Conventionalization of graphic representations of abstract concepts and metaphors in an experimental-semiotic communication game

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Abstract concepts are a hallmark of human cognition and culture. However, there is much debate over how they are structured and cognitively represented, and how they emerge and become conventionalized within a community. One influential approach is that abstract concepts are based on conceptual metaphors. This study investigates the emergence and conventionalization of abstract concepts and metaphors in an experimental-semiotic referential communication game in which participants have to rely on drawing to communicate abstract concepts and metaphors. The study sheds light on the different strategies participants use to evoke abstract concepts and shows that participants decrease the number of strategies they use over subsequent rounds of interaction, converging on more successful strategies and thereby initiating a joint process of conventionalization.

1. Introduction

Abstract concepts are pervasive in human cognition and culture. We can talk about "the meaning of life", something "weighing heavy on our memory" or "culture being the secret of our success" (Henrich, 2015). In fact, it has been estimated that 70% of the words that we use in our daily life signify abstract concepts (Recchia & Jones, 2012). The way we represent such abstract concepts is a heavily researched area of investigation (Bolognesi & Steen, 2018).

One influential approach is that we understand abstract concepts based on conceptual metaphoric associations (Kövecses, 2010; Lakoff & Johnson, 1980). In metaphor, we perceive and interpret one type of concept through the lens of another (Lakoff & Johnson, 1980). Elements of a source domain, which is typically more concrete (such as spatial concepts), are mapped onto a target domain, which is usually more abstract (such as time). This mapping allows us to comprehend and conceptualize abstract ideas by relating them to more familiar

experiences, often rooted in our embodied interactions with the world. For instance, the conceptual metaphor TIME IS SPACE gives rise to expressions like "a short time," "a long time," or "I'm looking forward to it" (Lakoff & Johnson, 1980; Kövecses, 2010). Importantly, the use of conceptual metaphorical mappings is not limited to spoken and written language but is routinely expressed in different modalities including co-speech gesture (Cienki & Müller, 2008), signed languages (Wilcox, 2000; Taub, 2001) and in graphical and pictorial representations (Stampoulidis et al., 2019; Forceville 2008). On this view, then, conceptual metaphor is pervasive in language, communication, cognition and culture across modalities. However, from a cultural-evolutionary perspective a key question is how metaphors first emerge in a communication system and how they become conventionalized parts of the communicative inventory of a community (Pleyer et al. 2024).

In their *career of metaphor* model, Bowdle and Gentner (2005) suggest that novel metaphoric extensions, initially processed 'online' in real-time, gradually become conventionalized word meanings. Over time, these expressions are perceived as less metaphorical and more conventionalized. However, this shift occurs gradually rather than instantly. Indeed, research by Gentner and King (2024) indicates that more recently developed word senses tend to be seen as more metaphorical compared to those that have been in use for a longer period. Overall, this highlights two central processes in the evolution of metaphorical meanings: the initial emergence of metaphorical meanings and their gradual conventionalization. In this study, we investigate these two factors using an experimental-semiotic referential communication game design (e.g. Garrod et al. 2007; Galantucci et al. 2012; Fay et al. 2018; Smith et al. 2025).

2. Methods

2.1. Participants

All the participants were recruited through a University Participant Recruitment Newsletter. Before the beginning of the experiment each participant was acquainted with the details of the process, each of them signing a participation consent form as well as a GDPR consent statement. 52 participants (N=52) took part in the experiment creating 26 pairs. Their ages varied from 19 to 51. Mean age of this sample averages to 26 (M=26) and median to 24 (Mdn=24). The experiment was conducted in Poland in English. The majority of the participants reported to possess language proficiency from B1 level to fluent, being C1 or C2 level. A small number of participants assessed their language skills at an A1-A2

level, but were not excluded from participating as they did not report any issues connected to understanding instructions and/or the assigned metaphorical phrases.

2.2. Stimuli

Participants were asked to communicate a total of six novel metaphors involving three different abstract concepts (LIFE, MEMORY, SUCCESS) via drawings. There were two metaphors for each abstract concept: LIFE IS A GARDEN, LIFE IS A THEATRE, MEMORY IS A TREE, MEMORY IS AN ICEBERG, SUCCESS IS A LADDER, SUCCESS IS GOLD.

2.3. Procedure

The research was conducted online utilizing a Pictionary-like approach where a pair of participants took roles of Drawer and Guesser, switching roles mid-round. For the means of communication between the Moderator and participants, we used *Discord*.[1] We created three private chats for game communication: one of the chats was used as the main means of communication where the Moderator and participants could exchange questions related to procedure or instructions and feedbacks related to drawings; the other two were created for private communication between the Moderator and each of the participants individually, where the Moderator was assigning phrases that the current Drawer was supposed to draw. Each participant logged into an account specifically pre-made for the purpose of this study. After acquainting themselves with the detailed instruction and rules of the experimental game, the participants then underwent a test round to familiarize themselves with the procedure as well as to ask questions. Due to the lack of an embedded feature of drawing on Discord, we used *Gartic phone*,[2] a drawing platform which allowed us to export the images, creating a database containing sets of pictures from each pair. The game consisted of two rounds, each round involving the same metaphorical phrases. In the first round the Drawer received three metaphorical phrases with an abstract target domain and a non-abstract source domain (see Stimuli). The drawer then had a maximum of three tries to draw the phrase in a way that the Guesser would understand what it represents. After the three first phrases were successfully guessed or when the tries were exhausted, the roles switched. The Guesser then became the Drawer and vice versa, where the new Drawer had to draw three phrases that had the same target domain but a different source domain. Round one finished as soon as the

[1] https://discord.com/
[2] https://garticphone.com/

last phrase was successfully guessed or the three allowed tries were exhausted. Round two repeated the process, however, now had a randomized order of the same phrases. In 100% of the cases all 6 phrases were guessed correctly at the end of round two. Feedback was an important part of the experimental game. Communication between the participants was supposed to remain minimal, relying mostly on communicating meaning through drawing. As soon as the drawing became visible, the Guesser's job was to write down a single guess as to what the phrase could be. The Drawer would then react and provide feedback by copying the Guesser's answer and editing the incorrect part of the phrase to bold, signaling to the Guesser which part of their guess was correct and which wasn't. Therefore, if the Drawer's response did not include any bold editing, the game immediately continued with the next phrase, however, if any part or the whole phrase was in bold, the Drawer would immediately start creating a drawing of the same phrase until the three tries were exhausted.

3. Data Analysis

We evaluated the results of the experiments in two analyses.[3] In the first, descriptive analysis, we investigated what was the dominant strategy to communicate about a given target domain. In the second, we implemented a Bayesian linear model to determine whether the number of trials correlates with a decreased number of strategies. In the experiments, participants had to communicate about novel metaphors with three target domains: MEMORY, LIFE, SUCCESS. They were free to choose how to communicate about those concepts via drawing, which is why we annotated the dataset for the types of strategies they used. The target domains and strategies are listed in Table 1.

Table 1. Target domains and communicative strategies.

Memory	**Life**	**Success**
AP - array of pictures (representation of a photoalbum, thought bubbles with or without pictures)	PR - pregnancy	RI - riches (cars, money, family)
BR - brain	HUM - human	TOP - top
TB - tree branch	HM - heart monitor (heartbeat line)	APP - approval (thumbs up, documents with ticks)

[3] Data and code are available at: https://osf.io/fr4xw/

PG - projector	NAT - nature (animals, trees, flowers)	TR - trophy
CM - computer memory (pendrive) etc.	BB - baby	ALC - alcohol
CAM - camera	CL - cycle of life (from birth to death)	PRO - progress
PUZ - PUZZLES	OY - old vs young	RP - rich vs poor
	PUP -puppets	WIN - winner
	DNA	TIC - a tick
	HP - game life scale	ARP - arrow up
	HRT - HEART	
	FAM - FAMILY	

The most frequent strategy to represent MEMORY was through an array of pictures (51%), the second brain (24%) and the third a camera (10%). The most common representation of LIFE was the drawing of a human (29%), next through a cycle of life (19%) and finally by heartbeat frequency (12%). As for SUCCESS, the dominant strategy was through drawing “top”, the second riches (such as cars and others), and the third by trophies.

In the second step, we fitted a bayesian linear model to the dataset. We assumed uninformative priors to estimate the beta parameter for the slope of round, trial and for an interaction between round and trial. The aim of the model was to evaluate whether participants simplify their drawings when they failed to communicate successfully in the first round. We ran a Monte Carlo Markov Chain sampler to obtain the posterior distribution for 2000 iterations, the first half of which were spent on warmup, and the second half on sampling. See Table 2 for predicted estimates.

Table 2. Results of analysis

	mean	sd	5.5%	94.5%	rhat	ess_bulk
alpha	1.23	0.15	0.99	1.47	1.00	246.50
beta_round	0.01	0.09	-0.15	0.15	1.00	238.20
beta_trial	0.05	0.09	-0.08	0.19	1.00	226.11
beta_both	-0.04	0.06	-0.13	0.06	1.00	225.08
sigma	0.47	0.02	0.45	0.50	1.01	252.24

The model indicates that there is a tendency for participants to decrease the number of strategies when they have to try to communicate again (estimate for the beta_both parameter is negative). This means that they try to simplify their images to communicate successfully.

4. Discussion

In the current study, participants played a dyadic communication game in which they had to communicate a number of meanings specified by the experimenter to a partner in the absence of language. Instead, they had to rely on the medium of drawing, forcing them to create a shared novel communication system. Previous studies using such a paradigm have identified several strategies that participants resort to that were also employed by participants in the current study. For instance, over repeated social interactions participants both simplified and aligned their communicative behavior (cf. Fay et al., 2018). In addition, participants decreased the number of strategies they used and stuck with those that were more successful, which is a first step towards conventionalization and the use of symbols – as agreed-upon conventions to express particular concepts. One of the preconditions of this process is inter-individual dyadic social-coordinative learning and a gradual shift from the information evoked by the drawing towards associations of the drawing with the participants' memory of the meaning and usage of the drawing (Fay et al. 2018).

The current study also shed light on the kind of strategies participants use to communicate abstract concepts such as LIFE, MEMORY, and SUCCESS. In language, abstract concepts like these can be communicated directly through words, whereas in visual representations, such abstract concepts must be conveyed by depicting concrete, graphically representable entities. Participants therefore needed to illustrate these concepts and the metaphors they are part of by using concrete concepts. On the one hand, participants used images that are related to salient shared cultural representations and associations of these concepts such as thought bubbles with pictures for MEMORY, or a heartbeat line for LIFE. Others seem to be grounded in conceptual metaphors such as drawing things communicating TOP for SUCCESS, which is licensed by the conceptual metaphor SUCCESS IS UP (Kövecses 2010) or drawing the cycle of life from birth to death to stand for LIFE. Importantly, most of these strategies ultimately seem to be based on the cognitive and communicative process of metonymy, where the evocation of one part of a domain gives mental access to another part of the same cognitive domain based on association of different sorts, such as a part for whole, or producer for product, or salient attribute for whole situation

(Littlemore 2015). For example, riches such as cars or money can be seen as part of success and again are often used as conventionalized depictions of success in culture and media. The same holds for indications of approval such as a thumbs up or celebrating success with alcohol, which can be seen as metonymically evoking the more general concept of SUCCESS they are often tied to.

As Bolognesi & Vernillo (2019) argue, metonymy can be seen as the key mechanism that enables interpreters to derive abstract concepts from metaphorical pictorial representations and this is also evident in the way participants communicated abstract metaphors and metaphors via drawing. Interestingly, the use of such 'situational' features is also in line with cognitive theories that see many abstract concepts as being grounded in situation-based perceptual knowledge (McRae et al. 2018). For example, McRae et al. (2018) have shown that abstract concepts and pictures of real-world situations activate one another. The current results support the view that providing situational information representative of or prototypically associated with an abstract concept can evoke that concept (Pecher et al. 2011).

5. Conclusion

The current study investigated how abstract concepts and metaphors are expressed and become conventionalized in a pictorial medium via drawing in an experimental semiotics referential communication game. It found that participants can use the medium of drawing to express abstract concepts. It also found that participants decrease the number of strategies over subsequent rounds of interaction, converging on more successful strategies and thereby initiating a joint process of conventionalization.

Successful communication of abstract concepts and metaphors therefore is based on the same processes found in other experimental semiotic studies on the emergence of a shared communication system, including the simplification of signals (in this case images) and pictorial strategies in order to communicate successfully and the reliance on salient shared semantic associations such as metaphoric conceptual mappings. As such, the study lends support to proposals that assign a crucial role to the process of metaphor in the cultural evolution of language and language change (Ellison & Reinöhl 2024; Gil & Shen, 2021; Knight & Lewis, 2017; Pleyer et al. 2024; Smith & Höfler, 2015)

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References

Bolognesi, M., & Steen, G. (2018). Editors' Introduction: Abstract Concepts: Structure, Processing, and Modeling. Topics in Cognitive Science, 10(3), 490–500. https://doi.org/10.1111/tops.12354

Bolognesi, M., & Vernillo, P. (2019). How abstract concepts emerge from metaphorical images: The metonymic way. Language & Communication, 69, 26–41. https://doi.org/10.1016/j.langcom.2019.05.003

Bowdle, B. F., & Gentner, D. (2005). The career of metaphor. Psychological Review, 112(1), 193–216.

Cienki, A. & Müller, C. (2008). Metaphor and Gesture. In Gs.3. John Benjamins Publishing Company.

Ellison, T. M., & Reinöhl, U. (2024). Compositionality, Metaphor, and the Evolution of Language. International Journal of Primatology, 45(3), 703–719. https://doi.org/10.1007/s10764-022-00315-w

Fay, N., Walker, B., Swoboda, N., & Garrod, S. (2018). How to Create Shared Symbols. Cognitive Science, 42(S1), 241–269. https://doi.org/10.1111/cogs.12600

Forceville, C. (2008). Metaphor in Pictures and Multimodal Representations. In Jr. Gibbs Raymond W. (Ed.), The Cambridge Handbook of Metaphor and Thought (pp. 462–482). Cambridge University Press. https://doi.org/10.1017/CBO9780511816802.028

Galantucci, B., Garrod, S., & Roberts, G. (2012). Experimental semiotics. Language and Linguistics Compass, 6(8), 477–493.

Garrod, S., Fay, N., Lee, J., Oberlander, J., & MacLeod, T. (2007). Foundations of representation: Where might graphical symbol systems come from? Cognitive Science, 31(6), 961–987. https://doi.org/10.1080/03640210701703659

Gentner, D., & King, D. (2024). The career of verb metaphor: Language evolution parallels online processing differences between nouns and verbs. In J. Nölle Raviv, L. ,. Graham, K. E. ,. Hartmann, S. ,. Jadoul, Y. ,. Josserand, M. ,. Matzinger, T. ,. Mudd, K. ,. Pleyer, M. ,. Slonimska, A. ,. Wacewicz, S. &. Watson, S. (Ed.), The Evolution of Language: Proceedings of the 15th International Conference (Evolang XV). https://doi.org/10.17617/2.3587960

Gil, D., & Shen, Y. (2021). Metaphors: The evolutionary journey from bidirectionality to unidirectionality. Philosophical Transactions of the Royal Society B, 376(1824), 20200193.

Henrich, J. (2015). The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter. Princeton University Press.

Knight, C., & Lewis, J. D. (2017). Wild voices: Mimicry, reversal, metaphor, and the emergence of language. Current Anthropology, 58(4).

Kövecses, Z. (2010). Metaphor: A Practical Introduction (2nd ed.). Oxford University Press.

Lakoff, G., & Johnson, M. (1980). Metaphors We Live By. University of Chicago Press.

Littlemore, J. (2018). Metonymy: Hidden Shortcuts in Language, Thought and Communication (Reprint edition). Cambridge University Press.

McRae, K., Nedjadrasul, D., Pau, R., Lo, B. P.-H., & King, L. (2018). Abstract Concepts and Pictures of Real-World Situations Activate One Another. Topics in Cognitive Science, 10(3), 518–532. https://doi.org/10.1111/tops.12328

Pecher, D., Boot, I., & Van Dantzig, S. (2011). Chapter seven - Abstract Concepts: Sensory-Motor Grounding, Metaphors, and Beyond. In B. H. Ross (Ed.), Psychology of Learning and Motivation (Vol. 54, pp. 217–248). Academic Press. https://doi.org/10.1016/B978-0-12-385527-5.00007-3

Pleyer, M., Kuleshova, S., & Placiński, M. (2024). Integrating approaches to the role of metaphor in the evolutionary dynamics of language. *Yearbook of the German Cognitive Linguistics Association*, 12(1), 145-176. https://doi.org/10.1515/gcla-2024-0007

Recchia, G., & Jones, M. N. (2012). The semantic richness of abstract concepts. Frontiers in Human Neuroscience, 6, 315. https://doi.org/10.3389/fnhum.2012.00315

Smith, A. D., & Höfler, S. (2015). The pivotal role of metaphor in the evolution of human language. In J. E. Díaz-Vera (Ed.), Metaphor and Metonymy across Time and Cultures: Perspectives on the Sociohistorical Linguistics of Figurative Language (pp. 123–139). De Gruyter.

Smith, K., Bowerman, J., & Smith, A. D. (2025). Semantic extension in a novel communication system is facilitated by salient shared associations. Cognition 261, 106129. https://doi.org/10.1016/j.cognition.2025.106129

Stampoulidis, G., Bolognesi, M., & Zlatev, J. (2019). A cognitive semiotic exploration of metaphors in Greek street art. Cognitive Semiotics, 12, 20192008.

Taub, S. F. (2001). Language from the Body: Iconicity and Metaphor in American Sign Language. Cambridge University Press. https://doi.org/10.1017/CBO9780511509629

Verhoef, T., Marghetis, T., Walker, E., & Coulson, S. (2024). Brain responses to a lab-evolved artificial language with space-time metaphors. Cognition, 246, 105763. https://doi.org/10.1016/j.cognition.2024.105763

Verhoef, T., Walker, E., & Marghetis, T. (2016). Cognitive Biases and Social Coordination in the Emergence of Temporal Language. Proceedings of the 38th Annual Conference of the Cognitive Science Society, 2615–2620.

Verhoef, T., Walker, E., & Marghetis, T. (2022). Interaction dynamics affect the emergence of compositional structure in cultural transmission of space-time

mappings. Proceedings of the Annual Meeting of the Cognitive Science Society, 44, 2133–2139.
Wilcox, P. P. (2000). Metaphor in American Sign Language. Gallaudet University Press. https://gupress.gallaudet.edu/Books/M/Metaphor-in-American-Sign-Language