Societal inferences from the physical world

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[Commentary on Mark W. Moffett's "What is a society? Building an interdisciplinary perspective and why that's important", in press, *Behavioral and Brain Sciences*]

Abstract
Moffett points to humans' use of physical markers to signal group identity as crucial to human society. We characterize the developmental and cognitive bases of this capacity, arguing that it is part of an early-emerging, intuitive *socio-physical interface* which allows the inanimate world to encode rich social meaning about individuals' identities, and the values of the society as a whole.

Main Text

Moffett proposes that a critical feature of human society is our ability to use physical markers as signals of shared group identity. We agree this is a notable feature of human cognition, and here argue that the use of physical markers to signal group identity is part of a broader human capacity to use the inanimate world as a rich source of social information. This reasoning, which we term the *socio-physical interface*, allows the inanimate world to encode social meaning, and is key to human social intelligence (Jara-Ettinger & Schachner, submitted). This supports our ability to detect and signal societal membership by using "things we make as a kind of societal extended phenotype" (Moffett, 2024).

A key question in the target article is the extent to which the ability to use physical markers as signs of group identity is early-emerging and intuitive for humans. Developmental research provides evidence of this: Children attend to physical markers of group membership from early in life, demonstrating a mental theory of intuitive sociology (Liberman et al., 2016; Shutts & Kalish, 2021). Young children use group membership to predict others' external behaviors and internal mental states (Kinzler, 2021; Shutts & Kalish, 2021; Tompkins et al., 2023). Children also use physical attributes as markers of power structures, inferring who is 'in charge' and which group holds higher status (Brey & Shutts, 2015; Dukler & Liberman, 2022; Shutts & Kalish, 2021).

Humans intuitively use physical markers to make a wide variety of social inferences, and reasoning about societal identity from these markers may be understood as part of this broader reasoning capacity. To link physical cues with social meaning, we at times rely on perceptual processes, which support quick perception of objects' recent history, and detection of objects shaped by agents (Chen & Scholl, 2016; Lopez-Brau et al., 2021). Perceptual features also support inferences about group identity. For example, children can use attributes

like clothing color to track group identity, particularly if clothing color previously predicted cooperative behavior (Shutts & Kalish, 2021).

People also use high-level causal reasoning to infer social information from physical markers, using mental theories of physics and psychology (Spelke, 2022). The resulting integrated causal theory allows for rational inferences about others' behavior, mental states, traits, and potentially societal identity, from physical cues alone. From static physical objects (e.g., a block tower; a dresser with some drawers open and others closed), even young children can infer others' goals, levels of skill, and knowledge states in a way that is well-predicted by Bayesian causal inference (Gweon et al., 2017; Lopez-Brau et al., 2022; Pelz et al., 2020). From childhood, humans can engage in *event reconstruction,* inferring the particular past behaviors that shaped inanimate features (Lopez-Brau et al., 2022; Pesowski et al., 2020). For example, people can reconstruct an agent's actions from cookie crumbs left behind, or a small object left to communicate that a spot is taken (Lopez-Brau et al., 2022; 2023). When viewing multiple objects, children and adults can use event reconstruction to infer when a design was copied, and thus trace social transmission of ideas (Hurwitz et al., 2019; Pesowski et al., 2020). Engaging in this complex causal inference may be cognitively slow and computationally expensive. However, people create shortcuts: We store the results as simple associations, and avoid constant use of complex reasoning by substituting heuristics in future similar situations (Lopez-Brau et al., 2023). In this way, both simple heuristics and theory-based causal reasoning link the social and physical world in the human mind, creating a rich socio-physical interface.

Societal identities directly shape which objects people create or possess, by motivating particular choices (of culturally-valued goods), or by determining their knowledge (of culturally-specific technologies or styles). Thus, the socio-physical interface may also support early-emerging inferences about societal identities from physical markers through causal reasoning about how objects or design ideas were created or obtained.

To be diagnostic of societal identity, physical markers should be difficult-to-fake, honest signals of a person's socio-cultural past (their social connections and cultural exposure). For example, linguistic accents vary by group and are notoriously hard to modify, and serve as informative social cues from infancy (Kinzler, 2021).

By this principle, objects that require specific, learned knowledge to create should be more diagnostic of one's social identity than other objects. Such design ideas are unlikely to be generated the same way twice independently, and therefore imply that learning via socio-cultural contact has occurred. This can involve unique functional designs, as in complex, passed-down cultural knowledge of tool design (Henrich, 2015). It can also involve unique style: Things like art, music, cuisine, and dress should be particularly diagnostic of societal identity, because their styles are highly variable and learned (Soley & Spelke, 2016).

Children are sensitive to this: They can trace social transmission of design ideas person-to-person by detecting suspicious coincidences in the features of objects they create (Pesowski et al., 2020). Children also use knowledge of culturally-specific objects like food and musical instruments (and not general world knowledge) to infer others' social affiliations and cultural groups (Öner & Soley, 2023). Similarly, infants and children use clothing as markers of group-specific social preferences and knowledge (Bian & Baillargeon, 2022; Weatherhead et al., 2022).

Physical markers in urban design also provide information about societies at large, allowing for rich, inductive inferences. The placement of a religious building, library, or social gathering place at a prominent location may signal the relative value that society places on different activities (Gehl, 2013). People intuitively view physical markers as having social messages: This understanding motivates action to remove Confederate monuments in the American South (Booth & Kizzire, 2016). These monuments in particular hold nuanced, tragic information about societal history. The number of lynchings of Black people in the historic record can be predicted by the number of Confederate memorials in that area (Henderson et al., 2021). People may infer endorsement, or at least tolerance, of nuanced political and moral views by the current society from its monuments. Interventions to change physical markers like monuments may powerfully change social values, by changing members' understanding of societal norms.

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