2 Methods

In the present study, we investigate how iconicity shapes the lexicon of two unrelated sign languages – BSL and DGS. This is achieved by conducting a direct comparison of the same concepts in these two languages. The target concepts were selected based on the results of a semantic elicitation task with deaf individuals in the UK and Germany. The signs were then analysed based on their iconic strategy (A), iconic instantiation (B), and form overlap (C). In a separate rating task, the concepts were rated for concreteness/abstractness.

3.2.1 Pre-study: Semantic elicitation

Lexical comparison studies are often conducted using word lists originally developed for eliciting supposedly culturally-neutral concepts in spoken languages. However, as

Woll (1984) already pointed out, such lists, even when adapted to sign languages, are inadequate for the study of modern, urban deaf populations, as many items are culturally irrelevant to these populations. Some more recent studies therefore developed their own lists. However, they frequently used written materials as a point of departure which introduces problems of accurate translation, where the written glosses may suggest a translation equivalence that does not reflect the true relationship between gloss and sign as discussed in Langer et al. (2014). By using BSL and DGS as points of departure, we mitigate this issue and are able to select concepts that are relevant to the sign language communities in question. We therefore conducted an open-ended semantic elicitation task with signers of BSL and DGS to elicit signs from a range of concrete and abstract semantic domains. These signs served as a basis for concept selection for our main analysis.

3.2.1.1 Participants

Deaf signers of BSL in the UK ($N = 4$, mean age = 42, SD = 5.23, range: $[37, 47]$; gender: 2 women, 2 men) and of DGS in Germany ($N = 5$, mean age = 38.2, range: $[25, 54]$; gender: 1 woman, 4 men) participated in a semantic elicitation task.[9] All participants used the respective sign language as their preferred means of communication. Participants received monetary compensation for their time.

3.2.1.2 Procedure

Participants were seated in front of an experimenter-addressee and filmed by a camera situated behind the experimenter. In the task, participants were asked to come up with as many individual signs as they could related to various semantic domains. The domains were presented as short signed category labels, such as “things to do outside” or “time”. Instructional materials and semantic domain labels were presented as videos in the respective sign language on a laptop, placed next to the participant. The semantic domain labels played in a loop until the participant chose to advance to the next item by pressing the space bar. Participants could interact with the experimenter throughout the data elicitation, including to ask clarification questions.

3.2.1.3 Annotation and concept selection

Responses were annotated in English for both the DGS and BSL data. The task resulted in a total of 2940 tokens in the UK and 6902 tokens in Germany[10]. From these, we selected 234 concepts which were produced in both languages. The purpose of matching concepts from BSL and DGS was to allow for a direct lexical comparison across two languages. The concepts came from a total of 24 semantic categories and included both

[9] Some of these data were intended as pilot data but included in the study as data collection was interrupted by the COVID-19 pandemic.

[10] As this data collection was intended as a piloting phase, the number of stimulus items differed between German participants.

concrete and abstract concepts. The signs were refilmed under studio conditions for further analysis and use as stimulus items in the rating tasks (see sign database).

3.2.2 Concept coding

(A) Iconic strategy The 234 concepts from the semantic elicitation task were coded for iconic strategy in BSL and DGS based on earlier taxonomies (Hou, 2018; Hwang et al., 2017; Masson-Carro et al., 2015; Müller, 2009; Padden et al., 2013, 2015; van Nispen et al., 2017), using the following criteria adapted from Ortega et al. (2019) (detailed instructions in the virtual appendix, see Appendix A):

- **Acting** – The hands represent the hands as a human body interacts with the referent or performs the target action; e.g., the DGS sign BREASTSTROKE recreates the action of swimming in breaststroke (all examples in Figure 3.3).

- **Representing** – The handshape represents the shape of the referent, while the movement indicates the movement associated with handling the referent; e.g., in the BSL sign DRILL, the handshape represents the long pointy end of the drill as it moves into a wall.

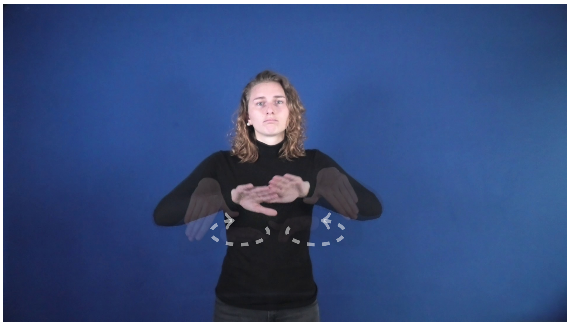
- **Personification** – A non-human body is mapped onto the whole body of the signer, such that body parts that are conceptualised as equivalent stand in for each other or are represented at the corresponding locations of the body; e.g., the DGS sign for COW uses the hands to represent horns at the forehead of the signer.

- **Entity** – The hand stands directly for the object. Unlike the *representing* strategy, the *entity* strategy does not imply any human interaction; e.g., in the BSL sign for AEROPLANE the hand represents the plane with the extended thumb and pinky as wings as it moves through the air.

- **Tracing** – The fingers or full hand trace the outline or surface of an object; e.g., the DGS sign HOUSE traces a pointy roof and house.

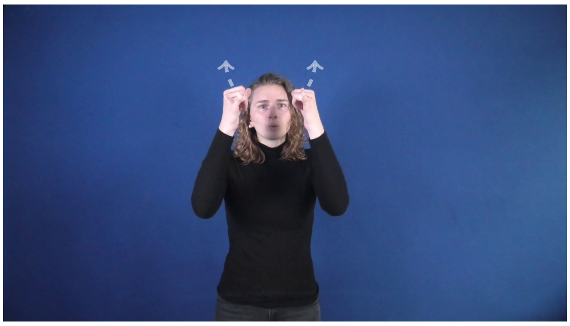
- **Deictic** – Signs that are not iconic but display an indexical relationship with the referent, typically through pointing with a single finger or the whole hand. This indexical relationship may refer to metaphorical as well as physical space; e.g., in the BSL sign TIME the index finger points to an imaginary watch located on the wrist.

- **Other** – Signs that did not fit into any of the strategies defined above, including signs for which the iconic motivation was too obscure to be clearly classified.

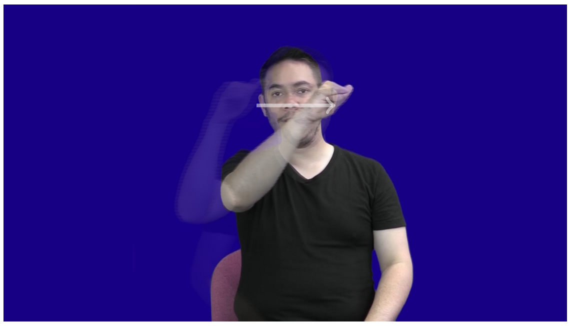


(a) DGS: BREASTSTROKE - *acting*

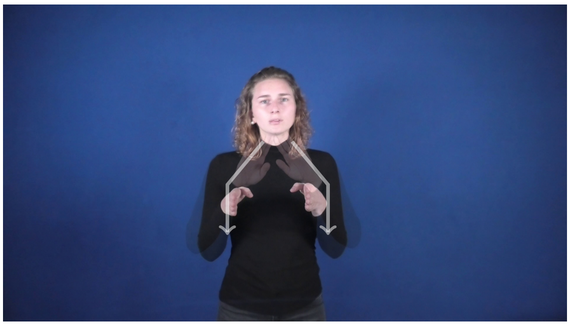
(b) BSL: DRILL - *representing*



(c) DGS: COW - *personification*



(d) BSL: AEROPLANE - *entity*



(e) DGS: HOUSE - *tracing*

(f) BSL: TIME - *deictic*

Figure 3.3: Illustrations of the examples for each iconic strategy. Solid lines indicate movement parallel to the coronal plane, dashed lines parallel to the sagittal/transversal plane. Double arrows indicate repeated movements.

Signs were annotated in an iterative process. First, every sign was annotated by a team member competent in the respective sign language. Subsequently, all annotations were discussed in the team to align coding across languages. Finally, all annotations were checked again by one team member to ensure that signs were consistently coded within and across languages. We used the iconic strategy coding to classify whether a given sign used the same or different iconic strategies in BSL and DGS.

(B) Iconic instantiation To establish the underlying iconic motivations, i.e. iconic instantiations, all team members ($N = 7$) recorded their perceived iconic instantiation for each sign in BSL and DGS, by describing what each sign depicted. The guideline for this process was to focus on whether or not the two signs were perceived as presenting the same underlying image. We condensed these judgements into a binary code for each concept, categorising them as using the same or a different iconic instantiation. Decisions were based on a coding scheme that took into account the distribution of judgements from all team members and the semantic content of each description (see Appendix A for access to the coding manual).

(C) Form overlap Two team members classified the degree of form overlap between the sign forms in BSL and DGS for each of the 234 concepts. We compared signs based on their handshape, location and movement (see Appendix A). We used a binary code for each of these constituents, whereby they could be the same (1) or different (0). Then, we calculated the composite score of each sign by adding the scores for each parameter. For instance, the signs for EAT in BSL and DGS are produced at the same location (1) and have the same movement (1) but use different handshapes (0). The overall score for EAT therefore adds up to two (see Table 3.2).

Parameter	**Coding**	**Score**
Location	same	1
Movement	same	1
Handshape	different	0
Form overlap	partial	2

Table 3.2: Form overlap coding for the DGS and BSL signs EAT.

The two raters classified all signs independently. Inter-rater agreement was Cohen's $\kappa > .82$ for each constituent, i.e. almost perfect agreement. Disagreements were resolved by discussion. Quantifying form overlap in this way allows us to establish the relationship between iconicity and form similarity between BSL and DGS.

3.2.3 Concreteness ratings

In order to investigate the role of concreteness as a factor influencing similarity, we asked signers who had not participated in the semantic elicitation task to rate the 234 concepts for concreteness in BSL and DGS. Hearing non-signers rated the translation equivalents of the 234 concepts for concreteness in English and German.[11] Participants gave holistic, impressionistic ratings of individual items.

[11]In the same study, we also collected iconicity ratings from a separate group of participants. These data were collected to answer a different research question and will not be discussed further in the present paper. We mention this here for the sake of procedural completeness.

3.2.3.1 Participants

Ninety-nine participants took part in the concreteness rating task (mean age = 28.3, $sd = 9.6$, range: $[18, 57]$; gender: 74.7% women, 22.2% men, 3.03% non-binary; signer: 44 non-signers, 55 signers; hearing status: 36 deaf, 6 hard of hearing, 57 hearing; country: 56.57% Germany, 43.43% UK). Participants were paid for their participation through online vouchers.

3.2.3.2 Procedure

Participants were randomly assigned to one of two rating tasks: concreteness or iconicity. The present study will only consider concreteness ratings. Participants first responded to demographic and linguistic background questions. Subsequently, they advanced to the rating task.

They rated the degree of concreteness for each concept on a scale from 100 to 700, with 100 labelled as concrete and 700 as abstract. This scale was chosen to easily map onto 7-point Likert scales frequently used in the literature, while maintaining a wide spread that would allow treating the data as interval-scaled. The instructions were adapted to BSL and DGS from Brysbaert et al. (2014) and back-translated to English and German to closely match the signed versions. Highly concrete concepts were defined by being subject to experience through sensory input, e.g. the concept SOFA, a thing people can see, touch and experience the feeling of sitting on it. HOPE was used as an example for abstract concepts, the understanding of which depends on context and explanation through language, and is not available to direct sensory experience. After recording their response, participants advanced to the next trial by pressing “next”. Signers first rated a set of signs and were subsequently asked to translate the signs into English or German. This served as a comprehension check, to ensure participants knew and rated the intended signs. Ratings for signs for which signers gave translations that did not match the intended meanings were excluded from the analysis. Non-signers were shown only the translation equivalents in English or German and asked to rate the concreteness of each concept.

The task was implemented using a university hosted LimeSurvey instance. Instructions were presented in BSL and/or English for British participants and DGS and/or German for German participants. For the rating task, the individual sign or word was presented in the middle of the screen, with the instructions and rating scale at the bottom of the screen. Videos played in a loop and words remained visible until the participant had recorded their response and continued to the next item. Participants were allowed to skip items if they did not know the sign or felt they could not give a response.

3.2.4 Analysis

Analyses were conducted using the R statistical language (version 4.4.1, R Core Team, 2022)[12] on Windows 11 x64 (build 26100). Bayesian analyses were conducted using the package brms (Bürkner, 2017, version 2.22.0). All models were estimated using MCMC sampling with 4 chains of 4000 iterations and a warmup of 2000. The correlation analyses contained a sensitivity analysis comparing sets of uniform, regularising and informative priors.[13] Regularising priors for all correlation analyses were set following the recommendations in Kurz (2019).

For analysis purposes, we centred the rating responses around the mid-point of the scale, such that negative numbers (min. = −300) indicate a bias toward concrete and positive numbers towards abstract (max. = 300). For signers, we only included the ratings for signs that were correctly understood as indicated by target-like translations (excluded = 719, included = 8114). Concreteness ratings from all groups were combined into an average score for each concept, following B. Thompson et al.'s (2020) cross-linguistic study, which shows high semantic alignment for similar cultural contexts. Ratings were also checked to confirm that they are correlated across participant groups (see Chapter 2).

We compared the use of iconic strategies in BSL and DGS with a Bayesian Pearson product-moment correlation model of strategy frequency. We used a Student's t-distribution and selected regularising priors (rank(BSL) ∼ 1, rank(DGS) ∼ 1, family = MV(student, student)).

We describe how the overlap in iconic strategy and iconic instantiation is related in our data through the relative likelihood and odds ratio. We excluded all concepts with signs that used the same strategy but were not based on the same iconic instantiation from further analysis ($N = 43$). For example, the signs for SUPERMARKET use the *acting* strategy in both cases, yet the sign in BSL depicts the handling of money, while the DGS sign imitates pushing a trolley.

Subsequently, we investigated how form overlap between BSL and DGS signs for the same concept is influenced by sharing the same iconic strategy for the concept and the concept's average concreteness rating. We ran a Bayesian ordinal regression with maximally uninformative default priors (form overlap ∼ 1 + iconic strategy overlap (binary) × concreteness, family = cumulative[logit]). Given the large difference in scale between the ratings and the form overlap metric, we rescaled the rating scales to measure the effect by 100 points on the rating scale to increase interpretability in the model.

To assess the relationship between iconic strategy overlap and concreteness ratings, we compared the average concreteness ratings for the concepts that shared a strategy between the two languages with those that did not share a strategy. For this, we dummy

[12] A full list of packages is available in the virtual appendix, see Appendix A.
[13] Full prior specifications are available in the analysis script.

coded the shared iconic strategies and ran a Bayesian linear regression model using the dummy coded iconic strategies as predictors for concreteness ratings and setting *different* as reference category. We used a Student's t-distribution and chose maximally uninformative default priors (concreteness $\sim 1 + \text{acting} + \text{representing} + \text{personification} + \text{entity} + \text{tracing} + \text{deictic}$, family = student).

Finally, we analysed whether particular iconic strategies are associated with higher form overlap using the same dummy coding approach. We ran a Bayesian ordinal regression with maximally uninformative default priors and *different* as a reference category (form overlap $\sim 1 + \textit{acting} + \textit{representing} + \textit{personification} + \textit{entity} + \textit{tracing} + \textit{deictic}$, family = cumulative[logit]).

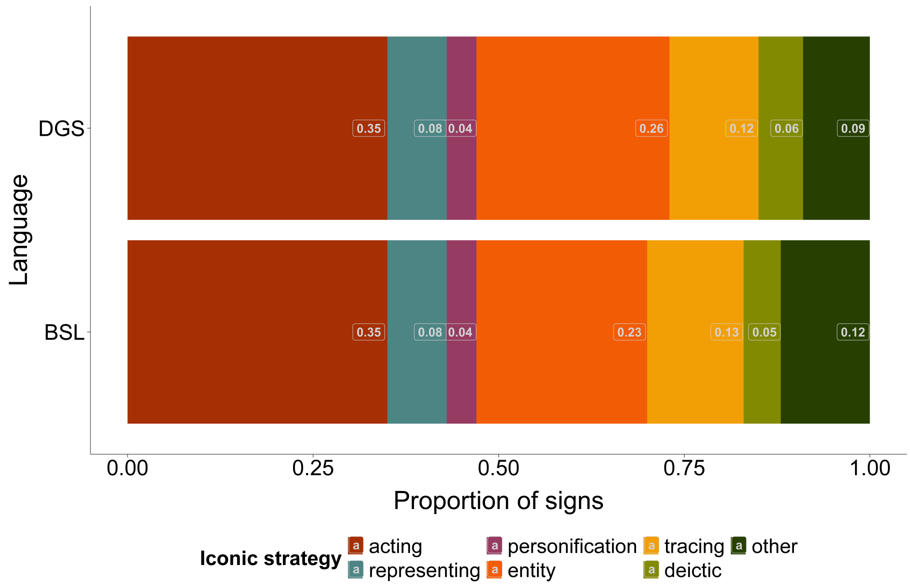
3.3 Results

In the first analysis, we present and compare the proportion of signs for each iconic strategy for BSL and DGS. We show the distribution of iconic strategies in the two languages (Figure 3.4a) and the correlation in frequency of use (Figure 3.4b). Both languages use the *acting* strategy most frequently, followed by the *entity* and *tracing* strategies; the *personification* strategy is used least frequently. A Bayesian Pearson product-moment correlation model of ranked strategy use between the two languages showed a robust positive correlation ($\hat{\beta} = 0.93$, est. error = 0.10, 95% CI $[0.68, 0.99]$, $\hat{R} = 1.00$, Bulk ESS = 2007, Tail ESS = 2313). This means that the use of iconic strategies is highly similar in the two languages across the lexicon and including abstract concepts. The posterior probability of the correlation effect being positive approaches 1.

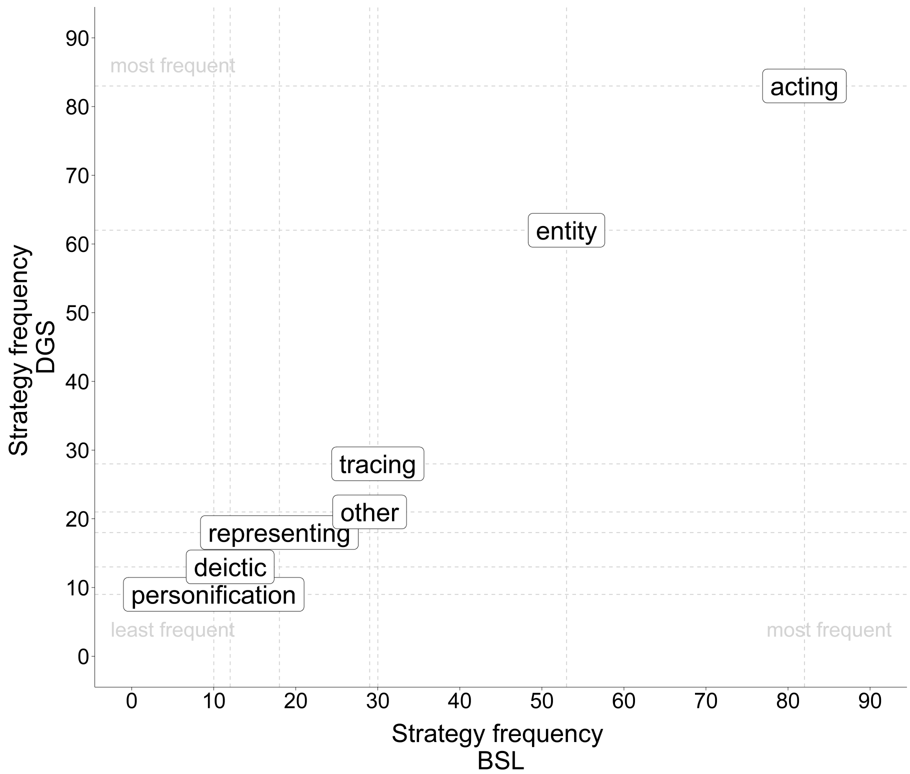
3.3.1 Iconic strategies and iconic instantiations

We investigate whether concepts that are depicted with the same iconic strategy in BSL and DGS are likely to be based on the same iconic instantiation in the two languages. Table 3.3 shows that iconic instantiation and strategy are closely linked, such that most concepts that share an iconic strategy are based on the same instantiation ($N = 124$) and, conversely, most concepts that use different strategies are also based on different instantiations ($N = 60$). We find that it is 2.3 times more likely for a concept to use the same strategy in BSL and DGS if the signs are based on the same iconic instantiation than if they are not – an odds ratio of 25.51. However, this indicates that a substantial proportion of signs (18%) are based on different iconic instantiations but use the same iconic strategy in both languages. For example, in the DGS sign SUPERMARKET, the *acting* strategy is used to depict pushing a trolley, while the BSL sign uses the same strategy to depict the handling of money or objects.[14] As we are interested in the relationship

[14]Note that lexical variants may exist of all of these items. In our selection of items for comparison, we selected the most frequent variant in the elicited data or the variant that was judged by deaf team members and colleagues to be most frequently used in the local deaf community. For more details on the selection process, see Chapter 2.



(a) Bar chart of proportions of signs that use each strategy in DGS (top) and BSL (bottom) for all signs ($N = 234$).



(b) Correlation chart of absolute frequency of use in BSL (x-axis) and DGS (y-axis).

Figure 3.4: Proportion of iconic strategies in BSL and DGS. Both use the *acting* strategy most frequently and the *personification* strategy least frequently.

between sign form and iconicity, based on the use of iconic strategy, we excluded signs that share an iconic strategy but are not based on the same iconic instantiation from further analysis ($N = 43$). After excluding items that shared an iconic strategy but were based on different iconic instantiations, no pairs of signs were classified as *other* in both languages.

Figure 3.5: SUPERMARKET in BSL (left) and DGS (right). Both signs use the *acting* strategy to depict actions associated with shopping in a supermarket, but differ in the action selected. The BSL sign depicts handling money or objects, while the DGS sign depicts pushing a shopping trolley.

Instantiation ↓| Strategy →	same	different	total
same	124	7	131
different	43	60	103
total	167	67	234

Table 3.3: Frequency of shared iconic strategy (columns) by shared iconic instantiation (lines) across BSL and DGS

3.3.2 Effect of iconic strategy overlap, iconic instantiation overlap and concreteness on form overlap

We then investigated how sharing an iconic strategy and concreteness ratings relate to form overlap. We ran a Bayesian ordinal regression, which shows that only iconic strategy overlap emerges as a statistically robust predictor of form overlap, when combining these factors. Concepts that share an iconic strategy are more likely to show increased form overlap than those that do not and the posterior probability for a positive effect approaches 1 in a hypothesis test (estimate = 3.33, est. error = 0.47, 95% CI $[2.57, 4.12]$). Figure 3.6 plots posterior samples of estimated effect sizes for the factors *concreteness*, *sharing the same iconic strategy*, and the interaction effect of these two. Density curves that include zero are indicative of non-robust effects. Here, neither concreteness nor the interaction term robustly predict form overlap. The density curve for using the same iconic strategy in both sign languages does not include zero and indicates a positive effect. This indicates that sharing an iconic strategy is associated with higher form similarity, regardless of concreteness.

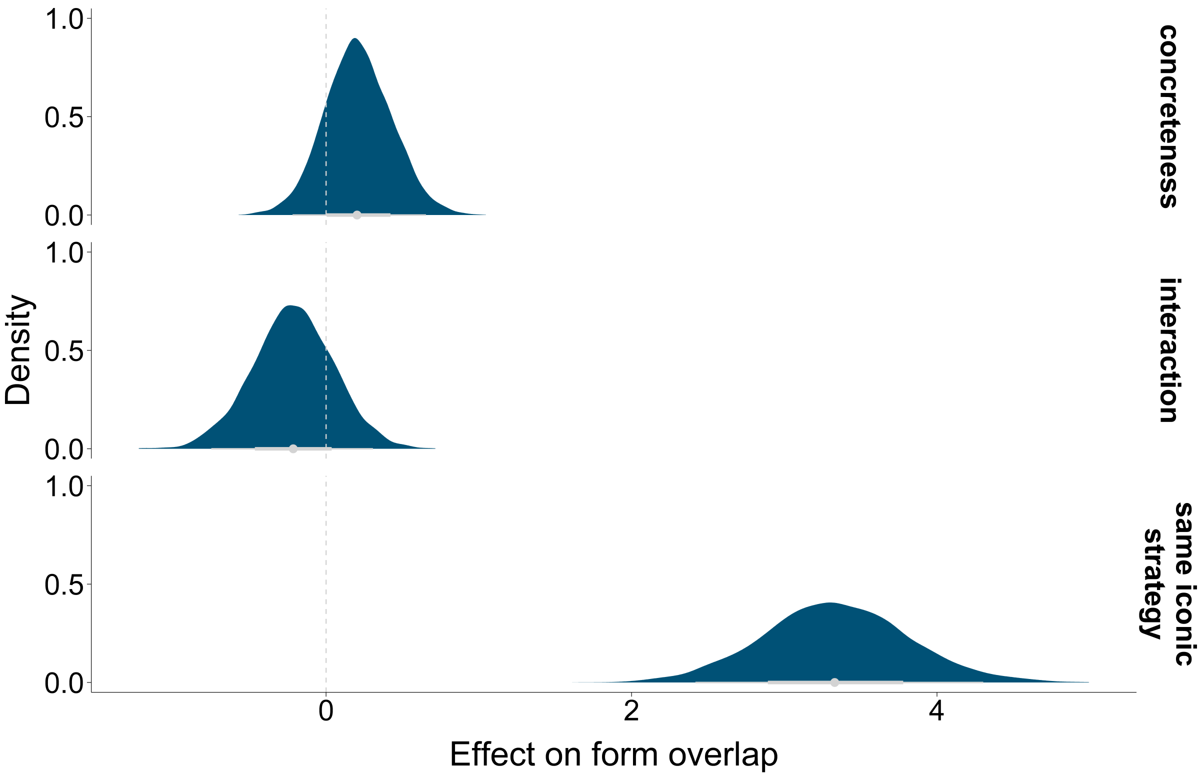


Figure 3.6: Posterior samples for the effects of concreteness and sharing the same iconic strategy in BSL and DGS on form overlap. The modelled effect sizes of each predictor are depicted on the x-axis. Density curves that do not include zero (dashed grey line) are associated with robust effects. BSL and DGS signs for the same concept that share an iconic strategy are more likely to show higher form overlap than those that do not. Concreteness does not have an effect and does not interact with iconic strategy use.

3.3.3 Distribution of iconic strategies in concrete and abstract concepts

While concreteness does not seem to predict form overlap, this may be due to high shared variation with iconic strategy use. In order to investigate how concreteness ratings relate to iconic strategies in BSL and DGS, we ran a Bayesian linear regression model with dummy coding for shared iconic strategies with concepts that do not share a strategy across languages as reference category. Figure 3.7 visualises this point, plotting concepts that use different strategies in BSL and DGS and those that share a specific strategy with their average concreteness ratings.

Compared to concepts that do not share a strategy, the shared *acting* strategy is negatively associated with concreteness ratings (estimate = -64.59, est. error = 20.32, 95%

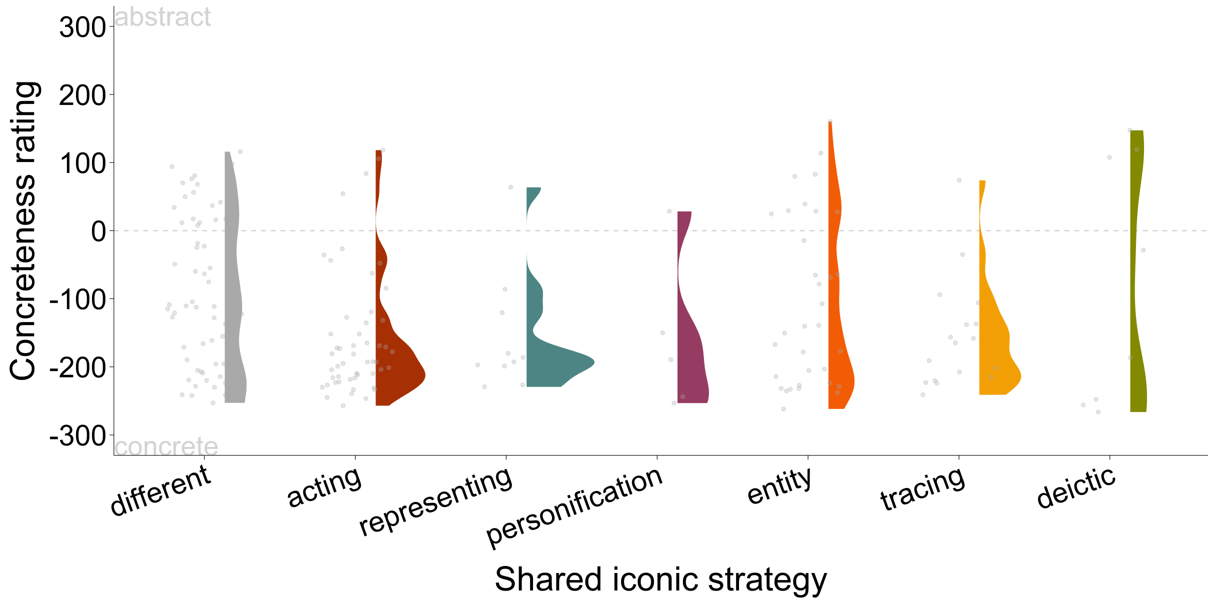


Figure 3.7: Distribution of concreteness ratings by shared iconic strategy across BSL and DGS. *Acting*, *tracing* and *representing* show a bias towards concrete concepts (higher concentration of data points below 0), while no robust bias is present for the other strategies.

CI $[-104.96, -24.78]$) with a probability that approaches 1 (evid. ratio = 1332.33). For the *representing* strategy, hypothesis tests reveal a 96% probability of a robust negative effect (evid. ratio = 22.12), though the 95% credible interval for the posterior probability of a negative association includes zero (estimate = −61.58, est. error = 36.76, 95% CI $[-134.42, 10.14]$). The *tracing* strategy has a negative association with concreteness ratings (estimate = −61.51, est. error = 29.70, 95% CI $[-110.00, -12.88]$) with a probability of 98% (evid. ratio = 53.05). The trends for *entity*, *personification*, and *deictic* are not statistically robust, failing to reach significance in hypothesis tests and including zero in the 95% credible intervals.

These findings indicate that the *acting* and *tracing* strategies are robustly biased towards concrete concepts compared to concepts that do not share an iconic strategy. The bias for the *representing* strategy is less robust in the data, though hypothesis testing suggests a significant effect. The strategies *entity*, *deictic* and *personification* do not show robust biases towards concrete concepts, indicating that they have similar concreteness ratings to items that do not share an iconic strategy.

It is noticeable that *entity*, the second most frequent strategy, does not show a relation to concreteness, indicating that it affords the representation of abstract concepts more easily than *acting*. The model shows that shared iconic strategies are associated with lower concreteness ratings, while highly abstract concepts are likely not to share the same strategy in the two sign languages. Figure 3.7 shows that the *entity* and *deictic* strategies are particularly evenly shared for concrete and abstract concepts. The *acting* strategy is also shared for some more abstract concepts, though it has a clear bias towards highly concrete concepts. The *personification*, *representing* and *tracing* strategies are shared extremely rarely for more abstract concepts.

3.3.4 Iconic strategies and form overlap

We also followed up on the relationship between shared iconic strategy and form overlap by investigating the specific contribution of particular iconic strategies in BSL and DGS to increased form overlap. We ran a Bayesian ordinal regression with dummy coding for iconic strategies, parallel to the model investigating the relationship between iconic strategies and concreteness ratings. Figure 3.8 visualises this model, plotting the degree of form overlap (from no shared parameter values to full overlap) for concepts that use different iconic strategies or share a strategy across BSL and DGS. Signs that share any of the strategies investigated here show higher form overlap than items that do not share a strategy across languages, as confirmed by hypothesis testing (all estimates > 2.17, est. errors < 0.77, 95% CIs $[> 0.91, < 4.21]$, evid. ratios > 443.44), approaching posterior probabilities of 1. Only the posterior distribution for the *personification* strategy includes zero; a robust prediction may be impeded by the very low number of items in this category. Estimated effects range from 2.16 to 3.16, indicating that it is substantially more likely for concepts that share any iconic strategy across languages to show higher levels of form overlap than for those that do not share a strategy.

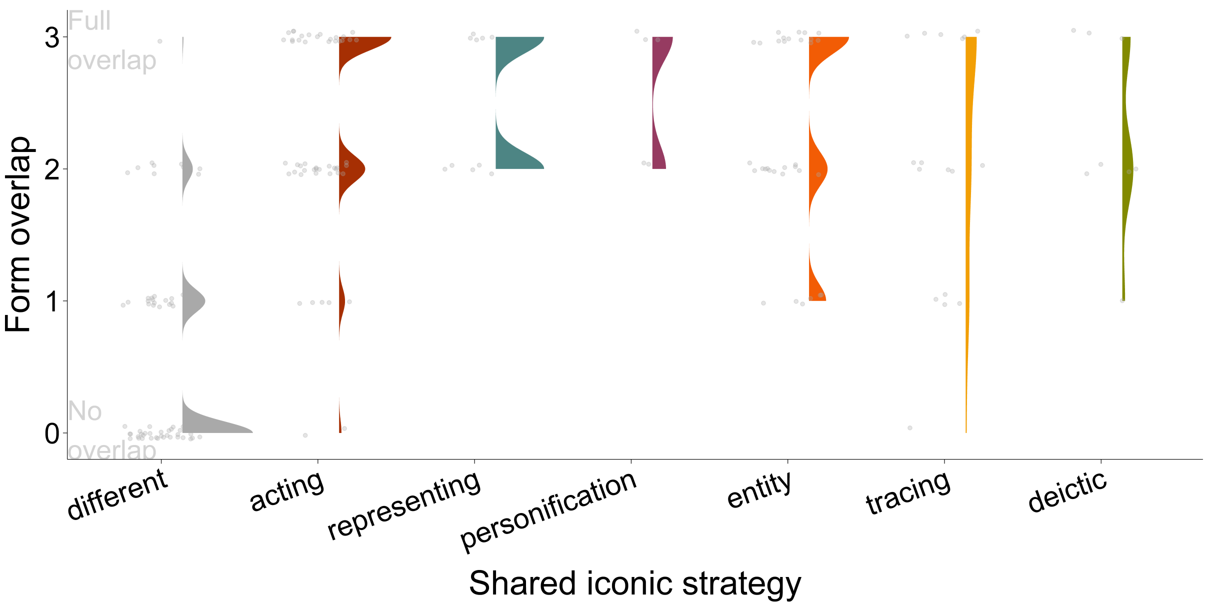


Figure 3.8: Distribution of form overlap by shared iconic strategy across BSL and DGS. The dots represent individual concepts, grouped by shared iconic strategy or lack thereof (*different*) and plotted according to the degree of form overlap from no overlap (0) to full overlap (3).

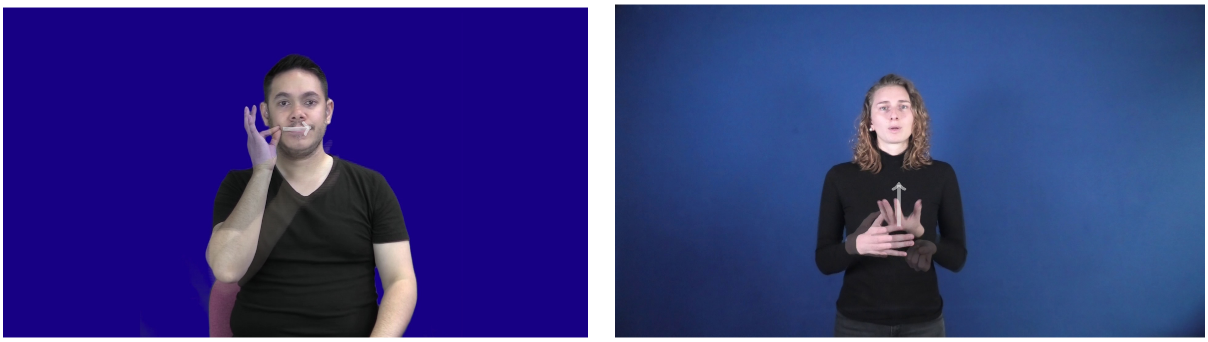
Figure 3.8 shows that only *acting* and *tracing* are shared for items that have no form overlap on very limited occasions, while still being used to depict the same iconic instantiation. The signs for GLOVES, for example, reproduce the action of putting on a glove using the *acting* strategy in both languages, yet they differ in whether the dominant hand moves along the non-dominant hand's back or palm, the specific handshape while pulling the glove and the joint that drives the movement (Figure 3.9b). Particularly, *representing* and *personification* only appear to allow for very high form overlap, where at least two parameters overlap. For example, the signs for COW differ only in movement, such that the DGS but not the BSL variant included a movement away from the forehead (Figure 3.9c). Signs that do not share a strategy are most likely to show no form overlap at all.

3.4 Discussion

In this study, we explored how iconicity and concreteness contribute to the similarity in lexical signs for concrete and abstract concepts in two unrelated sign languages (BSL and DGS). We analysed 234 concepts and their corresponding signs in both sign languages. All signs were annotated for iconic strategy and iconic instantiation, and we collected ratings of each concept's concreteness. We found that the distribution of iconic strategies is similar in both sign languages, with *acting* and then *entity* as the most frequent strategies, followed by *tracing*, while *personification* is the least frequent. We show that when the two signs for a concept are represented with the same strategy, they are typically based on the same iconic instantiation, while different strategies are used in signs that are based on different instantiations. These findings suggest that individuals from different communities exploit shared conceptual representations to develop iconic mappings in similar ways. An important and novel finding of this study is that concreteness is not a predictor of form similarity, when taking into account shared use of iconic strategy. Instead, shared iconic strategy across sign languages is associated with higher form overlap, regardless of how concrete or abstract a concept is. Analysing the link between iconic strategy and concreteness, we see that concrete concepts are more likely to share a strategy than abstract concepts. Among the iconic strategies, the *entity* strategy most easily affords the depiction of abstract as well as concrete concepts. At the other extreme, the *acting* strategy shows a strong bias towards concrete concepts. Iconic strategies also differ in how strongly they predict high form overlap. Low form overlap seems more likely for concepts that share the *acting* or *tracing* strategies, while *representing* and *personification* predict very high overlap.

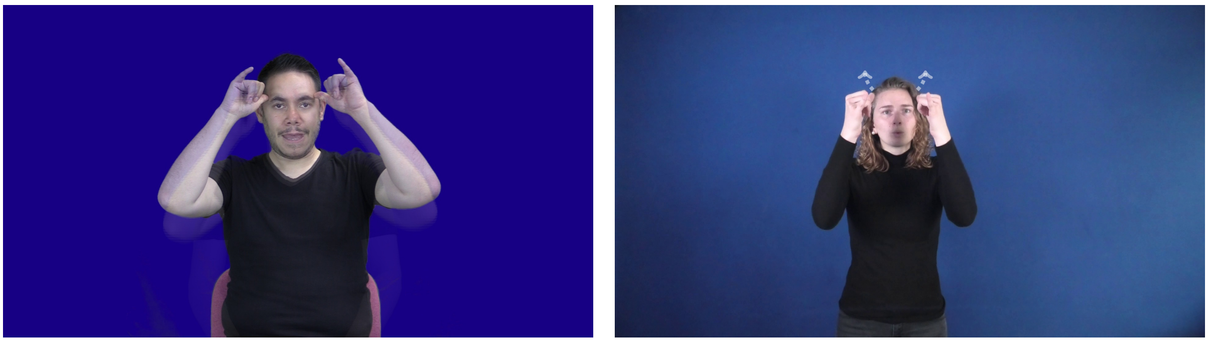
3.4.1 Iconic strategies in BSL and DGS (RQ 1)

BSL and DGS show highly similar distributions of iconic strategies across the 234 concepts in our study. We see two potential reasons for why two unrelated languages



(a) FLOWER | BSL: *acting* - DGS: *entity* | overlap = 0 (none)

(b) GLOVES | *acting* | overlap = 0 (none)



(c) COW | *personification* | overlap = 2 (HS + LOC)

Figure 3.9: Degree of form overlap with shared or different iconic strategies.

would exhibit similar iconic mappings for concepts across the lexicon. First, humans share similar conceptual representations about the world, and iconicity allows us to express the visual features of these concepts in the manual-visual modality (i.e. sign or gesture). Many concepts are related to human experiences and as a result these concepts would be represented in similar ways by individuals from different cultures, even though the individual embodied experiences are fundamentally subjective (Occhino et al., 2017). Humans may therefore converge in the way they depict them iconically. Second, shared cultural experiences would increase the likelihood of selecting the same features for iconic representations across languages. For example, the sign MARRIAGE in both BSL and DGS represents the wedding band that couples wear as a symbol of their union in Western societies (Figure 3.10).

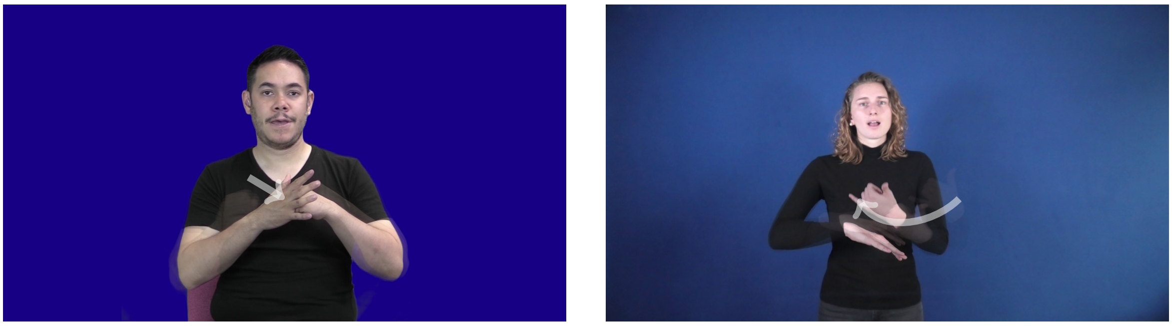


Figure 3.10: MARRIAGE in BSL (left) and DGS (right). Both signs depict the ring on the finger, however the BSL sign appears to depict the gleam on the ring, while the DGS sign includes the act of putting on the ring.

These two reasons, of course, are not mutually exclusive. They could be seen as a continuum, where some experiences are more universal, while others are more culturally determined. Particularly for abstract concepts, even small cultural differences may be visible in iconic representations, as in the signs for COURT in Figure 3.2. Though such differences may exist between the UK and Germany, the overall distribution of iconic strategies in our set of concepts in the two languages remains highly similar.

We show that *acting* emerges as the dominant iconic strategy in both BSL and DGS (∼ 35% of concepts use this strategy). Here, signers directly depict a bodily action to refer to the action itself, the object being handled, or even an abstract extension of the depicted concept (e.g. the sign LEARN in both DGS and ABSL, which depicts putting a metaphorical object into the head). These findings add to the now abundant body of work showing that the *acting* strategy is favoured in the representation of concepts in sign languages (Ergin, 2022; Padden et al., 2013). Embodied theories of language can account for this preference, since conceptual representations are assumed to be related to our sensorimotor system (Evans, 2007; Gallese & Lakoff, 2005; Hauk et al., 2004; Pulvermüller, 2005). For example, Hostetter and Alibali (2008, 2010) argue that representational gestures emerge as a product of action simulation that is part of expressing our thoughts. Our findings suggest that a similar process applies to sign languages, whereby the most salient iconic strategy for any referent would be the one that creates the closest possible mapping to the sensorimotor experience with the concept.

The body is the primary vehicle to interact with the world and thus the representation of these motions through the *acting* strategy is an efficient tool to convey meaning that is familiar to an interlocutor, who is likely to share these experiences. From a concept by concept comparison, a finding that merits attention is that the *acting* strategy is biased towards concrete concepts. These concrete concepts are substantially more likely to share the *acting* strategy across the two sign languages than abstract concepts. This partially supports the view that the close sensorimotor mapping of this strategy to a target referent is particularly suitable for concrete concepts, though it can also be used to depict abstract concepts.

The prevalence of the *acting* strategy has important implications for processes of language emergence and evolution. Studies eliciting silent gestures as proxy for communication of a non-conventionalised linguistic system have found that the *acting* strategy is the most commonly used to represent actions and manipulable objects (Ortega & Özyürek, 2020b). Similarly, Ergin (2022), investigated the iconic strategies used in an emerging sign language, (CTSL), which shows a strong preference for the *acting* strategy, accounting for approximately half of the lexical signs investigated, in a picture-naming task (Ergin, 2022). Padden et al. (2013) show that gesturers had a substantially stronger preference for the *acting* strategy than signers, regardless of whether the sign language was fairly young (ABSL) or a large, national sign language (ASL). The *acting* strategy has also been found to be commonly used in combination with other signs to create novel signs for objects (Safar & Petatillo Chan, 2020; Tkachman & Sandler, 2013). For instance, the *acting* sign POUR followed by a *tracing* sign of a round container may combine to form the sign TEAPOT. These studies show that the *acting* strategy capitalises on human bodily experience to develop new linguistic labels that link to human experience. Interlocutors share these bodily experiences and this may be the reason why the *acting* strategy is so strongly represented in two unrelated sign languages and are likely to be also significantly prevalent in other sign languages.

Indeed, several authors have suggested that the iconic and mimetic potential of manual gestures may provide a link between action and complex communication. Grounding understanding in the social potential of recognising voluntary action (Rizzolatti & Arbib, 1998) and mimicking actions as a communicative device may provide the neurobehavioural basis that provides the basis for more complex communicative behaviours. Armstrong (1999) argues that the structure implicated in single gestural depictions may provide the basis for grammatical structuring, later evolving into sentence-like utterances in a language evolution framework. Relatedly, Volterra et al. (2005) show how infants initially rely primarily on gestural articulations and use combinations of gestural and vocal components as a transition into primarily vocal communication and grammatical complexity. In such approaches, a clear continuity between action, gesture and sign is postulated, at least implicitly predicting the similarities across sign languages, that we find in our data.

If the *acting* strategy is highly embodied and can be argued to be the preferred strategy whenever possible, we may ask why it is not even more prevalent in the lexicon of BSL and DGS[15]. One reason is that the *acting* strategy relies on the referent affording some degree of physical interaction, which should also be related to salient characteristics of the referent. However, additional functional reasons, as well as factors influencing phonological change and contrasts, may emerge in the course of language evolution. Ergin (2022) shows that the strong bias for the *acting* strategy substantially decreased for items that were produced in context in a short narrative, rather than isolation, i.e. as responses to direct elicitation. In established sign languages, such as BSL and DGS, lexical signs are typically encountered and acquired in context. This contextual embedding in narrative and discourse structure may allow sign languages to expand their use of other iconic strategies in the lexicon. As such, we suggest that each of these strategies fulfils some underlying function, which reflects the semantic composition of a lexicon (for factors relevant to iconic strategy use in gestures, see for example Masson-Carro et al., 2015; Ortega & Özyürek, 2020b). This would account for the highly similar proportions in the use of all iconic strategies in BSL and DGS, even at a fine-grained level of distinction, as detailed below.

The second most frequent strategy in our data was the *entity* strategy ($23 - 26\%$ of concepts use this strategy). We found that this strategy is equally likely to refer to concrete and abstract concepts (Figure 3.7), a feature that is not shared with the other strategies. For example, the BSL and DGS signs for LAW both depict lines written on a piece of paper using the *entity* strategy (see Figure 3.11), which represent the concept "law" by metonymic extension. The same sign form in DGS can also be used to refer to a list of things, a plan, programme, rule, concept or schedule (see entry 928, DGS dictionary for alternative German translations; Langer et al., n.d.), all of which build on the same *entity* strategy with semantically related metaphorical extensions. The unique feature of the *entity* strategy is that even though it is detached from the direct embodied experience, it retains a core iconic element which provides a strong potential for abstraction. When the signer's body is semiotically backgrounded (Dudis, 2004), the sign can become a vehicle for iconic mappings unrelated to the human body.

Tracing is another frequent strategy, which highlights the outline of the referent, focusing on a feature that is primarily perceived visually. Past studies have shown that people were more likely to represent concepts with low manual affordances but high spatial specificity (e.g. pyramid, bridge) using the *tracing* strategy in gestures (Masson-Carro et al., 2015; Ortega & Özyürek, 2020a). In line with these studies, in our data the *tracing*

[15] The proportion of the *acting* strategy is typically $> 50\%$ in silent gesture and emerging sign language studies looking at concrete concepts (Ergin, 2022; Ortega & Özyürek, 2020b), compared to $\sim 35\%$ in our data.

Figure 3.11: LAW in BSL (left) and DGS (right). Both signs depict lines on a piece of paper, using different handshapes.

strategy is biased towards concrete concepts. It allows for a range of form features, e.g. variations in handshape, different movement patterns regarding directionality and orientation, and differences in location, reducing the degree of form overlap implied by the strategy compared to other strategies. Even though the signer's body is less salient in both the *entity* and the *tracing* strategies, the latter is more closely tied to the physical shape of the target referent.

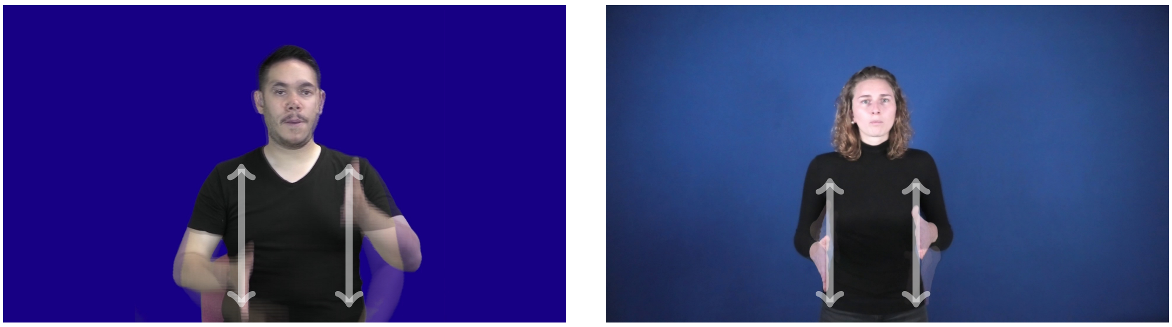


Figure 3.12: ROBOT in BSL (left) and DGS (right). Both signs depict a humanoid robot moving its hands in a mechanical fashion.

The less prevalent strategies (*representing*, *personification* and *deictic*), in turn, appear to have more specialised roles. Neither the *representing* nor the *personification* strategy appears with low or no overlap in our data, highlighting the high degree of specificity implied by these mappings. *Representing* combines features of *acting* and *entity*, providing a way to increase specificity of the *acting* strategy by adding semantic features related to shape (e.g. the shape of a pair of scissors as well as the cutting motion). The *personification* strategy maps animate entities that have some physical resemblance to the human body and thereby expands the articulators to include the head and torso of the signer. In our data, we find that across BSL and DGS this strategy is used to refer to animals and human-like entities (e.g. robots, see Figure 3.12). This is in line with previous studies investigating the use of the *personification* strategy in sign languages (Hou, 2018; Hwang et al., 2017) and silent gesture (Ortega & Özyürek, 2020b).

Finally, the *deictic* strategy provides a specialised non-iconic function. The *deictic* strategy is only available for referents that are either always present (e.g. body parts) or referents that are construed as codified abstract space (e.g. spatial timelines). For example, the sign form pointing to the wrist of the non-dominant hand could in principle be interpreted as referring only to the concrete concept "wrist", but also has more abstract meanings. BSL and DGS, the same sign form also represents the signs WATCH and TIME (see Figure 3.3f for the BSL sign). In the absence of the physical object, the meaning 'watch' could be considered an abstraction, since there is no present referent and the interpretation as "time" may represent a metonymic extension from a synchronic perspective (but see Lepic and Padden, 2017 for a diachronic perspective on the corresponding ASL sign). The ambiguity of referential space is exploited in the *deictic* strategy to depict concrete as well as abstract concepts, in a similar way to the referential ambiguity displayed in the *entity* strategy. Both strategies are thus frequently shared for concrete as well as abstract concepts.

3.4.2 Iconicity, concreteness and lexical similarity (RQ 2)

Overall, we find that form similarity is driven by a similar use of iconicity, across concrete and abstract concepts. This effect is mediated by the iconic strategies and instantiations employed in the languages under comparison, such that items that share an iconic strategy are highly similar in form, while even highly iconic signs that use different iconic strategies in the two languages are likely to result in substantially different representations. The analogue building model (Taub, 2001) can serve as a starting point to understand how iconicity shapes form similarity across unrelated sign languages and our data supports that this is also the case for abstract concepts.

Taub (2001) suggests that iconic signs are build up in a cognitive mapping process, consisting of a sequence of phases that go from a mental representation of the concept to its articulatory form. In this model, a specific image is selected to represent a concept (iconic instantiation) and then is schematised into a number of manual features using a particular iconic strategy (schematisation). Finally, the selected features are mapped onto the articulators, creating a valid sign form (encoding). This model, however, states that this process operates exclusively on concrete concepts but does not explain how iconicity can be used for abstract concepts. This may be the reason why some have proposed that iconicity is not amenable for abstraction (Lupyan & Winter, 2018). Meir and Cohen (2018) reconcile iconic mappings with the representation of abstract concepts by suggesting a double mapping, in which abstract concepts in sign languages can be grounded in a concrete depiction at the level of the iconic mapping, with the additional metaphorical level adding an abstraction away from that concrete base (e.g. a wig to represent a court).

What we find that is that iconicity can be used for abstract and concrete concepts and that the same iconic strategies support form similarity in both. In our data, abstract concepts that share the same metaphorical representation allow for parallel iconic strategies in both languages, resulting in form overlap. However, in most abstract concepts, the two languages choose different metaphors, resulting in different iconic mappings driving differences in sign forms. Therefore, iconicity is not less suitable for abstraction but rather the metaphors are much more varied than the images selected to represent concrete concepts.

Coming back to our research questions, we show that shared iconic strategies are used for abstract concepts, just as they are for concrete concepts. Form overlap is predicted by shared iconic strategy, particularly sharing the *representing* or *personification* strategy, but not concreteness, which is at least partially accounted for by concrete concepts being substantially more likely to share an iconic strategy than abstract concepts. Iconic strategies differ in how suitable they appear for the depiction of abstract concepts, drawing on the embodied affordances of each strategy. As such, specific iconic mappings are the main driver of lexical similarity between sign languages.

In summary, the fact that BSL and DGS use the iconic strategies in approximately the same proportions may reflect similar biases to select the same feature of a referent and depict it iconically. The interaction between affordances of referents and the ways in which the body can depict their features makes sign languages deploy strikingly similar iconic strategies. The high degree of overlap that goes with sharing most iconic strategies implies that the selection of form features in highly iconic signs is strongly influenced by the requirements of the iconic mappings, leaving limited room for differences in articulation. As such, the observed strategies in iconic representation in the manual-visual modality suggest common conceptual representations expressed in similar ways with the body.

3.4.3 Iconicity and word formation in all modalities of language

Traditional linguistics has frequently brushed away the influence of iconicity on the lexicon, assuming it to be a niche phenomenon, that, if at all present, will be eroded over time by lexical and semantic changes (Frishberg, 1975; Goldberg, 2006; Pinker, 1999). Theories of language evolution also sometimes argue that iconicity may have played a larger role at the emergence of language but that this influence erodes over time to make place for arbitrariness and a supposedly more efficient structuring of the lexicon (Christiansen & Chater, 2016; Christiansen & Monaghan, 2016; Gasser, 2004; Monaghan et al., 2011).

Such claims imply that the reason for higher levels of iconicity in sign languages may lie in their lack of time depth, assuming that spoken languages are much older than signed languages and that given sufficient time depth sign languages would also show a reduction in iconic forms, as suggested by Frishberg (1975) for ASL. However, Flaksman (2020) shows that iconicity is regularly re-introduced into the lexicon in spoken languages, maintaining their expressive potential. These processes are traceable in the time spans of no more than a few hundred years (Erben Johansson, 2020; Flaksman, 2020). Our findings indicate that sign languages retain high levels of iconicity across the concrete and abstract level, even for well-established national sign languages, like BSL and DGS, with a time depth that should be sufficient to see the results of such processes from a synchronic perspective. We show how the mapping processes in iconic strategies provide direct links between conceptual representations and possible sign forms that are shared across languages, driving cross-linguistic similarities that appear to be largely resilient to regularising processes in the lexicon. We therefore predict that these similarities will hold across sign languages in more general terms and that, in a diachronic perspective, iconicity is unlikely to be eroded in sign languages. This may be an important difference across the modalities of language that merits attention and further investigation.

3.5 Conclusion

Our findings contribute to a better understanding of how iconicity shapes the lexicon across unrelated sign languages. We show that iconicity but not concreteness plays a major role in driving form similarity and that the specific type of iconicity is essential to this relationship. We also show that iconic strategies are used and can be shared for abstract concepts, but that the distribution of iconic strategies may differ from how strategies are used in concrete domains. Considering the convergence of sign languages and silent gestures on using the same iconic strategies in similar ways in concrete domains, these findings may well generalise beyond the two sign languages under investigation in this chapter. Further research should investigate the specific association of iconic strategies with semantic distinctions in abstract concepts and include a wider range of languages in this comparison.

This study highlights that iconic mappings have a profound impact on the high lexical similarity found across sign languages, including in abstract domains. They drive feature selection and thereby influence sign forms within individual sign languages, as well as across sign languages, by making use of fundamental embodied experiences. As such, iconicity serves a productive role in shaping and creating the lexicon of languages across modalities.

Chapter 4

Iconicity in concrete and abstract concepts – A cross-linguistic and cross-cultural comparison of gestures and signs

4.1 Introduction

When asked to represent concepts through gestures without speech, people invariably attempt to produce gestural forms that depict mental representations of concepts based on how an object or action is experienced. Particularly gestures produced in the absence of speech have previously been used to investigate how non-signers are able to exploit the visuo-manual modality for depiction. Previous studies have shown that gesturers often converge on similar forms both within and across cultures, suggesting that some aspects of these representations may be shared (Masson-Carro et al., 2015; Ortega & Özyürek, 2020a, 2020b; van Nispen et al., 2017). Crucially, these shared representations often incorporate aspects of their meaning in the articulatory form, they are iconic (Ortega & Özyürek, 2020b; Perniss et al., 2010). At the same time, variation in gestural responses highlights the flexibility of the visuo-manual modality.

This study examines how non-signers, who do not have access to a fixed linguistic system of manual representations, use the visuo-manual modality to represent concepts through silent gesture, focusing on what drives systematicity in gestural representations. By comparing silent gestures to lexical signs in BSL and DGS, we explore the extent to which systematic gestures emerge in the absence of linguistic conventionalisation. Prior research has primarily examined highly concrete, often easily visualisable concepts (Ortega et al., 2019; van Nispen et al., 2017), leaving open the question whether abstract concepts are inherently less suitable for iconic representation (Lupyan & Winter, 2018) or simply exhibit lower systematicity in how they exploit their iconic potential (Winter, Lupyan, et al., 2023). To address this, we analyse how both concrete and abstract concepts are depicted through silent gesture and compare these representations to those found in sign languages.

The concept "eat" may serve as an intuitively accessible example (see Figure 4.1). When asked to produce a gesture that depicts this concept, most people depict bringing something to the mouth. Variation may occur with regard to how food is held – by hand, with a fork, with chopsticks, etc. – but the action of bringing food to the mouth is fundamental to the experience of eating.

4.1.1 Iconicity in the visual modality

Gestures that look like (some aspect of) what they mean are called *iconic*, a term we define as a resemblance-based relationship between form and meaning (Dingemanse et al., 2020; Perniss et al., 2010; Winter, Woodin, & Perlman, 2023). Iconicity is an important mechanism for grounding gestures, as well as the lexical signs of sign languages and words in spoken languages in sensori-motor experiences with bodily actions and visual percepts (Flaksman, 2020; Perniss & Vigliocco, 2014). The relationship between forms and their meanings can be understood as structure-preserving mappings (Gentner, 1983) between

Figure 4.1: Silent gestures produced for EAT by non-signers in Germany (left, blue background) and the UK (right, grey background). Solid lines indicate movements on the coronal plane, dashed lines on the sagittal plane. Double arrows indicate repeated movements.

the conceptualisation of the referent and its articulatory form (Emmorey, 2014; Taub, 2001).

Iconicity is not exclusive to the visuo-manual modality but has been described as particularly salient in this modality (Dingemanse et al., 2015; Perniss et al., 2010). This may be related to the direct way in which our embodied actions, the way we experience the world around us, can be mapped onto articulations in that modality (Müller, 2009; Padden et al., 2015). The visuo-manual modality is particularly well-suited for iconicity because it allows direct mappings between embodied experience and articulation. This is evident in both sign languages and co-speech gestures, where visual and manual elements enhance communicative efficiency. Language thus exploits available modalities to maximise communicative efficiency (Perniss, 2018; Vigliocco et al., 2014). As such, even non-signers consistently use the visuo-manual modality alongside spoken language, and this information is crucial in face-to-face interaction (Holler & Levinson, 2019) and is integrated immediately and simultaneously in language processing (Hagoort & Özyürek, 2024). Understanding how iconicity contributes to language in this modality provides insights into the human cognitive capacity for communication.

Iconicity not only grounds meaning but also contributes to structural similarities across sign languages. Since sign languages independently exploit the expressive potential of the visuo-manual modality, their lexicons often develop cross-linguistic similarities in form that go far beyond what would be expected in developments that are historically unrelated (Woll, 1984). Iconicity, therefore plays a confounding role in attempts to chart historic relationships between sign languages around the world, as it drives similarity (Parkhurst & Parkhurst, 2003; Woll, 1984). Gestures that accompany spoken languages are also often cited as highly similar across cultures and languages, although differences may emerge, for example with regard to social acceptability and thus frequency, intensity and specific form of gestures (Ladewig, 2024) but also in the realisation and structuring of gestural representations (Kita & Özyürek, 2003; Özyürek, 2021). These similarities suggest a shared cognitive basis for iconic mappings across linguistic and non-linguistic systems.

Other studies have investigated this by studying whether iconicity is used in the same way across different sign languages and in the gestures of hearing people (Hou, 2018; Hwang et al., 2017; Masson-Carro et al., 2015; Ortega & Özyürek, 2020a; Padden et al., 2013). These studies show that the use of particular iconic mappings often coincides with semantic distinctions, such as an alignment of acting as if performing an action with the representation of actions, or in sign languages the grammatical function of verbs, as opposed to the representation of shapes and size for objects or nouns (Padden et al., 2013). The similarities found in these studies are surprising, considering that these are not only separate systems but also used in different communicative contexts and cultures. However, these studies typically focus exclusively on concrete concepts, often through elicitation with images, further narrowing their investigation to concepts that are easily depicted visually (for an example using images and short videos as stimulus materials, see Padden et al., 2013).

4.1.2 Iconicity strategies

When describing iconicity in the visuo-manual modality, one approach is to classify the mappings based on the relationship between the referent and the linguistic form. Müller (2014) proposed a set of categories for this classification. We adopt the term *iconic strategies*, frequently used in sign language linguistics (Hwang et al., 2017; Keränen, 2021; Ortega & Özyürek, 2020b; Padden et al., 2013, 2015), to describe a number of mapping strategies (see Subsection 4.4.2 for details).

Past studies comparing the use of iconicity have found considerable similarity in how these iconic strategies are used across gestures both within and across cultures (Masson-Carro et al., 2015; Ortega & Özyürek, 2020a, 2020b; van Nispen et al., 2017; Yang & Kita, 2024). These studies examined spontaneous silent gesture production and co-speech gesture in hearing non-signers and found that gesturers used similar iconic strategies for the same depictive goals and semantic categories. Similarly, several studies have investigated the use of iconic strategies across sign languages, sometimes also including silent gesture (Hou, 2018; Hwang et al., 2017; Keränen, 2021; Kimmelman et al., 2018b; Padden et al., 2013, 2015; Witz, 2024).

Iconic strategies show functional differentiation in both sign languages and gestures, mapping onto how the body interacts with different referents and aligning with semantic domains. Looking specifically at studies that include gestural representations, actions are often represented the *acting* strategy, where the handling of an object or the action itself is enacted, while objects are represented using the *representing* or *entity* strategy, where the hand represents the shape of an object, with or without the action included (Hwang et al., 2017; Ortega & Özyürek, 2020b; Padden et al., 2015; van Nispen et al., 2017). Similarly to sign language findings, gesturers tend to use the *personification* or *entity* strategies to represent animals (Hwang et al., 2017; Masson-Carro et al., 2015; van Nispen et al., 2017). For representations of object, affordances for handling seem to play a role, with non-manipulable objects showing a preference for *tracing* or *moulding* strategies, as opposed to manipulable objects, which can be easily mapped onto the body with the *acting* or *representing* strategies (Masson-Carro et al., 2015; Ortega & Özyürek, 2020b). Overall, these studies show a strong preference for the *acting* strategy in silent gesture and interesting variation which is at least partially informed by semantic domains and affordances of the target referent.

Silent gestures, though spontaneous, show systematic similarities across participants and studies with regard to the use of these iconic strategies. Both signs and gestures are described using the same sets of strategies, showing similar patterns in representing concepts within the visuo-manual modality (Hwang et al., 2017; Ortega et al., 2019; Padden et al., 2015; Quinto-Pozos & Parrill, 2015). This combination of systematic similarities at the group level with individual variation in iconic strategy use in silent gestures, is of particular relevance to this study.

4.1.3 Iconicity and abstract concepts

The predominance of concrete concepts in past research likely stems from the assumption that iconicity is more easily applied to physically perceptible objects and actions, whereas abstract concepts, being largely linguistic in nature, might resist direct iconic representation (Lupyan & Winter, 2018). Meir and Cohen (2018) argues that in order to use iconicity to represent abstract concepts, a double mapping is required in which the iconic mapping is extended to be interpreted through metaphor or metonymy. However, Keränen (2021) and Chapter 3 showed that the same iconic strategies described for concrete concepts are at the core of iconic mappings for highly abstract concepts in unrelated sign languages. Importantly, the use of the same iconic mapping in both languages is the strongest predictor for high form overlap, regardless of degree of abstraction (see Chapter 3). To the best of our knowledge, no previous studies have investigated the use of iconicity in the representation of abstract concepts. However, evidence from sign languages showing iconicity as a viable strategy for depicting abstract concepts and showing similarities to gestural representations in concrete concepts suggests that iconicity may also support abstract representations in the visuo-manual modality more broadly.

These findings challenge the assumption that iconicity is primarily suited for concrete concepts. Instead, we see how iconicity can play a role in depicting abstract concepts in lexical signs. If iconicity is such a central property of the visuo-manual modality, differences in use may not stem from abstraction alone but also from the communicative context in which it is employed. This brings us to a key distinction in how signers and non-signers use the visuo-manual modality in their communication, which may affect their expertise in exploiting the full potential of iconic mappings.

We thus see that iconicity is an important mechanism for forming linguistic expressions in the visuo-manual modality. We have also highlighted that not only signs but also manual gestures use this modality. However, signers and hearing non-signers, or gesturers, differ in crucial ways in their use of the modality and in turn of visual iconicity (Goldin-Meadow & Brentari, 2017; Müller, 2018). Signers use languages that systematically exploit the visuo-manual modality and its potential for iconicity. Their linguistic repertoire thus includes a deep understanding of how iconicity can be employed to enhance communication and how it is systematically used in the language in question. Most signers are also experts at communicating with hearing non-signers, as they encounter them in their daily lives, and many develop advanced skills for communicating with this group as well, using iconicity to maximise comprehension (Crasborn & Hiddinga, 2015).

Gesturers, meanwhile, can rely on spoken language to communicate, except in rare circumstances. They are also taught about language in ways that are decoupled from its multimodal nature, as they learn about sequential grammatical structures in written representations of text. Even when travelling outside their linguistic bubble, they can often rely on English as a lingua franca (Meierkord, 2006; ten Thije et al., 2012), only using gesture as an aid in creating multimodal representations that aid communication. As such, their gestures can be assumed to be largely co-dependent on speech. Some researchers, then, posit a sharp divide between gestural and linguistic components of communication, arguing that gestures are unsystematic and lexcially unspecified, firmly placing manual gestures on one side of the divide and signs on the other (Goldin-Meadow & Brentari, 2017; McNeill, 1985). The parallels between iconic mappings seen in signs and gestures may, from this point of view, come as a surprise. Comparing signers' and non-signers' use of iconicity in this modality provides an interesting test case that highlights how linguistic expertise in exploiting iconicity to its full potential depends on the communicative burden carried by each modality and the frequency with which each modality is used in communication.

Sign languages are fully fledged languages and as such their lexical signs are elements of a conventionalised system. If iconicity is a characteristic of the visuo-manual modality, that poses the question of what the raw potential of iconic mappings for communication is.

This can be tested by moving away from the conventionalised nature of sign languages and comparing lexical signs to manual gestures produced spontaneously and in the absence of speech, so called *silent gestures* (Goldin-Meadow, 2015). Such a comparison then provides us with a comparison between manual representations that differ in terms of whether they belong to a conventionalised system with linguistic structure that affects how iconicity is used but are similar in that communicative reliance is placed on the visuo-manual modality.

By comparing how iconicity is used in both conventionalized lexical signs and non-conventionalized silent gestures, we gain insight into the flexibility of the visuo-manual modality. Silent gestures allow us to tap into the pluripotentiality of iconic associations (Winter, Lupyan, et al., 2023), revealing the range of possible mappings before a system settles on a single form. Sign languages, in contrast, reflect how conventionalisation constrains this variation across languages.

4.1.4 The present study

This study investigated the role of iconicity in shaping the representation of concrete and abstract concepts in the visuo-manual modality. We explore how the potentially greater suitability of iconicity for representing concrete concepts manifests in gestures and how iconicity may be used to represent abstract concepts in gestures. By investigating the role of iconicity in silent gesture and sign languages, this study sheds light on how modality shapes the emergence of systematicity in gesture. In doing so, it challenges the assumption that abstract concepts are inherently less iconic, as claimed for spoken languages (Lupyan & Winter, 2018), and provides insight into the interplay between linguistic structure and visual representation. In addition, we investigate the relationship between silent gestures and the sign language lexicon, asking whether the role of iconicity in silent gesture also manifests in lexical items in sign languages.

4.2 Methods

In the present study, we investigate how hearing non-signers use iconic strategies to depict concrete and abstract concepts in silent gestures and whether a higher diversity of iconic strategies in gestures also manifests in the lexicon of two unrelated sign languages - BSL and DGS. The dataset consist of (1) silent gestures produced by hearing non-signers in the UK and Germany and (2) signs from deaf signers of BSL and DGS. Gestural responses were coded for passes and manual gestures. Signs and gestures were analysed based on their iconic strategy. In a separate rating task, the concepts were rated for concreteness. The data is then combined to compare the use of iconic strategies in silent gestures and lexical signs for concrete and abstract concepts.

4.2.1 Concept set

We conducted a self-paced semantic elicitation task with native signers of BSL and DGS to elicit signs from a range of concrete and abstract semantic domains. The participants were deaf signers of BSL in the UK (age $M = 42$, range: $[37, 47]$; gender: 2 women, 2 men) and of DGS in Germany (age $M = 38.2$, range: $[25, 54]$; gender: 1 woman, 4 men). All participants used the respective sign language as their preferred means of communication. Participants received monetary compensation for their time.

In this semantic elicitation task, participants were asked to produce as many signs as they could think of for a range of semantic domains. The resulting productions (UK: 2940 tokens, Germany: 6902 tokens) were glossed and compared across countries. From this comparison, we selected a total of 234 concepts from 24 semantic domains, ranging from categories with highly concrete concepts (e.g. 'food' or 'sport') to those with highly abstract concepts (e.g. 'law'). Items were only selected if they had been produced in both countries, to allow for a cross-lexical comparison. The distribution of iconic strategies in the selected countries also mirrored the overall distribution in the elicited data of that country.

Concepts were refilmed in studio conditions by a deaf signer of DGS and a deaf signer of BSL, to serve as stimulus items for further data collection. Additionally, all items were translated to Standard German and British English.

4.2.2 Gesture elicitation

We used the 234 concepts from the concept set to elicit silent gestures from 15 hearing non-signing university students in the UK and 15 in Germany (age $M = 23.43$, $SD = 5.65$; range: $[18, 43]$; gender: 63.33% women, 36.67% men). All German participants were native speakers of German, with two being early bilinguals with another language (Turkish, Italian; none with English). The British participants were native speakers of English, none of who reported growing up bilingually. All German participants reported knowing English, while none of the British participants knew German. Participants received monetary compensation for their time.

4.2.2.1 Materials and procedure

After signing consent forms and providing demographic information, participants were seated next to a laptop on which the individual concepts (N = 234) appeared one at a time in randomised order. These concepts were the English/German translations of the BSL/DGS signs from the semantic elicitation task. We asked participants to come up with a gesture that conveys the same meaning as the concept on the screen. They were instructed not to produce any spoken words or vocalisations and not to point at any objects in the room (e.g. pointing at a table when the word 'table' appeared on the screen). If they could not think of a response, they were asked to say "Pass", to clearly mark non-responses. They were filmed throughout the experiment, using one or two cameras at an angle that captured their upper body from their knees (in seated position) to where they would move their hands over their head.

Each trial started with a fixation cross (500 ms). Then, the individual concept, represented as an English or German word, appeared in the middle of the screen for 4000 ms. Participants had to generate a gesture as quickly as possible. Once the 4000 ms had passed, a fixation cross marked the start of the next trial. The whole experiment lasted approximately 17 minutes.

4.2.2.2 Gesture annotation

Gestural responses were annotated in ELAN ("ELAN", 2021). Even though participants were instructed to produce a single gesture for every concept, they frequently produced strings of gestures. We identified meaningful gestural units, consisting of a preparation phase, stroke and partial or full retraction (Kita et al., 1998), following a coding scheme developed prior to data collection, based on Ortega and Özyürek (2020a). All unique gestures were annotated and analysed, but direct repetitions of the same gestural unit were ignored.

Instances where participants failed to produce a gesture were coded as *Passes* and responses that mis-identified the target were coded as *incorrect target* (e.g. interpreting the target *tablet* as a type of pill rather than the electronic device). Responses that consisted of exclusively facial expressions were coded as *non-manual* and were not included in the analysis of manual responses (e.g. displaying the emotion ANGRY by frowning without moving the hands). Responses in which the participant moved out of the camera frame or when coders were unable to identify the meaning of the gesture were disregarded and not included in the analysis ($N = 34$).

4.2.3 Iconic strategy coding

Both silent gesture responses and the DGS and BSL signs for each concept were coded for iconic strategy use. The coding was based on earlier taxonomies (Hwang et al., 2017; Müller, 2009; Ortega & Özyürek, 2020a), using the following criteria (detailed instructions in the coding manual, accessible through Appendix A):

- **Acting** – The hands represent the hands as a human body interacts with the referent or performs the target action (e.g., the gesture in Figure 4.2a depicts handling a type of FRUIT). This category includes what others have labelled *handling* or *manipulation* (Hwang et al., 2017; Padden et al., 2015).

- **Representing** – The handshape represents the shape of the referent, while the movement indicates the movement associated with handling the referent (e.g., in the gesture in Figure 4.2b the handshape depicts a telephone receiver being moved to the typical position for PHONECALLS). This strategy has sometimes been called *instrument* (Padden et al., 2013, 2015).

- **Personification** – A non-human body is mapped onto the whole body of the signer. Body parts stand in for parts of the non-human body or are represented at the corresponding locations of the body (e.g., the gesturer in Figure 4.2c depicts typical movements of a CHICKEN, using the arms as wings). This strategy is sometimes grouped with *acting* under the label *enactment* (van Nispen et al., 2017) and was introduced as personification by Hwang et al. (2017).

- **Entity** – The hand stands directly for the object. Unlike the representing strategy, the *entity* strategy does not imply any human interaction (e.g., in the gestures in Figure 4.2d, the thumb and index fingers become the GLASSES, through which the gesturer is looking). This strategy is sometimes grouped with *representing* in the *object* strategy (Hwang et al., 2017).

- **Tracing** – The fingers or full hand trace the outline or surface of an object (e.g., the gesturer in Figure 4.2e traces the wavy outline of HILLS). We are including both 2- and 3-dimensional traces under this label. *Tracing* is sometimes separated into two-dimensional *drawing* and three-dimensional *moulding* (Keränen, 2021; Müller, 2014).

- **Deictic** – Gestures or signs that are not iconic but display an indexical relationship with the referent, typically through pointing with a single finger or the whole hand. This indexical relationship may refer to metaphorical as well as physical space (e.g., in the gesture in Figure 4.2f the index finger points to an imaginary watch located on the wrist to indicate TIME). The pointing may result in physical touch.

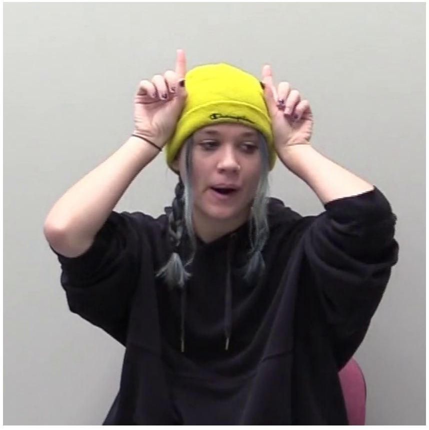
- **Other** – Gestures or signs that did not fit into any of the strategies defined above, including productions for which the iconic motivation was too obscure to be clearly classified.

DGS and BSL signs were coded for iconic strategy in an iterative process. First, every sign was glossed by a team member competent in the respective sign language. Subsequently, all signs were annotated for iconic strategy and checked by a second team member. The annotation of the signs provided the proof of concept for our coding scheme, which was refined based on the iterative coding process. After finalising the annotation guide, all signs were checked again by one team member to ensure that signs were consistently coded within and across languages.

Individual manual gestures produced in the gesture elicitation task were coded for iconic strategy following the annotation guide developed on the sign language data, with

(a) *acting*: FRUIT (DE)

(b) *representing*: MOBILE PHONE (UK)



(c) *personification*: COW (UK)

(d) *entity*: PHOTOGRAPHY (UK)

(e) *tracing*: HILLS (DE)

(f) *deictic*: TIME (DE)

Figure 4.2: Silent gesture examples of iconic strategies in Germany and the UK.

20% of all responses from both countries (i.e. 3 videos out of 15 per country) re-coded by the first author to establish inter-coder reliability. Fleiss' Kappa for inter-rater reliability of two raters was $\kappa = 0.783$ ($z = 43.6$, $p < .001$) for the German data and $\kappa = 0.79$ ($z = 42.8$, $p < .001$) for the British data, a substantial overlap (Landis & Koch, 1977).

Disagreements in coding were resolved by discussion and systematic issues identified in the discussion were subsequently corrected across all annotations. Since participants did not always stick to the instruction of producing only a single manual response for each item, this resulted in a total of 7311 interpretable gestural responses across sites, of which 7087 were manual gestures, for a total of 7020 individual trials.

4.2.4 Response diversity

The structure of our data requires a differential approach to measuring diversity of iconic strategies. For the sign language data, we can establish one-to-one correspondences, where every concept is represented by a single sign in BSL and DGS, respectively. This allows us to operationalise diversity as a binary characteristic. In the gesture data, we do not have this clear correspondence, as we have a range of gestural responses, sometimes including several responses from the same person. We therefore need to quantify the relative diversity of strategies used to measure diversity of responses.

For the sign language data, this results in the following operationalisation of diversity. For each concept, we coded whether the DGS and BSL signs used the same iconic strategy, creating a binary coding where signs were coded as 'same' (1) or 'different' (0).

In order to measure diversity of gestural responses, we used the Gini-Simpson index a derivation of the Simpson index (Simpson, 1949), a measure from ecology originally designed to take into account type and abundance of each species. The original index gives an indication of the probability λ that two randomly and independently chosen individuals from the population will be from the same group, with λ ranging from 0 to 1 as population constants (Simpson, 1949). As a measure of diversity, this index is more readily interpreted if polarity is reversed as $1 - \lambda$, such that 0 is minimal diversity (all possible pairs will be from the same group) and 1 is maximum diversity (all possible pairs will be from different groups). This is achieved in the Gini-Simpson version of the index (see Jost, 2006, 364, for a comparison of entropy and diversity indices), also known Gini's diversity index in machine learning (e.g., "Growin decision trees", n.d.).

Here, we adapt it to the use of iconic strategies used by gesturers, in their attempts to produce gestures for each concept. For each concept, gesturers produced N gestural renditions, for which they used R unique iconic strategies from 1 to R, each with frequencies of n_1 to n_R. Each concept then receives diversity scores reflecting the diversity of gestural responses (div):

$$D = 1 - \left(\sum_{i=1}^{R} \frac{n_i(n_i - 1)}{N(N-1)}\right) \qquad \text{(Gini-Simpson index)}$$

4.2.5 Rating tasks

We collected ratings of concreteness for every concept from raters in Germany and the UK. Raters were hearing non-signers and deaf and hearing signers, who were recruited to participate in an online study. We chose to collect ratings from these groups to receive ratings that reflected the perspective of both the signers of both sign languages and hearing gesturers from both countries. [1]

99 raters participated in the concreteness rating task. (age $M = 28.3$, $SD = 9.61$, range: $[18, 57]$; gender: 74.75% women, 22.22% men, 3.03% non-binary participants; hearing status: 36.36% deaf, 6.06% hard of hearing, 57.58% hearing; signer: 55.56% signers, 44.44% non-signers; country: 43.43% from Germany, 56.57% from the UK). Raters were paid for their time through online vouchers.

4.2.5.1 Materials and procedure

Concepts in the concreteness rating task were presented as signs in DGS or BSL to signers and as words in German or English to non-signers. Participants were asked to rate each item on a scale ranging from concrete (100) to abstract (700) by moving a slider across the scale. Participants could skip items if they did not recognise a concept or felt unable to rate it.

The scale range was chosen to easily map onto the 7-point Likert scales, frequently used in the literature, while maintaining a wide spread that would allow treating the data as interval-scaled. The instructions were adapted to BSL and DGS from Brysbaert et al. (2014) and back-translated to English and German to closely match the signed versions. The instructions defined concrete items as subject to experience through sensory input, e.g. the concept SOFA refers to a thing that people can see, touch and experience the feeling of sitting on. HOPE was used as an example for abstract concepts. In the instructions, we explained that the understanding of abstract concepts depends on context and explanation through language, with no or limited availability through direct, sensory experience (details on instructions available through Appendix A).

For analysis purposes, we centred the rating responses around the mid-point of the scale and re-scaled the ratings to increase interpretability of statistical models, such that negative numbers indicate a bias toward concrete (min. $= -3$) and positive numbers toward abstract (max. $= 3$). For signers, we only included the ratings of signs that were correctly understood as indicated by target-like translations (excluded $= 719$, included $= 81145$).

Concreteness ratings from different groups were substantially correlated across participant groups (scripts and data checks available through Appendix A). Due to the high

[1] In the same study, we also collected iconicity ratings from a separate group of participants. These data were collected to answer a different research question and will not be discussed further in the present paper. We mention this here for the sake of procedural completeness.

correlation, concreteness ratings from all groups were combined into an average score for each concept, following B. Thompson et al. (2020) cross-linguistic study, showing high semantic alignment for similar cultural contexts.

4.2.6 Analysis

Analyses were conducted using the R statistical language (R Core Team, 2022, version 4.4.1,)[2] on Windows 11 x64 (build 26100). We assessed the relationship between concreteness ratings and pass responses through a Welch Two Sample t-test and used Pearson's product moment correlation to investigate the relationship between concreteness ratings and the number of manual gestures produced. We report descriptive statistics for the distribution of iconic strategies in silent gesture in Germany and the UK for concrete and abstract concepts. Subsequently, we investigated the relationship between concreteness ratings and the diversity of iconic strategies across participants and the diversity of iconic strategies in the two sign languages using linear regression.

4.3 Results

The gesture elicitation task resulted in a total of 9120 coded responses from participants in both Germany and the UK. For the analysis, manual gestures ($N = 7087$) were coded separately from non-manual reactions ($N = 224$), in which participants produced a representation of the target concept without using their hands, e.g. through facial expression and posture. Both manual and non-manual gestures were coded for iconic strategy. Participants passed on a total of 1661 items and produced inconclusive gestures 34 times. Some participants also clearly misinterpreted the word and produced a non-target gesture ($N = 110$). In 4 instances, participants moved out of the camera range, rendering an interpretation of the gesture impossible.

4.3.1 Pass responses and manual gestures by concreteness

First, we investigated the relationship between concreteness ratings and participants' ability to produce gestures. When comparing the concreteness ratings of concepts that elicited passes and manual gestures, we found that participants produced more manual responses to concrete than abstract concepts. In contrast, pass responses were more evenly distributed from concrete to abstract concepts (see Figure 4.3). This suggests that abstract concepts were more challenging for participants, as evidenced by the relative over-representation of passes in abstract concepts. A Welch Two Samples t-test confirmed that concreteness ratings were significantly higher for concepts that elicited manual gestures ($M = -1.336$, $SD = 1.085$) than those that elicited passes ($M = -0.793$, $SD = 1.096$, $t = -17.572$, $df = 2791.4$, $p < .001$).

[2] A full list of packages is available in the virtual appendix, see Appendix A.

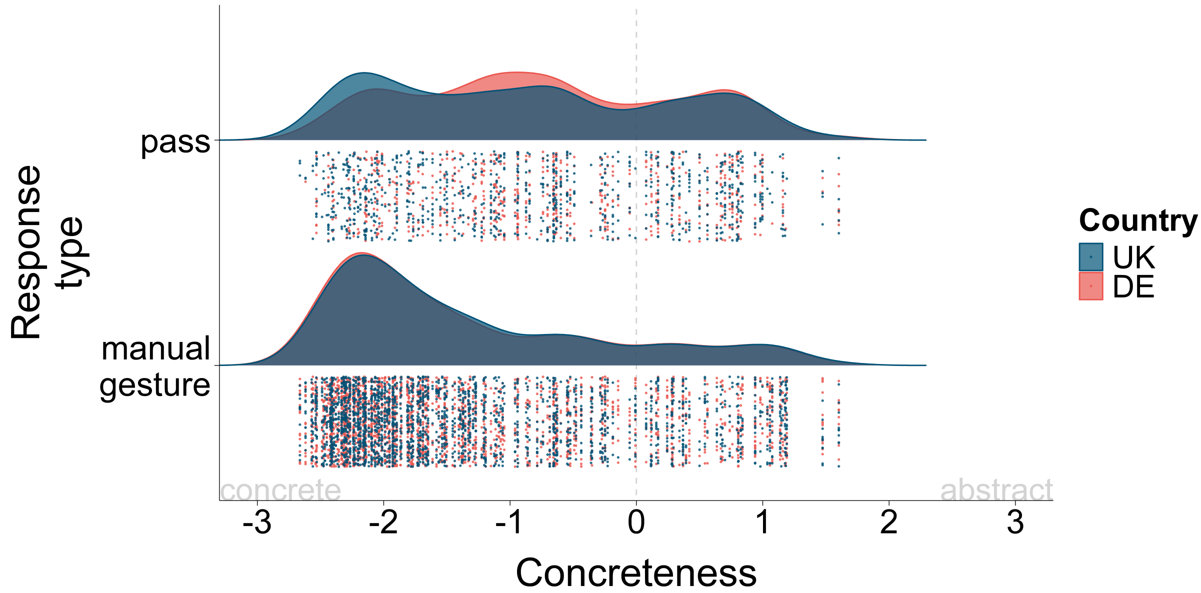


Figure 4.3: Distribution of passes (top) and manual gestures (bottom) in the UK (blue) and Germany (red). Dots represent individual gestures or instances of a pass response. Participants in both countries produced relatively more manual gestures for concrete concepts and passed relatively more for abstract concepts.

We found no significant correlation between concreteness and the number of responses per item ($r = -.003$, $p = .932$). This indicates that the relationship between responses and concreteness was not confounded by the number of responses per items. Participants did not produce more or fewer manual gestures for individual abstract concepts.

4.3.2 Distribution of iconic strategies in silent gesture and signs

Next, we investigated how iconic strategies are distributed in abstract vs. concrete concepts (see Figure 4.4). Concepts were classified as abstract or concrete based on their concreteness ratings, with those with mean ratings above the midpoint classified as *abstract* and those below the midpoint as *concrete*. For this analysis, we only considered manual gestures. There was very little difference between German and British gestures in terms of the proportion of strategies used. We therefore pooled data from both countries for the following analyses.

We found that the *acting* strategy was highly frequent in both concrete and abstract concepts, with a stronger preference in concrete concepts (60.43% of manual gestures on concrete concepts vs. 47.70% for abstract concepts; see Figure 4.4). The *tracing* strategy was also more frequent for concrete (15.44%) than abstract concepts (9.29%). The *personification* strategy was only used for a single abstract concept (0.39%), but showed up in a little over 2% of responses to concrete items in both countries.

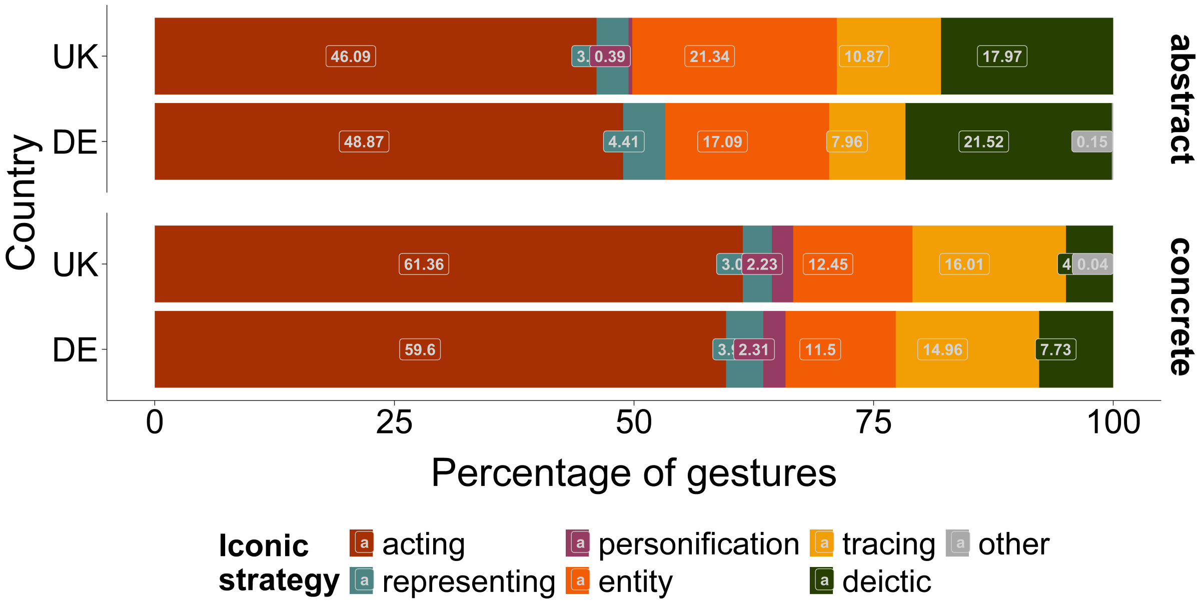


Figure 4.4: Proportion of iconic strategies in gestural responses for concrete (bottom, mean rating < 0) and abstract (top, mean rating > 0) concepts in Germany and the UK.

Conversely, some strategies were more frequently used in the depiction of abstract than concrete concepts. The *entity* and *deictic* strategies were notably more common for abstract concepts, with the *entity* strategy used in 19.04% of manual responses to abstract concepts but only 11.94% in concrete concepts. Similarly, the *deictic* strategy was used in 19.96% of manual responses to abstract concepts but only 6.42% in concrete concepts. This indicates a preference for the *entity* and *deictic* strategy for depicting abstract concepts.

Two gestures in the responses were categorised as *other* because they did not align with any of the defined strategies. Both instances involved the "thumbs up" emblem, commonly used to indicate the meaning "good" in both German and British culture. The emblem appeared in multi-gesture strings, one referring to the concept HEALTH and the other to "liking" something on INSTAGRAM. Although this emblem is used consistently in both cultures, it appeared only twice in our data, making it exceedingly rare.

4.3.3 Diversity of iconic strategies in gestural responses

Finally, we analysed the relationship between diversity of iconic strategies and concreteness, first within gestures and then including information from the sign language data to expand our perspective (see Figure 4.5). We found that concreteness ratings significantly predicted the diversity of iconic strategies in gestural responses in a regression analysis (est. $= 0.033$, $SE = 0.012$, $t = 2.733$, $p = .007$). For example, concrete concepts like HAIR, BICYCLE or GLOVES elicited very similar gestural responses across participants, though there are some concrete items that elicited highly diverse responses, for example LEAF. In contrast, abstract concepts generally elicited highly diverse gestural responses, with the notable exception of some emotions (SURPRISED, EXCITED, FRUSTRATED, SHOCKED), which elicited more systematic gestures. Interestingly, we saw a difference in spread, where concrete concepts showed a wider range of diversity scores than abstract concepts, which were strongly associated with high diversity values(see Figure 4.5).

These findings indicate that concreteness had a small but robust effect on the diversity of iconic strategies in gestural responses. Participants' generated highly varied gestural responses to abstract concepts. For concrete concepts, the pattern was less clear, suggesting that some concepts may have have obvious iconic representations, eliciting very similar iconic strategies, while others are less easily visualisable.

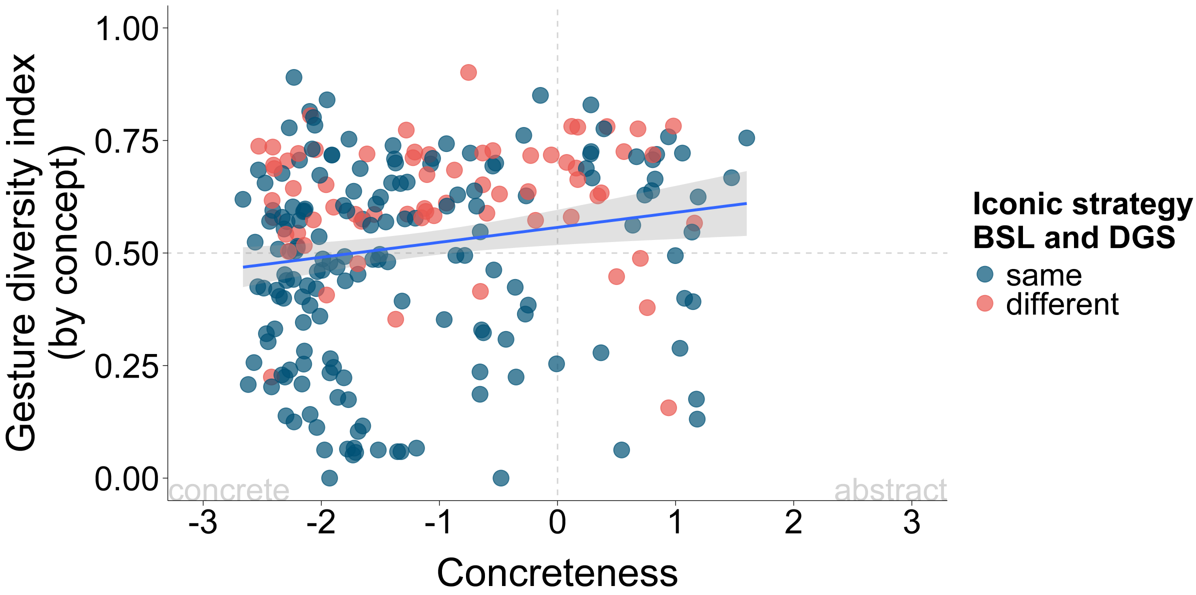


Figure 4.5: Distribution of diversity scores of iconic strategies for every concept (dots) in gestures (y-axis) and signs (colours) by concreteness (x-axis). More abstract concepts are more likely to be represented by a wider range of iconic strategies than more concrete concepts in gesture and use different iconic strategies in signs.

To further explore how this difference in diversity plays out in sign languages, we included data from BSL and DGS in the analysis. The regression model improved significantly when adding whether BSL and DGS shared the same iconic strategy as a predictor ($F = 24.31$, $p < .001$). In the new model, concreteness still had a significant effect on the diversity of gestural responses, such that abstract concepts were more likely to result in more diverse responses (est. $= 0.025$, $SE = 0.012$, $t = 2.165$, $p = 0.0314$). Concepts that shared an iconic strategy in the sign languages were much more likely to show less diverse responses in gestures than those that did not share an iconic strategy (est. $= -0.14$, $SE = 0.029$, $t = -4.931$, $p < .001$).

This indicates that diversity of iconic strategies in gestures and signs is related. Concepts that elicit diverse responses in gestures are also more likely to be depicted using different iconic strategies across sign languages. Conversely, concepts that elicited fairly homogeneous responses from gesturers tend to share a strategy across sign languages. This was true for both concrete and abstract concepts.

4.4 Discussion

In the present study, we investigated the role of iconicity in shaping the representation of concrete and abstract concepts in the visuo-manual modality. We explored the role of iconic strategies in representing concrete and abstract concepts in silent gestures produced by hearing non-signers in Germany and the UK. Two ways in which difficulties in producing representations for specific items manifest in gestures emerge from the data, namely passing on items and the diversity of responses given. Finally, we compared response patterns to signs in German Sign Language and British Sign Language.

Gesturers were highly successful in producing gestures for both concrete and abstract concepts overall. However, preferences for individual iconic strategies differ between concrete and abstract concepts. While gesturers use the *acting* strategy for approximately 60% of gestures in concrete concepts, followed by around 15% using the *tracing* strategy and around 12% using the *entity* strategy, the proportion of *acting* and *tracing* drop to around 47% and 9%, respectively, for abstract concepts, while the *entity* and *deictic* strategy account for around 19% each. This indicates that the same iconic strategies are available for displaying concrete and abstract concepts but that particular types of mappings are more aligned with concrete concepts, while others are more suitable for abstraction in silent gestures.

We find that hearing non-signers find it more difficult to come up with gestures for more abstract concepts. They passed more for abstract concepts than for concrete concepts. However, the number of manual gestures produced to represent a given concept did not correlate with concreteness. It thus appears that hearing signers have a harder time coming up with gestures for abstract concepts but once they do, they do not differ in how many individual gestures they produce to represent the concept. Abstract concepts also showed high diversity scores in iconic strategies. This suggests that the difficulties in coming up with gestural responses to these items also resulted in very diverse responses, with participants unable to draw on shared representations. Concrete concepts had lower diversity scores on average and displayed a range from using highly systematic iconic strategies on some concepts to higher diversity on other concepts. Concrete concepts thus differ in the diversity of gestural responses they elicit, with some concepts being particularly likely to elicit highly systematic gestures, while the depiction of other concepts is less evident, eliciting diverse responses from participants.

Interestingly, the concepts that elicited highly diverse responses, both concrete and abstract, were also more likely to use different iconic strategies in British and German Sign Language. This indicates that it is a characteristic of the concepts that drives this diversity of responses across the visuo-manual modality and points towards a shared characteristic of silent gesture and the lexical signs of sign languages.

Overall, our findings demonstrate that non-signers in our study were able to use diverse iconic strategies to represent both concrete and abstract concepts. Their preferences for particular strategies aligned with preferences found in signers, though the bias for individual strategies appeared stronger in our participants. This suggests that while non-signers have access to the same iconic strategies for meaning making in the visuo-manual modality as signers, sign languages more systematically exploit the semantic potential of the less uses strategies in their lexicon, while gesturers default to the main strategies, whenever possible. Gestures also proves an interesting basis for estimating the potential for diversity in iconic strategies, as concepts which elicited highly diverse gestural representations were more likely to also use different iconic strategies in BSL and DGS.

4.4.1 Capacity of hearing non-signers for producing iconic representations for abstract concepts (RQ 3)

Participants in our experiment were astonishingly good at devising gestural representations for the concepts presented. This is in contrast to common assumptions that gestures are spontaneous and idiosyncratic and that hearing non-signers do not have a fixed manual repertoire for representing concepts in the visuo-manual domain (McNeill, 2000). There was considerable inter-person variation in the ability to produce manual gestures, yet overall, only 23.68% of items elicited a pass response across countries and participants. The 34 responses that were not identifiable to coders seemed to represent failed attempts at producing a satisfactory gesture, rather than deliberate non-iconic representations. This indicates that participants intend to produce iconic representations of concepts in our dataset and are well able to do so most of the time.

To determine whether abstract concepts were more challenging for participants, we first investigated manual gesture responses and passes by concreteness ratings. Participants are more likely to pass on abstract than concrete concepts, as these did not elicit a gestural response as often as concrete concepts. Given that participants were clearly attempting to create iconic mappings for concepts and considering the underlying requirement for a double mapping (Gentner & Asmuth, 2017; Meir & Cohen, 2018; Taub, 2001), this could indicate difficulties at two levels. Participants might have struggled to identify appropriate metaphors that can be visually grounded or they may find it difficult to create iconic representations for the metaphorical anchor.

A first indication may come from the high variability emerging for abstract concepts. Participants who produced gestural responses to abstract concepts generally did so in widely different ways, using different iconic strategies. Chapter 3 shows that iconic strategies are typically aligned with iconic instantiations in sign languages, such that the use of different iconic strategies in BSL and DGS typically indicates that different underlying images are being depicted. If the same is true for gestures, this would suggest that participants used different images to anchor their metaphorical representations. However, the iconic and metaphoric mapping may also interact in creating difficulties.

When considering the representation of concrete concepts, some concepts elicited systematic representations, while others received a wide variety of responses. The same may be true for abstract concepts, where participants may or may not converge on a similar metaphor for specific concepts. Some of these anchors, in turn, may be more easily translated into an iconic mapping than others. Taub (2001, p. 45) suggests in the analogue-building model that affordances of the manual components may influence the image selection process, e.g. by restricting the modality of information to be encoded. Expanding this view, the potential for visualising a particular metaphorical anchor might influence the selection of an appropriate metaphor, as formalised in the double-mapping constraint posited by Meir (2010). Thus, our finding suggest that difficulties with the metaphoric and iconic mapping may be connected. Further investigations into the nature of these difficulties would be a fruitful avenue for gaining a better understanding of the nature of iconic-metaphorical double mappings.

4.4.2 Iconic strategies in concrete vs. abstract concepts (RQ 4)

Comparing the distribution of iconic strategies gestures used by participants in Germany and the UK showed striking similarities (see Figure 4.4), with distributional differences emerging mainly between concrete and abstract items. This similarity likely stems from similar cultural and linguistic experiences, resulting in gesturers falling back on similar conceptualisations to produce highly embodied, iconic gestures (Hostetter & Alibali, 2008, 2010; McNeill, 2000; Taub, 2001). Past research has highlighted similar patterns of iconic strategy use in silent gestures across different cultures (Hwang et al., 2017; Masson-Carro et al., 2015; Ortega & Özyürek, 2020a, 2020b; Padden et al., 2015; Quinto-Pozos & Parrill, 2015; van Nispen et al., 2017). We show that some strategies, particularly the *acting* strategy, dominate across both concrete and abstract concepts, while others are used less frequently. This is in line with research on sign languages, which shows similar patterns, although the bias for the *acting* strategy emerges less strongly lexicon of sign languages, making room for other strategies (Chapter 3; Ergin, 2022; Hwang et al., 2017; Keränen, 2021; Padden et al., 2013). This may point to a wider functional differentiation of iconic strategies in sign languages. Signers typically find their own sign languages more iconic than other sign languages and also find signs more iconic than gesturers do, indicating that they are more attuned to the systematic iconicity in the sign language lexicon (Occhino et al., 2017; Sehyr & Emmorey, 2019; Sehyr & Villwock, 2022). These comparisons with sign languages and co-speech gesture suggest that gesturers show a less diversified use of iconic strategies than we see in sign languages around the world, failing to exploit the full potential of the different strategies.

Different explanations are possible in order to account for this difference in strategy use between signs and gestures. Padden et al. (2015) argues that in ASL, iconic strategies are systematically employed to differentiate between nouns and verbs, thus codifying syntactic function in the lexicon. This would firmly place the explanation in linguistic territory, aligning it with specific linguistic structures in the lexicon of sign languages. These would then not be available in the idiosyncratic gestures produced by hearing people. However, neither BSL nor DGS are reported to show systematic noun-verb distinctions in the citation forms of lexical items and the concepts selected for this study are not selected to provide pairings of verbs and nouns. Rather, many of the items are ambiguous without context, such as the example EAT cited at the beginning of this chapter, which could just as well be glossed as FOOD in both sign languages.

Ergin (2022) provides an interesting comparison that sheds light on a more basic effect that may be influencing these differences in frequency, blurring the lines of what is considered linguistic and non-linguistic. She shows that the frequency of using the *acting* strategy differed between tasks in signers of CTSL, an emerging sign language. In two picture-naming tasks, the *acting* and *entity* emerged as dominant strategies, respectively, accounting for about 40% of items, respectively. However, interestingly, in a video description task in which participants provided additional context through narrative embedding, the signers produced shorter strings and relied much less on the *acting* strategy, with the *entity* strategy now accounting for over 50% of items. These findings suggest that the presentation of lexical items in a communicative context may have an effect on how iconicity is used.

While there seems to be no fully conventionalised lexicon for the items used by Ergin (2022) in CTSL, this is different for the signs in our study. Being conventional, lexical items, the signs in BSL and DGS are not usually presented in isolation, as in this study, but are embedded in a communicative context. Meanwhile, silent gestures differ from co-speech gestures by their removal from the context of spoken communication. It may be the case that the distribution of iconic strategies would be more similar to that found for gestural productions in this study, if we were to look at constructed action in sign language communication, where meaning-making emerges from context and sign forms are used in a more creative manner. A finding that may be illuminating in this regard is the observation that signers and gesturers tend to use similar perspective taking strategies, when describing scenes (Quinto-Pozos & Parrill, 2015). These observations are relevant to this discussion, because the types of viewpoints they distinguish map onto certain characteristics of our iconic strategy distinctions, creating a division of strategies in which the signer or gesturers embodies the subject of an action, as in for example the *action* and *personification* strategies, and those in which the body is semantically backgrounded, as is the case for the *entity* strategy. Quinto-Pozos and Parrill (2015) find that character viewpoint emerged primarily in constructed action contexts, while observer viewpoint, though present in both contexts, was used more frequently in classifier constructions. This suggests that, in sign languages, the perspective taking implied by iconic strategy use emerges as a linguistic device that structures narratives, beyond the lexical level. It thus seems that as conventionalisation and contextual embedding increase, the reliance on the *acting* strategy reduces and alternative, potentially less embodied strategies, gain in power.

Additionally, the productions of our hearing participants strongly resemble those of the CTSL-signers, in that they produce not only single gestures but also strings of gestures that add meaningful information from different iconic strategies. This points to an additional possible explanation. Gesturers, in our study, frequently combined two (or sometimes more) gestural responses, often combining different strategies sequentially. This frequently involved the *acting* strategy, accompanied by another strategy. The lexical signs in our selection, meanwhile, are single signs and do not include any compounds. As such, if information that requires different strategies needs to be combined in a sign, a single strategy that can realise this combination is employed (see also Slonimska et al., 2020). The *representing* strategy does just that, combining information that could be separated into *acting* and *entity* components. And indeed, the *representing* strategy is much less frequent in the gestural responses (approx. 3%) than signs (approx. 10%). Signs may thus have developed to include more information simultaneously in a single sign, while gesturers are more likely to tease these apart into individual gestural realisations. Taken together, the frequency of different iconic strategies appears related to important differences in how gestures and signs are used in communication, their conventionalisation and the degree to which information is packaged into single signs or gestures.

Iconic strategies varied not only in absolute frequency but also in their relative use for concrete and abstract concepts. Hostetter and Alibali (2008, 2010) argue that representational co-speech gestures emerge from action simulation. They posit this process as integral to the human expression of thought. As silent gestures rely on the expressive potential of the manual form more strongly than co-speech gestures, these processes may also be more evident here. Since concrete concepts are directly subject to embodied experience, they may be more suitable for this action simulation, where participants re-enact their experience with the object and activate salient features for representation. Abstract concepts, meanwhile, are further removed from experience and require more explicit grounding through double mappings (Meir, 2010; Taub, 2001). This same intuition underlies claims that iconicity is less suitable for representing abstract concepts in a more general sense (Lupyan & Winter, 2018).

Three strategies – *acting*, *tracing*, and *personification.* – are substantially more frequent for concrete than for abstract concepts in our data. Interestingly, these strategies closely map onto embodied experience, directly involving the gesturer's body in the construal of meaning. Müller (2014) groups these strategies as one of two underlying modes of representation under the label *acting.* This is opposed to strategies in which the body is semiotically backgrounded and perception-based characteristics are highlighted, which she groups under the label *representing.*

The *acting* strategy most closely maps onto embodied experience, as the gesturer's body directly enacts its own actions. Masson-Carro et al. (2015) also showed that concepts that have a higher affordability for handling, e.g. tools, are more likely to be accompanied by co-speech gestures associated with acting on the object than those that have a low affordability for handling, e.g. a house. Abstract concepts are intrinsically less susceptible to handling than more concrete concepts, so the same mechanism may play into the differences in iconic strategy use in our data.

While the strong alignment with embodied experience makes the *acting* strategy highly salient, it may also lack discriminability, as different experiences may elicit similar actions. For example, differentiating between verbal, e.g. "combing hair", and nominal meanings, e.g. "hairbrush" may be difficult for motorically similar actions such as sweeping the floor, raking leaves or shovelling snow through the *acting* strategy alone. This lack of discriminability in iconic depictions may be largely irrelevant in co-speech gesture, where the accompanying speech serves to disambiguate reference, yet it becomes increasingly important as the visuo-manual modality carries increasing communicative load, as is the case for silent gesture and even more so for signs in sign languages (Dingemanse et al., 2015; Padden et al., 2015).

Comparing the gesture use found for silent gesture in this chapter to other studies, we see that the *acting* strategy is substantially more frequent in our gesture data than in the corresponding BSL and DGS signs (see Chapter 3). Particularly for concrete concepts, the proportion of *acting* responses in our data is also higher than what Ergin (2022) elicited in a picture naming task with signers of the village sign language CTSL, used by about 25 deaf signers and some 80 hearing signers in a village in the Central Taurus mountain range in southern Turkey. This preference of gesturers for the *acting* strategy is also found in Hwang et al. (2017), though their categories included mainly highly manipulable everyday objects and, indeed, the proportion of the *acting* strategy in their gesture data is even higher than in our data. This suggests that the *acting* strategy acts as the default mode for representing any concept that affords this strategy in gestures, a direct mapping to the embodied experience of interacting in the world (Hostetter & Alibali, 2008, 2010; Müller, 2014). Sign languages, on the other hand, appear to diversify their strategy use more.

The *personification* strategy is extremely infrequent overall and only used in a single instance in an abstract concept. One participant in the UK used this strategy to depict the concept "childhood". There might be an argument to code this as an instance of the *acting* strategy, after all, the depicted body is clearly a human body. However, the signer employs a whole body mapping and clearly highlights the embodiment of a different "type" of body, namely a much smaller one with a different perspective on the world. We therefore decided that this is not simply an instance of enacting an experience that adult humans share but the personification of the perspective of a small child. For concrete concepts, this strategy is more frequently used, particularly in depicting animals. This domain use is in line with findings on sign languages (Hou, 2018; Hwang et al., 2017) and silent gesture (Ortega & Özyürek, 2020b). Gesturers in our data also used it as the dominant strategy for the concept AEROPLANE, something that was also observed in (Ortega et al., 2019) for Dutch gesturers.

The *acting* and *personification* strategy involve an explicit body-to-body mapping. Similarly, the *tracing* strategy can be interpreted as enacting the tracing of an outline or shape of an object with the hands (Müller, 2014, p. 1692). While the depicted object may experience a substantial change in size for this to be possible, the underlying activity of tracing or moulding the shape of an object can be experienced and represents how infants explore the world through active haptic perception (Lederman & Klatzky, 1987; Müller, 2014; Overvliet et al., 2024). In contrast, the *entity* and *deictic* strategies focus use distinct semiotic devices and are used more for abstract than concrete concepts. Müller (2014) argues that the *entity* strategy highlights the Gestalt representation of the concept, semiotically backgrounding the gesturer's body and virtually turning the hand into the object (Dudis, 2004). It appears that this removal from immediate experience facilitates more abstract mappings in our data. The *deictic* strategy also focuses attention on the object, through indexical reference (Fricke, 2014; Kendon, 2004; Kita, 2003). As we observe in our gesture data, referential ambiguity of these strategies may facilitate interpretation by attuning the recipient of the message to the possibility of an abstract interpretation.

In the *entity* and *deictic* strategy, the manual representation is explicitly removed from embodied experience, focusing the attention to perception based aspects of the referent (Müller, 2024). This makes the metonymic relationship between a gestural representation more salient than in the case of more embodied strategies. On the production side, gesturers in our dataset appear to do this more for abstract concepts, as the abstract nature of the referent removes it from lived experience, turning the concept into something to observe at a distance, rather than something to experience directly. In turn, gesturers may expect their interlocutor to interpret such representations as more abstract, though this is not immediately testable in our production data.

Overall, the overwhelming majority of gestural responses were clearly iconic or deictic and so far, we have observed the differences between iconic strategies. Non-iconic emblems, conventionalised gestures with abstract meanings (McNeill, 2000), were exceedingly rare in our data. Only two instances of the thumbs-up gesture to indicate the meaning "good" were recorded. This highlights non-signers ability and drive to use iconic strategies to depict concepts, even for highly abstract concepts. Other conventionalised elements were found in relation to numerical concepts, such as MATHS or WEEK, where the metaphorical link between the gestural form and its meaning relied on conventionalised symbols as the elements to be depicted. Here, gesturers frequently used iconic strategies to depict numbers or mathematical symbols, e.g. by tracing them in the air or showing the corresponding number of fingers. They were thus drawing on both iconic strategies and their knowledge of arbitrary symbols for abstract concepts. This example highlights the difference between abstract concepts and arbitrary depictions, where abstract concepts may be represented with iconic mappings (Meir & Cohen, 2018; Taub, 2001), while arbitrary depictions are defined by the absence of a meaningful relationship at the form-meaning level.

4.4.3 The relationship between gestures and signs (RQ 5)

We have been able to show that iconic strategies are used in the silent gestures of participants in Germany and the UK to depict both concrete and abstract concepts. Participants were relatively more likely to pass on abstract than on concrete concepts. This suggests that abstract concepts were more difficult to depict, though if a depiction is produced, the number of gestures does not differ between concrete and abstract concepts. The difficulty in finding an appropriate (iconic) representation was also visible in the diversity of iconic strategies chosen to depict abstract concepts. Abstract concepts consistently elicited highly diverse responses, so participants seem to have been unable to identify common strategies and established metaphors to represent these concepts. Concrete concepts varied with regards to the diversity of responses. While some concrete concepts elicited highly consistent responses, others showed high diversity scores, similar to the more abstract concepts.

As laid out in the introduction of this chapter, comparing unstructured gestural responses to lexical data from sign languages requires the use of different metrics. Comparing the diversity of gestural responses to whether the lexical signs in DGS and BSL use the same iconic strategy for a given concept, reveals how the potential for diverse representations plays out in sign languages. Our data show that the same concepts that have high diversity scores in silent gesture productions are also more likely to use different iconic strategies in the two sign languages. This suggests that the same factors driving diversity in silent gesture are also at play in driving diversity in lexical signs across languages. As gesturers do not rely on conventionalised representations, their productions are an indication of the different possible mappings that may be available for a given concept. While the manual productions recorded in this study are unlikely to represent the entire set of possibilities for each concept, the diversity scores provide an indication for distinguishing concepts that afford more diverse representations from those that afford a limited set of distinct gestures, e.g. because they have highly salient features that are easy to visualise. Our comparison of lexical signs in BSL and DGS, in contrast, provides a more limited view into the diversity of iconic representations of concepts across sign languages and within the sign language lexicon. That these two measures are still highly related, points to similar underlying mechanisms in the iconic mappings, such as manipulation affordances (Masson-Carro et al., 2015; Ortega & Özyürek, 2020a), cultural metaphors (Meir, 2010; Mittelberg, 2014; Occhino et al., 2017; Taub, 2001), and shared motor and mental imagery (Hostetter & Alibali, 2010; Lupyan & Winter, 2018; Perniss et al., 2015). Future research may look at how iconic strategies are used across a wider range of sign languages and in lexical variation within sign languages, tapping into the typological and language-internal diversity of sign languages.

4.5 Conclusion

We find that gesturers are highly successful at depicting both concrete and abstract concepts in a gesture elicitation task. Participants in Germany and the UK found it easier to produce gestures for concrete than abstract concepts, as evident from lower pass rates and a higher likelihood of systematic representations across participants. They showed a strong preference for the *acting* strategy, particularly for concrete concepts, while the *entity* and *deictic* strategies played an important role in the depiction of abstract concepts. Cultural differences between the two countries appeared negligible. The preference for dominant strategies, particularly the *acting* strategy, was stronger in our gesture data than the corresponding signs in DGS and BSL, though gesturers did use the whole range of iconic strategies identified in the sign language data. The same concepts that elicited a highly diverse set of iconic strategies from gesturers were also more likely to be represented by different iconic strategies in DGS and BSL. Signs and gestures thus seem to exploit the same iconic potential in individual concepts, though gesturers may have a less fully developed repertoire in using the full potential of the different strategies.

With this, we contribute to our understanding of how the communicative potential of iconic mappings is exploited in the visuo-manual modality, by gesturers and signers. We show that gesturers are capable of producing iconic mappings even for abstract concepts, using largely the same strategies as for concrete concepts. This implies that the double mappings of metaphorical iconic signs (Meir, 2010) are also at play in gestures and thus part of the mechanisms by which non-signers conceptualise abstract concepts. Future research should establish the role of cultural visual metaphors in these mappings, as well as whether the constraints that govern double mappings in sign languages also apply to gestures.

This study highlights that iconic mappings are a profound part of gestural depiction, including in the abstract domain. Diversity in iconic strategies in our gesture data predicted overlap in iconic strategies in the lexicon of two sign languages. We predict that the same effect holds for a wider range of sign languages, particularly when taking into account the diversity of gestural responses across more diverse cultures. Iconic mappings allow gesturers to ground their manual representations in embodied experiences, creating common ground for bootstrapping even abstract meanings. As such, iconicity serves a productive role in shaping and creating gestural representations across individuals and cultures.

Chapter 5

Overall discussion

The investigation of iconicity in manual gestures and signs provides insights into a part of human communication in which what has traditionally been conceived of as categorically linguistic or non-linguistic becomes blurred, as the same semiotic resources are employed in clearly lexicalised signs and as well as spontaneous gestures. When investigating structural features of language, linguistics has often ignored the effects of modality on the structuring principles of a linguistic system. As Slobin points out, “the brute facts of communication impose bottlenecks between communicative intent and realized message” (2013, p. 47), thereby structuring linguistic elements to fit the constraints of the communicative modality. He argues that morphological complexity in spoken languages is, at least partially, imposed by the linearity of signal transmission in the vocal modality, while the visuo-manual modality allows for simultaneous morphology much more easily, reducing the need for complex sequential morphological constructions. Communicative expression across modalities is thus shaped by a variety of factors, with the weight of individual factors affected by the modality it operates in. One such factor is iconicity, creating grounded representations of concepts that closely map onto embodied experiences (Perniss & Vigliocco, 2014). While spoken languages are limited in their ability to exploit this factor, though mappings of auditory, temporal and potentially size-related information are available to some extend (Cwiek, 2022; Dingemanse et al., 2016; Perniss et al., 2010), communicative signals in the visuo-manual modality can exploit iconicity to a much greater extend (Perniss, 2018), giving it a more weight in this modality.

This dissertation, therefore, explores how iconicity shapes form-meaning mappings in lexical signs of two sign languages and the gestures of hearing non-signers in concrete and abstract concepts. The comparison of lexical signs from two sign languages will provide us with insights into how iconicity acts within the confines of a structured linguistic system. The comparison with silent gestures, in turn, allows for an observation of the raw potential of iconicity when shaping impromptu communicative signals that are unconstrained by a phonological system and attempt to provide clear depictions of the semantic information to be communicated. The strong similarities between these systems call into question narrow models of what is considered linguistic, calling for a wider conceptualisation of language that considers different semiotic practices that contribute to our communicative capacity (Perlman & Woodin, 2021; Perniss, 2018).

In this discussion section, we will first revisit the main results from chapters 2 to 4 and then put those findings into the context of the relevant research literature. While the results of the individual studies have already been discussed in detail within the respective chapters of this dissertation, this overall discussion brings together the results from the entire dissertation to clarify key takeaways. As laid out in the introduction, this dissertation presents answers to the following five research questions:

RQ 1: How are iconic strategies distributed in BSL and DGS, and does the distribution differ by language?

RQ 2: What is the relationship between iconic strategies, degree of concreteness, and form overlap?

RQ 3: How does the (supposed) greater suitability of iconicity for representing concrete concepts manifest in gestures?

RQ 4: How is iconicity used in gestural depictions of abstract concepts?

RQ 5: Does the role of iconicity in silent gesture also manifest in lexical items in sign languages?

Chapter 2 described the selection process for 234 concepts that served as a basis for comparisons across the studies of this dissertation and provided details on how concrete those concepts were perceived to be by different groups of raters. Each concept was represented by a single lexical sign from BSL and DGS and translation equivalents in English and German were provided. The signs and their translation equivalents were rated by signers and non-signers, respectively, in Germany and the UK. Concepts showed an overall bias towards the concrete end of the rating scale. Concreteness ratings, reflecting the overall perception of concreteness, showed a high, positive correlation between the two countries. Ratings by signers and non-signers within both countries showed at least medium strength correlations. The chapter provided the background on the data used in the later comparisons and provides a rationale for the concept selection process.

Chapter 3 compared the 234 signs from BSL and DGS, showing highly similar distributions of iconic strategies, with a preference for the *acting* and *entity* strategies in both languages (RQ 1). Concrete items were more likely to show higher form overlap, though this effect was mediated by shared iconic strategy (RQ 2). This means that even highly abstract concepts showed high form overlap, if they shared an iconic strategy. However, as sharing a strategy was more frequent for concrete concepts, high form overlap was also more frequent in those. Overall, we thus find that iconicity and specifically the use of similar iconic mappings are highly relevant factors shaping the lexicon of sign languages for both concrete and abstract concepts. These findings set the stage for exploring how these patterns extend to gestures in non-signers.

Chapter 4 builds on these findings by exploring whether these relationships can be seen in the visuo-manual modality more broadly. To this end, the chapter examines how non-signers represent the same concepts through gesture, and how their productions are influenced by iconicity and concreteness. Non-signers in both countries were, overall, quite successful at producing gestures for the 234 concepts, though abstract concepts appeared more difficult than concrete concepts (RQ 3). Participants were more likely to pass on abstract concepts and abstract concepts elicited highly diverse responses. Concrete concepts showed a wider spread in diversity scores, ranging from concepts that elicited very homogeneous responses to those that elicited highly diverse responses. Overall, concrete concepts elicited more systematic gestural responses. The *acting* strategy was most frequently used, accounting for approximately 60% of productions for concrete concepts and close to 50% for abstract concepts. The *entity* and *deictic* strategies were substantially more frequently used to depict abstract than concrete concepts (RQ 4). The diversity of iconic strategies in the gestural data was significantly associated with whether BSL and DGS used the same strategy (RQ 5). This suggests that the potential for different iconic mappings is available to gesturers and exploited in a systematic way across sign languages.

5.1 Iconicity shapes the lexicon in the visuo-manual modality

The 234 concepts and the signs representing them in BSL and DGS were not selected for their iconicity, yet only about 10% of the lexical signs could not be clearly identified as exhibiting any of the defined strategies and only about 5% were primarily deictic, rather than iconic in the two sign languages. This means that in our selection of items, the overwhelming majority (85%) can thus be clearly classified as iconic, using one of the strategies in our classification system. Similarly, the non-signers overwhelmingly attempted to create iconic depictions. Deictic signs covered proportions between 4% of concrete items in the UK to 21% of abstract items in Germany. Even more strikingly, only 2 items overall were clearly emblematic and could not be grouped in any of the iconic strategies, and a very limited number of items were coded as inconclusive, all of which had participants visibly struggling to come up with a gesture and motorically exploring, rather than confidently producing a non-iconic representation. The overwhelming majority of signs and gestures could be construed as iconic, alongside primarily deictic items. Moreover, iconic strategies appeared to relate to and make evident how signers conceptualised the target meanings, as they showed a strong relationship with descriptions of iconic instantiations. These findings highlight the central role of iconicity in the creation of meaningful lexical representations in signs and gestures, as well as the suitability of iconic strategies as a way of classifying the relationships between form and meaning, based on the underlying conceptualisations.

This is in line with studies that highlight the importance of iconicity as a structuring principle in the visuo-manual modality (Perniss et al., 2010) and language in more general terms (Perlman & Woodin, 2021). While prior research has suggested that languages lose their iconic features over time and sign languages simply retain higher proportions of iconic lexical items than spoken languages due to a lack of time depth (for such tendencies in ASL, see Frishberg, 1975), our data suggest that, at least at the lexical level, this is not necessarily the case (see also Pietrandrea, 2002). Indeed, Spruijt et al. (2023) show that signs from DGS are not significantly less transparent nor perceived as systematically less iconic than gestures produced by German hearing non-signers, even showing clear examples of increased iconicity at the expense of phonotactic simplicity, e.g. producing the sign for PHOTO as if taking a photo with one index pressing the trigger (more iconic, asymmetrical and thus more complex), while most gesturers produced a symmetrical movement of both index fingers (less iconic, less complex). Both BSL and DGS are established national sign languages used by large deaf communities with areal and social stratification and with solid historical records, yet the data presented in this dissertation does not show any clear indication of a loss of iconicity at the lexical level. While we have no diachronic data to compare our results to, the proportion of signs that can be clearly categorised according to the iconic strategies used is extremely high, rendering a historical baseline with even higher levels of iconicity somewhat implausible. Taken together with the gestural data, which shows the same reliance on iconic mappings that are retained in the sign language data, this leads us to suggest that, contrary to the proposal that sign languages lose their iconic properties over time (Frishberg, 1975), iconicity is a stable property of the visuo-manual modality, at least at the lexical level explored in this dissertation.

In addition, iconic strategies showed a clear effect on articulatory form, with shared iconic strategies leading to higher form overlap in sign pairs between BSL and DGS. As concrete items were more likely to share iconic strategies in both languages, they were also more likely to show more substantial form overlap. While this dissertation does not provide a direct measure of form overlap across gestures, if we assume the same relationship between systematic strategy use and form overlap in the gestural data, the increased diversity scores of abstract concepts would point towards a similar pattern for silent gesture. As such, iconicity may directly influence articulatory form not only in signs but also in gestures. Iconic strategies appear to differ in the degree to which they restrict form, with *representing* and *personification* showing particularly strong effects on how the articulators are recruited. As laid out in Chapter 3, Taub's (2001) analogue-building model and Meir and Cohen's (2018) double-mapping approach can account for the ways in which iconicity can influence form in both concrete and abstract concepts. While Meir and Cohen (2018) explicitly talk about sign languages, the mechanism can be assumed to also account for abstract reference in silent gesture, as we see in Chapter 4.

The systematic use of iconicity in the sign language and gesture data appears to be related, as diversity in gestural responses translates to a higher likelihood of different strategies used in BSL and DGS. Concepts and their mental representations thus seem to have an intrinsic potential for iconicity, allowing for more or less diverse representations, in line with the suggestions in Perlman and Woodin (2021). That is, concepts may differ in the range of features that are available for iconic depiction, interacting with the modality of expression. For example, to concept "table" has a fairly limited set of ways in which we perceive it and interact with it. It is primarily defined by a large surface area on legs, which we prototypically use to put things on. Meanwhile, the concept "car" has a typical shape and is typically experienced in a range of ways, e.g. while steering a car, riding as a passenger in the front or back, opening and closing the side doors and trunk (which involve different actions), as well as encountering and observing cars from the outside as stationary objects or in traffic. All of these features are, in principle, available for iconic depictions. For example, BSL and DGS not only have lexical variants that depict steering a car, but also use classifiers showing a flat, downward facing hand, that is moving through space. The classifier form also comes back in lexical signs, such as the signs for PARK (A CAR) (for DGS sign, see TO-PARK1^, Konrad et al., 2020) or TRAFFIC JAM (for DGS sign, see STAU1B^, Konrad et al., 2020), which depict typical movements and configurations of cars, respectively. A car also makes typical noises that could be depicted in the auditory-vocal modality but are unavailable for depiction in the visuo-manual modality. Iconicity thus interacts with modality, both in terms of the proportion of concepts it is available for and in terms of types of mappings. Slobin et al. (2003) argues that many grammatical features and structures of language may be influenced by such properties of modality, such that they may be the result of how modality-related constraints shape language structure. Iconicity appears to be one of the devices used to create meaningful linguistic utterances, which interacts with modality in shaping the lexicon of any given language.

Signers and non-signers can exploit this potential for iconicity in their depictions, providing an indication why iconic signs may be similar, even across unrelated sign languages (Woll, 1984). These depictions also appear to be accessible to observers, even in the context of unconventionalised gestures, which are still likely to be communicatively successful as shown in a study on gesture elicitation and comprehension by Yang (2023). While our study does not trace a diachronic perspective of a gesture-to-sign trajectory, the synchronic comparison between gestures and signs points to shared cognitive affordances for meaning making by linking embodied and perceptual experience to articulatory form. Sign languages appear to systematise this in a more extensive way, though our data do not show any suggestions of language specific preferences for individual strategies.

5.2 Iconicity is realised in similar ways in gestures and signs

Both gestures and signs could be classified in terms of the same iconic strategies, with the same preferences for particular strategies. Both gestures and signs showed a marked preference for the *acting* strategy, followed by the *entity* strategy, though at different proportions. This shared preference in signs and gestures suggests that these two strategies play a prominent role in structuring reference in the visuo-manual modality. However,gesturers appear to strongly default to the *acting* strategy, essentially whenever it is available, and only resorting to the other strategies if necessary. Ortega and Özyürek (2020a) showed that gesturers overall favoured the *acting* strategy, but this was particularly noticeable for manipulable objects, while *tracing* was favoured for non-manipulable objects and *personification* for animate entities. This suggests functional differentiation of iconic strategies, which may also be relevant to the use of iconic strategies in our data. Both sign languages appear to further diversify the use of iconic strategies, showing lower proportions for the two main strategies and higher proportions for the smaller strategies, overall.

This suggests a more systematic exploitation of iconic strategies within the linguistic systems, possibly as a property which emerges within the development of a sign language (Ergin, 2022). Indications of such effects can be identified in the comparison of gestural and signed data from different contexts and at different levels of conventionalisation. It appears that unconventional, spontaneous gestures show the strongest reliance on the *acting* strategy, similar to less conventionalised constructed action in sign languages (see Quinto-Pozos & Parrill, 2015). At the other extreme, the high conventionalisation of lexical signs goes along with an increased use of other strategies, as shown in the BSL and DGS data in this dissertation. As such, the conventionalisation processes inherent in language development and language change may thus contribute to a diversification of iconic strategy use.

These findings align with past research that suggests similar patterns in other sign languages and gestures of hearing people in other countries (Hou, 2018; Hwang et al., 2017; Ortega & Özyürek, 2020b; Padden et al., 2013; van Nispen et al., 2017), though the proportions of strategies across sign languages in our study are more consistent than what has previously been reported when looking at individual semantic domains. Some studies have suggested semantic category as a factor in selecting specific iconic strategies (Hou, 2018; Hwang et al., 2017; Padden et al., 2013, 2015). Other factors that have been proposed include the ability to enact a referent (Hostetter & Alibali, 2008, 2010; Müller, 2014), affordances for handling (Masson-Carro et al., 2015; Ortega & Özyürek, 2020a), balancing communicative efficiency and cognitive load in simultaneous representation of information (Slonimska et al., 2020), and the availability of contextual cues and the communicative load on the manual form (Ergin, 2022). Contributing to these considerations, this dissertation proposes concreteness as another feature that is of crucial importance in how iconicity can interact with meaning in shaping the lexicon in the visuo-manual modality. Iconicity appears to not only support the representation of concrete but also abstract concepts, building on the same set of iconic strategies, while using differences between iconic strategies to display more or less concrete concepts. Importantly, iconicity shaping lexical form not only affects the lexicon of individual sign languages and gestural representations, but also drives similarities across unrelated sign languages and even with spontaneous gestures, which are not part of a conventionalised, linguistic system.

We thus show that the same iconic strategies are available in signs and gestures, though their relative use may diverge. Our comparison expands our understanding of what influences the selection of iconic strategies, suggesting that the linguistic organisation of sign languages increases the reliance on more specialised iconic strategies. These differences between signs and gestures point to important differences in linguistic experience, particularly with regards to the usage of these lesser used strategies.

While the use of iconic strategies in the lexical items of sign languages is, by necessity of lexical conventionalisation, fixed and does not immediately depend on individual interpretations of the iconic form-meaning relationship, gestural productions more directly display the diversity of conceptualisations and the subjective nature of creating suitable form-meaning mappings (Occhino et al., 2017). However, fully idiosyncratic, personal experiences would likely be communicatively unsuccessful. Indeed, the degree of systematicity found, even in the gestural productions, suggests that gesturers attempted to focus on shared experiences, be it common personal or collective cultural experiences.

One might assume that such a systematisation in the linguistic system would be language specific (see, for example, Occhino et al., 2017; Sehyr & Emmorey, 2019; Sehyr & Villwock, 2022), yet our comparison of BSL and DGS does not show any strong systematic differences that would support this view. Instead, the exploitation of less frequent iconic strategies may be a more general property of sign languages. If we assume that the stratified use of iconic strategies reflects the need to for semantic differentiation and lexical diversification in the face of the increased communicative load placed on manual signs in sign languages when compared to gestures, this appears to be a plausible hypothesis (for examples of associations of iconicity with semantic or phonological neighbourhood density, see Caselli et al., 2017; Cates et al., 2013). At the same time, the observation may be related to overall structural similarities of BSL and DGS that are not the subject of this investigation. Such similarities could be related to the similarity of the cultural context in which the two sign languages are used, which may affect lexical similarities, precisely because of the power of iconic depictions to infuse shared experiences, including cultural experiences, into lexical signs. A sample of more typologically diverse sign languages or a focus on specific morpho-syntactic contexts that would suggest differences to emerge would be necessary to falsify this claim.

5.3 Iconic strategies are available for both concrete and abstract concepts

While the same iconic strategies appear to be available in principle for both concrete and abstract concepts, some strategies appear to support abstraction better, both in gestures and signs. For example, the *entity* strategy appears to be particularly useful for abstract reference in both signs and gestures, while the *personification* strategy is rarely shared across abstract concepts in BSL and DGS and in a single gesture for an abstract concept. The *entity* and *deictic* strategies emerge as the main strategies for abstract concepts in both signs and gestures. The *acting* strategy, though still frequently used in abstract concepts, is much more commonly used for concrete concepts. Similarly, Keränen (2023) finds that the same iconic strategies described for concrete concepts are available for emotion and sensory signs in FinSL. This raises important questions about how abstract concepts are mentally represented and how different strategies facilitate their depiction in sign languages and gestures more specifically.

Considering the close link between iconic strategy use and the underlying conceptualisations in signs, it seems reasonable that the increased diversity in iconic strategies for abstract concepts in gestures goes along with a wider range of conceptualisations in this domain. In turn, the high systematicity for some concrete concepts in gestural representations points to shared conceptualisations. One may even argue that these representations are conventionalised to some degree and represented in the mental lexicon of gesturers.

Differential use of strategies between concrete and abstract concepts might be associated with the implied embodiment. As Dudis (2004) describes, some signs semiotically background the body such that the hands can take on meanings detached from their bodily function. This is the case for the *entity* strategy and for the handshape but not the movement in the *representing* strategy. For example, in the DGS sign for FAMILY, two hands move around each other in a circular motion. At face value, this could be interpreted as two objects moving around each other, here interpreted as the metaphor of family members turning around each other and belonging together in a family unit. To get to the iconic mapping, this sign requires considerable deconstruction of both an iconic mapping and a metaphorical meaning extension to an abstract interpretation. At no point, in this deconstruction, can the hand be interpreted as a hand. As such, strategies might differ in their dependence on an embodied reading, potentially freeing signs that use the *entity* strategy for more diverse, abstract interpretations. Such an interpretation opens up the understanding of iconicity in abstract concepts in terms of embodied cognition (Borghi et al., 2014), in the context of an iconically grounded double-mapping (Meir, 2010).

5.4 Limitations

The selection of items from BSL and DGS was entirely data-driven, following the signs produced in the sign elicitation task conducted in Germany and the UK. However, due to Covid-19 restrictions in the two countries, we were unable to conduct the full-scale study we had planned for this phase. Had we been able to follow through with the full-scale data collection, this would have provided us with a wider range of signers and potentially a wider range of variants of sign forms for the same concepts, creating a more representative sample of items overall. As a result of the restrictions on in-person data collection, we had to rely on a smaller set of lexical items, potentially limiting the representativeness of sign forms in our data set. However, most of the signs selected had been produced by multiple signers in the sign elicitation task and were confirmed by deaf team members and colleagues, as suitable lexical variants that were used by the local deaf community. In order to analyse data in a sign-to-sign comparison, we selected only a single lexical item as representative of each concept. This approach ignores the lexical variability present in both sign languages.

As highlighted in Chapter 2, the setup of the task may also have biased the item selection towards more concrete items. With a more large-scale data collection, unhampered by covid-19 restrictions, we would have been able to use concreteness ratings from other studies, e.g. Brysbaert et al. (2014), as a predictor for concreteness to create a more balanced data set. However, with the limited amount of items available, this was not feasible. This does not limit the validity of the studies presented here, as concreteness is measured as a continuous variable, allowing for the computation of relationships along the entire scale of ratings. Future studies with a more balanced dataset including a larger number of clearly abstract items may facilitate the emergence of specific patterns of how iconic strategies are used in abstract concepts in both gestures and signs.

The raters in the concreteness rating task represent a convenience sample, containing a mix of personal connections, primarily in the deaf community, followers of the social media accounts of the researchers and students at the respective research institutions. As such, it is not a representative sample, though it is likely to be more diverse than the samples of psychology students from a single university frequently observed in psycholinguistic studies. It should be noted, that particularly the recruitment of deaf participants for any type of research study is difficult. Popular recruitment platforms do not provide filters for sign languages (e.g. Prolific does not have any sign languages in their list of languages) or deafness, which would be sensitive medical information, and from personal connections, we know that deaf individuals tend to not be registered on these platforms. We therefore aimed to collect data from 30 deaf and 30 hearing participants per country (before exclusion) and massively advertised for participation in the deaf community in both countries. A final number of 36 may be considered a substantial number of participants, particularly in the field of sign language linguistics, yet it does not reach our target of 30 participants per country. This left us with an unbalanced sample of raters, limiting the representativeness, particularly of ratings from (deaf) signers. This dissertation solves this issue by collapsing ratings from different groups after confirming that the ratings were indeed correlated across groups.

5.5 Implications for research and practice

The findings presented in this dissertation contribute to our understanding of sign languages, gestures and the cognitive processes that contribute to the development of the linguistic structures and lexical elements in sign languages. These findings thus have specific implications for research and practice. In this section, these implications are brought together going from broader theoretical implications to specific practical suggestions for sign language teaching.

This dissertation highlights important similarities between gestures and signs, considering how they use the affordances of the visuo-manual modality and the manual articulators to create representations of concepts, both concrete and abstract. An important finding of this dissertation is that non-signers use the same iconic strategies as signers to represent both concrete and, importantly, abstract concepts. The findings presented here tie in with conceptions of a sign-gesture continuum (McNeill, 2000; Özyürek & Woll, 2019), which posits differences between (representational) gestures and signs as gradual rather than categorical in nature and depending on linguistic functions performed by individual manual representations, the communicative load that lies on the visuo-manual modality and the semantic domain a concept falls into. Silent gesture, then, provides valuable insights in the underlying cognitive capacities of hearing non-signers, which may not necessarily emerge in their everyday language use including co-speech gestures. High similarities with patterns found in sign languages suggest that these patterns, rather than being a property of sign languages, emerge from these cognitive capacities that are available to non-signers as well. This should not be taken to devalue the linguistic complexity of sign language, but rather as a call for a careful differentiation between linguistic characteristics that are a function of modality and those that are specific to groups of languages. It is likely that this is true for spoken languages as well, where some structural and grammatical elements may well be structured by properties of the auditory-oral modality (see for example Slobin, 2013). If we consider (silent) gestures to be fundamentally similar to lexical signs, this raises the question of whether specific cognitive constraints observed in sign languages also apply to gestures. The next paragraph explores one such constraint, the double-mapping constraint (Meir & Cohen, 2018), in the context of gestural representations of abstract concepts.

Chapter 4 shows that non-signers use iconic mappings to ground their representations of abstract concepts. This being the case, the double-mapping constraint (Meir & Cohen, 2018) may be directly relevant to gestural representations. While the diversity of responses in the gesture data suggests that non-signers do not have established metaphors to rely on in their representations, it is likely that the idiosyncratic mappings created by individual gesturers still conform to a double-mapping constraint. This would mean that only such iconic mappings are chosen that fit available metaphors to ground the concept in question, and, possibly, that only metaphorical anchors are chosen that can be iconically represented. For example, the concept INTERNET elicited mostly pass responses and was evidently difficult to depict visually. Participants that provided gestures mostly used the *acting* strategy depicting typing something and then showed how whatever they had typed moved into some undefined space around them with the *tracing*, *deictic* or *entity* strategy. This indicates a shared conceptual representation of the internet as something that is around us in an immaterial way and which we interact with by typing things into a device. However, this shared representation appeared difficult to capture in an iconic gesture. In fact, it may be specifically this interaction between the metaphorical and the iconic mapping that creates difficulties for the non-signers, as they are trying to find representations that combine a suitable metaphor and iconic mapping. Future research may attempt to gain a more detailed understanding of these iconic mappings in gestures to broaden our understanding of how iconicity enables abstract representation across the visuo-manual modality.

Despite the challenges faced by non-signers in integrating iconic and metaphorical mappings, they are able to use iconic strategies for abstract reference. Therefore, systematic patterns of using iconic strategies to delineate semantic distinctions as proposed for a range of sign languages and silent gesture (e.g. Hwang et al., 2017; Padden et al., 2013) may also extend to abstract concepts. For example, Padden et al. (2015) argues that iconic strategies are systematically used in ASL to distinguish nouns and verbs. This may, in principle, also hold for more abstract concepts, e.g. the nouns and verbs associated with cognitive processes. Identifying the specific functional differentiations supported by iconic strategies in the abstract domain, similarly to what Padden et al. (2015) shows for concrete concepts, may thus prove a fruitful avenue of future research.

For gesturers, some past research has suggested interesting biases on the comprehension side, where participants in one study showed a bias towards interpreting gestures that were initially produced for both actions and objects as the associated actions and that they were more likely to choose less abstract interpretations of a gesture, rather than overextending its meaning (Ortega et al., 2019). For example, they were more likely to interpret a gesture enacting the peeling of a banana to mean “peel a banana”, rather than either "banana" (the object) or "to peel" as a more general, abstract concept. This mirrors the effects we see in production, where participants struggle with providing iconic representations of abstract concepts. If iconic strategies systematically shape the entire lexicon in the visuo-manual modality in BSL and DGS and gestures in two countries, an important next step is to expand this investigation by including wider cross-linguistic and intra-language variation for both comprehension and production.

In Chapter 3, we provide one-to-one comparisons of lexical signs between BSL and DGS. Future research could expand this approach in two ways, thereby contributing to an even better understanding of how iconicity shapes the lexicon in both concrete and abstract concepts. One avenue is a broader comparison including more diverse sign languages, thereby expanding the cultural and linguistic diversity of the lexical items included. The methods used on the gestural data might provide a basis for such a wider comparison, exploring the diversity of iconic strategies across a typologically diverse set of sign languages. A second avenue is the inclusion of lexical variability within sign languages. While the signs analysed in this dissertation are signs that are used by members of the deaf community in the two countries, they are not necessarily the only signs available or the most prevalent variants for each concept. Allowing for lexical variation within datasets could contribute to gaining a better understanding of the functional differentiations demarcated by iconic strategy use, expanding on notions of patterned iconicity (Gehlbach, 2025; Padden et al., 2013, 2015). Understanding the intra- and cross-linguistic variation of iconic strategy use is not only of theoretical significance but comes with practical implications for language teaching.

If sign languages and gestures differ in their reliance on specific iconic strategies, this has implications for sign language teaching. Prior research suggests that non-signers use their gestural repertoire to predict and interpret sign forms on first encounter (Ortega et al., 2019) and in early learning (Ortega et al., 2020). This dissertation suggests that using their knowledge of iconic strategies from their gestural repertoire is likely to limit learners in fully exploiting less prevalent strategies, as they are used in sign languages. Sign language instruction may therefore benefit from explicitly teaching learners about iconic strategies, particularly those that are less prevalent in gestures. Based on past findings that suggest facilitatory effects for sign comprehension (Ortega et al., 2020; R. L. Thompson et al., 2009) but inhibitory effects for phonologically accurate sign-production (Ortega & Morgan, 2015a, 2015b; Ortega-Delgado, 2013), these domains might be affected by such instructional approaches. However, additional research would be required to investigate how such explicit instruction impacts learners' comprehension and production abilities.

The findings presented here contribute to an ongoing conversation on the cognitive foundations of language by investigating how both signers and non-signers employ iconic strategies in depicting concrete and abstract concepts. While our findings highlight the similarities between gestures and signs, as they exploit the visuo-manual modality, future research should explore how linguistic and cultural diversity contribute to this picture. Cross-linguistic comparisons of diverse sign languages and gestural repertoires could reveal both modality-specific patterns and language-specific variation. Additionally, investigating the role of iconic strategies in sign language acquisition and the developmental trajectory of children acquiring sign languages or gestural systems, could offer deeper insights into the emergence of cognitive constraints and the systematic exploitation of iconicity as a linguistic device. In addition, research into how these patterns play out in different communicative settings and linguistic systems, including established and emerging sign languages, home sign, and diverse gestural systems, will contribute important insights to our understanding of the role of iconicity in language.

Chapter 6

Summary of results

This dissertation explored how iconicity shapes form-meaning mappings in the visuo-manual modality and shapes the lexicon for both concrete and abstract concepts. This is accomplished through comparisons of 234 concepts as represented by lexical signs from BSL and DGS and silent gestures produced by hearing non-signers in Germany and the UK.

Iconic strategies in BSL and DGS were distributed in highly similar ways, with a clear preference for the *acting* and *entity* strategies (RQ 1). While this was also true for abstract concepts, not all strategies proved equally suitable for abstract reference. Iconic strategies were also the main driver of lexical similarities across the two sign languages. A spurious correlation between concreteness and form overlap was entirely accounted for by the shared use of iconic strategies, leaving iconicity as the driving force behind lexical similarities (RQ 2).

Non-signers found concrete concepts easier to gesture than abstract ones, though all concepts, even the most iconic ones, did elicit valid responses (RQ 3). Just as the signers, the non-signers showed a marked preference for the *acting* strategy, though it made up a larger proportion of their productions than we saw in the sign languages. The *entity* and *deictic* strategies were more frequently used in the gestures for abstract concepts (RQ 4), mirroring their use for abstract concepts in signs (RQ 5). The diversity of iconic strategies across gestural responses was significantly associated with both concreteness ratings and whether BSL and DGS used the same iconic strategy to depict a given concept (RQ 5).

Overall, the findings presented in this dissertation confirm that both gesturers and signers systematically exploit the iconic potential of the visuo-manual modality, though sign languages more systematically exploit the semantic potential of lesser used iconic strategies. Importantly, this dissertation shows that the power of iconicity for shaping the lexicon extends to abstract concepts, not only in signs, but also in the gestures of hearing people. This is achieved in both concrete and abstract concepts through the creation of form-meaning mappings that can be classified, in the visuo-manual modality, into a set of iconic strategies. The same mappings are available in the linguistic systems of sign languages and in the gestures of non-signers. These gestures are shown to be variable, particularly in abstract concepts, and yet rely on the same types of mappings. The results of this dissertation therefore suggest that signers and gesturers share a cognitive capacity for creating effective form-meaning mappings for concrete and abstract concepts. More broadly, this ability may allow humans to expand their linguistic expressivity across modalities, optimising their use of semiotic resources appropriate to any given context.

Chapter 7

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Appendix A

Virtual appendix

The videos, annotation guides, instructions to participants and data analysis materials are available in an OSF repository at: https://osf.io/yuqak/.

Appendix B

Abbreviations used

ABSL Al-Sayyid Bedouin Sign Language 40, 60, 61

ASL American Sign Language 40, 42, 61, 87, 99, 106

BSL British Sign Language 19, 22, 23, 26–29, 33, 35, 38, 39, 41, 43, 52, 55, 57–60, 62–66, 68, 73–76, 78, 79, 83, 85–87, 89, 92, 93, 97–104, 107, 110, 139

CSL San Juan Quiahije Chatino Sign Language 40

CTSL Central Taurus Sign Language 40, 61, 87–89

DGS German Sign Language (Deutsche Gebärdensprache) 19, 22, 23, 26–29, 31, 33, 35, 38–41, 43, 52, 55, 57, 58, 60, 62–66, 68, 73–76, 78, 79, 83, 85–87, 89, 92, 93, 97–104, 107, 110, 139

FinSL Finnish Sign Language 43, 103

HNSL Ha Noi Sign Language 40

ISL Israeli Sign Language 40

JSL Japanese Sign Language 40

KSL Kenyan Sign Language 40

NGT Sign Language of the Netherlands (Nederlandse Gebarentaal) 43

Appendix C

List of selected concepts

Table C.1: Selected concepts by semantic category.

Sem. category	Concept (English)	German	BSL file name	DGS file name
Animals	ANIMAL	TIER	ANIMAL_a	ANIMAL_1-1
	CHICKEN	HUHN	CHICKEN_a	CHICKEN-3
	COW	KUH	COW_b	COW_1-2
	DOG	HUND	DOG_a	DOG-2
	GOAT	ZIEGE	GOAT_a	GOAT-1
	HORSE	PFERD	HORSE_b	HORSE_B
	MOUSE	MAUS	MOUSE_a	MOUSE_X
	SHEEP	SCHAF	SHEEP_b	SHEEP_1-1
	SNAKE	SCHLANGE	SNAKE_b	SNAKE-2
	SPIDER	SPINNE	SPIDER_a	SPIDER-2
Art	ART	KUNST	ART_a	ART-2
	CINEMA	KINO	CINEMA_b	CINEMA_X-1
	DRAWING	ZEICHNEN	DRAWING_a	DRAW-1
	LIGHT	LICHT	LIGHT_a	LIGHT_1-1
	MUSEUM	MUSEUM	MUSEUM_a	MUSEUM-2
	PAINTING	GEMÄLDE	PAINTING_b	PAINT_2-1
	PHOTOGRAPHY	FOTOGRAFIE	PHOTOGRAGHY_a	PHOTO
	PICTURE	BILD	PICTURE_a	PICTURE_1-1
	POETRY	POESIE	POETRY_b	POETRY-2
Body	BODY	KÖRPER	BODY_c	BODY_2-1
	EAR	OHR	EAR_e	EAR_2-1
	EYE	AUGE	EYE_a	EYE_1-2
	FEET	FÜSSE	FEET_a	FEET-2

Sem. category	Concept (English)	German	BSL file name	DGS file name
Body	HAIR	HAARE	HAIR_a	HAIR-1
	HANDS	HÄNDE	HANDS_b	HAND_X
	HEALTH	GESUNDHEIT	HEALTH_a	HEALTHY_1-2
	LEGS	BEINE	LEGS_e	LEGS-1
	MOUTH	MUND	MOUTH_b	MOUTH-2
	NOSE	NASE	NOSE_b	NOSE-1
Body care	BATH	BAD	BATH_a	BATHROOM_WASH-BODY_2-1
	FACECREAM	GESICHTSCREME	FACE MOIS-TURISER_c	FACE-CREAM-2
	HAIRDRYER	FÖHN	DRYING HAIR_b	HAIR-DRYER-1
	MASSAGE	MASSAGE	MASSAGE_b	MASSAGE-1
	SHAMPOO	SCHAMPOO	SHAMPOO_c	SHAMPOO-2
	SHAMPOO	SCHAMPOO	SHAMPOO_c	SHAMPOO-2
	SOAP	SEIFE	SOAP_b	SOAP
	WASH BODY	KÖRPER WASCHEN	WASH BODY_b	WASH-BODY_2-1
	WASH FACE	GESICHT WASCHEN	WASH FACE_a	WASH-FACE_1-1
	WASH HAIR	HAARE WASCHEN	WASH HAIR_a	WASH-HAIR-1
Childhood	BABY	BABY	BABY_a	BABY-2
	CAKE	KUCHEN	CAKE_b	CAKE_1-2
	CARDS	KARTEN	CARDS_b	CARDS_game-2

Sem. category	**Concept (English)**	**German**	**BSL file name**	**DGS file name**
Childhood	CHILDHOOD	KINDHEIT	CHILDHOOD_c	CHILDHOOD-CHILD_1-3
	DOLL	PUPPE	DOLL_c	DOLL_2-2
	FRIEND	FREUND*IN	FRIEND_a	FRIEND_2-2
	GAME	SPIEL	GAME_b	GAME
	HOBBIES	HOBBYS	HOBBIES_b	HOBBY_1-1
	PARTY	PARTY	PARTY_b	PARTY-2
	TOYS	SPIELZEUG	TOYS_c	TOY
City	BANK	BANK	BANK_b	BANK-2
	BUILDING	GEBÄUDE	BUILDING_b	BUILDING_BUILD_1-1
	CENTRAL	ZENTRAL	CENTRAL_b	CENTRAL-CENTER_1-1
	CITY	STADT	CITY_a	CITY-1
	HOSPITAL	KRANKENHAUS	HOSPITAL_b	HOSPITAL_1-1
	PARK	PARK	PARK_b	PARK-1
	PUB	KNEIPE	PUB_b	PUB-2
	RESTAURANT	RESTAURANT	RESTAURANT_b	RESTAURANT_1-1
	ROAD	STRASSE	ROAD_a	STREET_1-1
	SUPERMARKET	SUPERMARKT	SUPERMARKET_b	SUPERMARKET_1-2
Clothing	CLOTHING	KLEIDUNG	CLOTHING_a	CLOTHES_1-1
	COAT	MANTEL	COAT_b	COAT_1-2
	DRESS	KLEID	DRESS_a	DRESS_1-2
	GLASSES	BRILLE	GLASSES_a	EYEGLASSES_2-1

Sem. category	Concept (English)	German	BSL file name	DGS file name
Clothing	GLOVES	HANDSCHUHE	GLOVES_a	GLOVES-1
	HAT	HUT	HAT_b	HAT-2
	JUMPER	PULLOVER	JUMPER_b	SWEATER-PULLOVER_1-2
	SCARF	SCHAL	SCARF_b	SCARF
	SHOES	SCHUHE	SHOES_b	SHOE
	SKIRT	ROCK	SKIRT_a	SKIRT_A
Communication	COMMUNICATION	KOMMUNIKATION	COMMUNICATION_b	COMMUNICATION-2
	COMMUNICATION BREAKDOWN	FEHL-KOMMUNIKATION	COMMUNICATION BREAKDOWN_c	COMMUNICATION-BREAKDOWN_b-1
	EMAIL	E-MAIL	EMAIL_b	EMAIL-1
	GESTURE	GESTURE	GESTURE_a	GESTURE
	INFORMATION	INFORMATION	INFORMATION_c	INFORMATION_1-1
	PHONE CALLS	TELEFONANRUF	PHONE CALLS_a	PHONE-CALL_B
	SIGNING	GEBÄRDEN	SIGNING_a	SIGN_1-2
	SPEECH	SPRECHEN	SPEECH_b	SPEAK-2
	TYPING	TIPPEN	TYPING_a	TYPE-ON-COMPUTER_1-2
	WRITE	SCHREIBEN	WRITE_a	WRITE_1-1
Drinks	BEER	BIER	BEER_b	BEER_1-2
	COCKTAIL	COCKTAIL	COCKTAIL_a	COCKTAIL_2-1
	COFFEE	KAFFEE	COFFEE_b	COFFEE_1-2
	DRINK	TRINKEN	DRINK_a	DRINK-2
	MILK	MILCH	MILK_a	MILK_1-1

Sem. category	**Concept (English)**	**German**	**BSL file name**	**DGS file name**
Drinks	TEA	TEE	TEA_a	TEA_B-1
	VODKA	WODKA	VODKA_b	VODKA
	WATER	WASSER	WATER_b	WATER_1-1
	WHISKY	WHISKY	WHISKY_a	WHISKEY-1
	WINE	WEIN	WINE_a	WINE_1-2
Education	EXAM	PRÜFUNG	EXAM_b	EXAM_TEST_1-2
	LEARNING	LERNEN	LEARNING_b	LEARN_1-1
	LECTURER	DOZENT*IN	LECTURER_a	LECTURER
	MATH	MATHE	MATH_b	MATHEMATICS-1
	READING	LESEN	READING_c	READ-L
	SCHOOL	SCHULE	SCHOOL_d	SCHOOL-2
	SHOW	ZEIGEN	SHOW_a	SHOW-1
	STUDENTS	STUDENT*IN	STUDENTS_b	STUDENT-2
	TEACHER	LEHRER*IN	TEACHER_b	TEACHER_B
Emotions	ANGRY	SAUER	ANGRY_b	ANGRY_1-1
	CRYING	WEINEN	CRYING_a	CRY_X-1
	EMOTIONS	GEFÜHLE	EMOTIONS_b	EMOTIONS_1-FEELINGS_1-2
	EXCITED	AUFGEREGT	EXCITED_b	EXCITED-2
	FRUSTRATED	FRUSTRIERT	FRUSTRATED_b	FRUSTRATED-ANGRY_FRUSTRATED_X-2
	HAPPY	FRÖHLICH	HAPPY_a	HAPPY_1-1
	LOVE	LIEBE	LOVE_a	LOVE_1-1

Sem. category	Concept (English)	German	BSL file name	DGS file name
Emotions	SHOCKED	SCHOCKIERT	SHOCKED_a	SHOCK
	SURPRISED	ÜBERRASCHT	SURPRISED_a	SURPRISED-1
	UPSET	WÜTEND	UPSET_b	UPSET-ANGRY
				_UPSET-1
Family	AUNT	TANTE	AUNT_b	AUNT_A
	BIRTH	GEBURT	BIRTH_e	BIRTH_1-1
	BROTHER	BRUDER	BROTHER_b	BROTHER-2
	FAMILY	FAMILIE	FAMILY_a	FAMILY_2-1
	FATHER	VATER	FATHER_a	FATHER_1-1
	HOUSE	HAUS	HOUSE_a	HOUSE-1
	MARRIED	VERHEIRATET	MARRIED_a	MARRY-2
	MOTHER	MUTTER	MOTHER_a	MOTHER_1-1
	SISTER	SCHWESTER	SISTER_a	SISTER-2
	UNCLE	ONKEL	UNCLE_a	UNCLE_X-1
Food	BREAD	BROT	BREAD_b	BREAD_B
	BUTTER	BUTTER	BUTTER_a	BUTTER_1-2
	EAT	ESSEN	EAT_b	EAT_1-1
	FRUIT	OBST	FRUIT_c	FRUIT-2
	MEAT	FLEISCH	MEAT_b	MEAT-2
	ONION	ZWIEBEL	ONION_a	ONION-2
	ORANGE	ORANGE	ORANGE_a	ORANGE_1-2
	PIZZA	PIZZA	PIZZA_b	PIZZA-2

Sem. category	**Concept (English)**	**German**	**BSL file name**	**DGS file name**
Food	STRAWBERRY	ERDBEERE	STRAWBERRY_d	STRAWBERRY-BERRY_STRAW-BERRY_X-1
	VEGETABLES	GEMÜSE	VEGETABLES_b	VEGETABLES_A-1
Household	BED	BETT	BED_c	BED_B
	CHAIR	STUHL	CHAIR_a	CHAIR-2
	DOOR	TÜR	DOOR_d	DOOR_1-1
	KITCHEN	KÜCHE	KITCHEN_a	KITCHEN
	PAN	PFANNE	PAN_a	PAN-2
	PLATE	TELLER	PLATE_a	PLATE-2
	SHELF	REGAL	SHELF_a	SHELF-2
	SINK	WASCHBECKEN	SINK_a	SINK-2
	SPOON	LÖFFEL	SPOON_a	SPOON-1
	TABLE	TISCH	TABLE_b	TABLE_3-1
Jobs	ARCHITECT	ARCHITEKT*IN	ARCHITECT_a	ARCHITECTURE-2
	BOSS	CHEF*IN	BOSS_a	BOSS_2-2
	BUILDER	BAUARBEITER*IN	BUILDER_a	BUILDER-2
	CARPENTER	SCHREINER*IN	CARPENTER_b	CARPENTER_1-1
	DOCTOR	ARZT / ÄRZTIN	DOCTOR_d	DOCTOR
	ELECTRICIAN	ELEKTRIKER*IN	ELECTRICIAN_a	TECHNICIAN_X-2
	EMPLOYED	ANGESTELLT	EMPLOYED_b	EMPLOYEE-2
	NURSE	KRANKEN-PFLEGER*IN	NURSE_c	NURSE_3-1
	POLICE	POLIZEI	POLICE_b	POLICE

Sem. category	**Concept (English)**	**German**	**BSL file name**	**DGS file name**
Jobs	PROFESSOR	PROFESSOR*IN	PROFESSOR_a	PROFESSOR-1
Law	COURT	GERICHT	COURT_a	COURT-OF-LAW-2
	FOLLOW	FOLGEN	FOLLOW_a	FOLLOW-1
	FRAUD	BETRUG	FRAUD_a	FRAUD-2
	LAW	GESETZ	LAW_a	LAW-BILL-1
	MUST	MÜSSEN	MUST_a	MUST-1
	PRISON	GEFÄNGNIS	PRISON_a	PRISON_1-1
	WAR	KRIEG	WAR_a	WAR-2
	WITNESS	ZEUG*IN	WITNESS_a	WITNESS_X-1
Media	FACEBOOK	FACEBOOK	FACEBOOK_a	FACEBOOK-2
	INSTAGRAM	INSTAGRAM	INSTAGRAM_a	INSTAGRAM_1-1
	INTERNET	INTERNET	INTERNET_a	INTERNET_1-1
	NEWS	NACHRICHTEN	NEWS_a	NEWS_3-2
	NEWSPAPER	ZEITUNG	NEWSPAPER_a	NEWSPAPER-2
	RADIO	RADIO	RADIO_a	RADIO
	RESEARCH	FORSCHUNG	RESEARCH_a	RESEARCH-2
	SKYPE	SKYPE	SKYPE_d	SKYPE_B
	TWITTER	TWITTER	TWITTER_b	TWITTER-2
Nature	EARTH	ERDE	EARTH_a	EARTH-1
	FLOWER	BLUME	FLOWER_a	FLOWER-2
	HILL	HÜGEL	HILL_b	HILLS-1
	LAKE	SEE	LAKE_a	LAKE_1-2
	LAND	LAND	LAND_a	LAND_1-2
	LEAF	BLATT	LEAF_a	LEAF_A

Sem. category	Concept (English)	German	BSL file name	DGS file name
Nature	LIGHTNING	BLITZ	LIGHTING_b	LIGHTNING-2
	PLANT	PFLANZE	PLANT_a	PLANT_1-2
	RIVER	FLUSS	RIVER_b	RIVER-1
	TREE	BAUM	TREE_a	TREE_1-1
	WORLD	WELT	WORLD_a	WORLD
Sports	BADMINTON	BADMINTON	BADMINTON_a	BADMINTON-2
	BASKETBALL	BASKETBALL	BASKETBALL_a	BASKETBALL_3-2
	BREASTSTROKE	BRUSTSCHWIMMEN	SWIMMING BREASTROKE_a	SWIMMING-BREASTSTROKE-1
	FRONTCRAWL	KRAULSCHWIMMEN	SWIMMING FRONT CRAWL_a	SWIMMING-FRONT-CRAWL
	HIKING	WANDERN	HIKING_a	HIKING_2-2
	HOCKEY	HOCKEY	HOCKEY_b	HOCKEY_X-2
	ICE SKATING	SCHLITTSCHUH LAUFEN	ICE SKATING_a	ICE-SKATING
	SPORT	SPORT	SPORT_b	SPORTS_1-1
	TENNIS	TENNIS	TENNIS_d	TENNIS_X-2
	TABLE TENNIS	TISCHTENNIS	TABLE TENNIS_b	TABLE TENNIS_2-2
Technology	ELECTRICITY	STROM	ELECTRICITY_a	ELECTRIC_1-3
	EXPERIMENT	EXPERIMENT	EXPERIMENT_a	EXPERIMENT-1
	KEYBOARD	TASTATUR	KEYBOARD_d	COMPUTER-KEYBOARD
	LAPTOP	LAPTOP	LAPTOP_a	LAPTOP-1
	MOBILE PHONE	HANDY	MOBILE PHONE_b	MOBILE-PHONE_1-2

Sem. category	Concept (English)	German	BSL file name	DGS file name
Technology	PLUG	STECKER	PLUG_c	PLUG-IN_1-1
	ROBOT	ROBOTER	ROBOT_a	ROBOT-1
	SCREEN	BILDSCHIRM	SCREEN_a	SCREEN-1
	TABLET	TABLET	TABLET_b	TABLET
	WIFI	WLAN	WIFI_a	WIFI_WLAN-2
Time	AGE	ALTER	AGE_a	AGE
	DAY	TAG	DAY_1	DAY_1-2
	FUTURE	ZUKUNFT	FUTURE_a	FUTURE_1-2
	MONTH	MONAT	MONTH_a	MONTH-2
	PAST	VERGANGENHEIT	PAST_a	PAST_1b-1
	SPRING	FRÜHLING	SPRING_b	SPRING_1-1
	SUMMER	SOMMER	SUMMER_b	SUMMER-1
	TIME	ZEIT	TIME_2	TIME_1-1
	WEEK	WOCHE	WEEK_b	WEEK_1-1
	WINTER	WINTER	WINTER_b	WINTER-2
Tools/handcraft	CRAFT	HANDWERK	CRAFT_a	HANDICRAFT_1-2
	CROCHET	HÄKELN	CROCHET_b	CROCHET
	DRILL	BOHRER	DRILL_a	DRILL_B
	HAMMER	HAMMER	HAMMER_b	HAMMER_1-2
	KNITTING	STRICKEN	KNITTING_a	KNIT-1
	NAIL	NAGEL	NAIL_b	NAIL
	SAW	SÄGE	SAW_a	SAW_A
	SCREWDRIVER	SCHRAUBEN-ZIEHER	SCREWDRIVER_b	SCREWDRIVER_1-2

Sem. category	Concept (English)	German	BSL file name	DGS file name
Tools/handcraft	SEWING	NÄHEN	SEWING_a	SEW
	TOOLS	WERKZEUG	TOOLS_b	TOOL_1-2
Transportation	AEROPLANE	FLUGZEUG	AEROPLANE_a	AEROPLANE_AIRPLANE-1
	BICYCLE	FAHRRAD	BICYCLE_a	BICYCLE_1-1
	BOAT	BOOT	BOAT_a	BOAT-1
	BUS	BUS	BUS_b	BUS_1-2
	CAR	AUTO	CAR_a	CAR_1-1
	HELICOPTER	HUBSCHRAUBER	HELICOPTER_a	HELICOPTER-2
	LORRY	LASTWAGEN	LORRY_c	TRUCK-LORRY-1
	MOTORBIKE	MOTORRAD	MOTORBIKE_b	MOTORCYCLE-1
	TRAIN	ZUG	TRAIN_a	TRAIN_1-1
	TRANSPORT	TRANSPORT	TRANSPORT_b	TRANSPORT-2
Weather	CLOUDS	WOLKEN	CLOUDS_a	CLOUD_1-1
	COLD	KALT	COLD_a	COLD-1
	HOT	HEISS	HOT_a	HOT_1-1
	RAIN	REGEN	RAIN_a	RAIN_1-1
	SNOW	SCHNEE	SNOW_b	SNOW-1
	STORM	STURM	STORM_b	STORM-1
	SUN	SONNE	SUN_a	SUN_2-2
	WEATHER	WETTER	WEATHER_a	WEATHER-1
	WIND	WIND	WIND_d	WIND

Appendix D

Semantic domains

The labels listed here are the German and English translations of the stimulus items in DGS and BSL, respectively.

D.1 Semantic elicitation DGS-01 and -02

Stimulus materials presented to participant 1 and 2 in the DGS pilot trials. Since the list was so long, it was presented in two sets, separated below.

First half:

- Aktivitäten
- Amt
- Ausbildung
- Bad
- Bauernhofmaschinen
- Baustelle
- Beziehungen
- Beziehungen Sch-Bereich (romance)
- Bildung
- Campen
- Emotionen
- Erdkunde
- Essen und Trinken
- Familienbereich
- Farben
- Festtage
- Gebäude
- Geschichte
- Gesellschaft
- Handwerk
- Haushaltsartikel
- Haustiere
- Indoor Aktivitäten
- Jahreszeiten
- Kindheit
- Kindheit
- Kommunikation
- Körperpflege
- Kultur
- Landschaft
- Lebendige Natur
- Lokationen im Raum
- Material und Substanz
- Mengen
- Nutztiere
- Pflanzen
- Recht und Justiz

- Schlafzimmer
- Sozialer Beich
- Sport
- Stadt
- Technische Geräte
- Technologie
- Traditionen
- Transportmittel
- Unbelebte Natur
- Urlaub
- Verkehr
- Wahrnehmung
- Was braucht man im Haushalt?
- Was macht man draußen?
- Werkzeuge
- Wildtiere
- Wohnung
- Zeit
- Zeltplatz

Second half:

- Alltag
- Amt
- Bauernhof
- Bauernhoftiere
- Beruf
- Beziehungen Familienbereich
- Beziehungen sozialer Bereich
- Bildung Schule
- Denken und Kognition
- Emotionen
- Essen
- Feiertage
- Freizeit
- Gebäude
- Geschichte
- Handwerk
- Haus
- Haushalt
- Haushaltsartikel
- Hobbies
- Kindheit
- Kleidung
- Körper
- Küche
- Kunst
- Lebendige Natur
- Lokationen im Raum
- Material
- Medien
- Möbel
- Nutztiere
- Outdoor Aktivitäten
- Politik
- Sch-Bereich
- Schule
- Spielzeug
- Sprache
- Substanz
- Tätigkeit
- Technische Geräte
- Technische Geräte
- Tiere
- Traditionen
- Transport
- Trinken
- Urlaub
- Verkehrsmittel
- Wandern
- Was macht man drinnen?

- Wetter
- Wochenende
- Wohnzimmer
- Zeit
- Zelten
- Zoo

D.2 Semantic elicitation - remaining DGS participants

The remaining participants in Cologne participated with a shortened list on which the most successful variants were selected.

- Alltag
- Beruf
- Beziehungen Sch-Bereich
- Bildung Schule
- Campen
- Denken
- Emotionen
- Erdkunde
- Essen
- Familie Bereich
- Farben
- Feiertage
- Geschichte
- Handwerk
- Haus
- Hobbies
- Kindheit
- Kleidung
- Kommunikation
- Körperpflege
- Kunst
- Landschaft
- Lebendige Natur
- Lokationen im Raum
- Material
- Medien
- Mengen
- Politik
- Recht und Justiz
- Spielzeug
- Sport
- Stadt
- Technologie
- Tiere
- Transport
- Trinken
- Verkehr
- Wahrnehmung
- Wetter
- Wohnung
- Zeit

D.3 Semantic elicitation BSL

- Activities
- Animals
- Art
- Bathroom
- Bedroom
- Body care
- Body
- Camping
- Childhood
- City
- Clothing
- Communication
- Construction site
- Culture
- Daily Life

- Drinks
- Education
- Emotions
- Family
- Farming
- Food
- Furniture
- Geography
- Handicraft
- Hiking
- History
- Hobbies
- Holidays
- Home
- Household items
- Job
- Kitchen tools
- Kitchen
- Landscape
- Language
- Law
- Leisure-Free time
- Living room
- Living Space
- Materials
- Media
- Pet
- Politics
- Relationships
- Romantic relationships
- Sense perception
- Spatial relationships
- Sport
- Technology1
- Technology2
- Timeline1
- Tools
- Toys
- Traditions
- Transportation1
- Transportation2
- Weather
- Weekend
- What do you do outside