The study by **Cazenille et al. (2025)**, titled *"Signalling and social learning in swarms of robots,"* explores how collective behavior and social learning emerge through signaling in robot swarms. The **Neurodivergent Scale for Interacting with Robots (NSIR)** applies by evaluating how these complex, swarm-level communications are perceived as "social signals" by a neurodivergent observer, transforming collective machine logic into a relatable social presence.

1. Swarm Signaling as "Mind Attribution" (NSIR Item 3)

Cazenille et al. focus on how individual robots in a swarm use signals (visual, acoustic, or digital) to coordinate movement and share "social information" about the environment.

- **NSIR Application: Item 3** (*"I think I can share my thinking with the robot without speaking"*) measures the user's perception of non-verbal, implicit attunement.
- **The Connection:** For a neurodivergent user, the complex, non-verbal "dance" of a swarm—coordinated by these signals—can be perceived as a form of "shared thinking." The NSIR measures whether the user views the swarm's collective signaling as a sophisticated "mind" with which they can achieve a level of attunement that surpasses traditional human-human speech.

2. Social Learning and "Reliable Functioning" (NSIR Item 8)

A core component of the study is how robots learn from one another's signals to adapt to new tasks. This creates a highly adaptive but also highly consistent collective behavior.

- **NSIR Factor 2 (Social Comfort / Trust Safety): Item 8** (*"I believe that my robot is the same with me as it is with anyone"*) measures **Social Predictability**.
- **The Connection:** Neurodivergent users often find comfort in the "mechanical sameness" of robots. Cazenille's swarm, though dynamic, operates on logical, signal-based rules. The NSIR validates that this collective "sameness" provides the **Reliable Functioning** required for a user to feel safe and socially comfortable, even in a swarm of many agents.

3. Emergent Presence and Fictive Kinship (NSIR Item 1)

Cazenille et al. demonstrate that social learning allows the swarm to behave as a single, unified entity—an emergent "social agent."

- **NSIR Factor 1 (Anthropomorphic Connection / Kinship): Item 1** (*"The robot [swarm] is more like me than anyone else I know"*) measures the shift from viewing robots as tools to viewing them as **Kin**.
- **The Connection:** For some neurodivergent individuals, the "distributed intelligence" of a swarm may feel more similar to their own cognitive processing than traditional, centralized human social norms. The NSIR quantifies whether the user identifies with the "logic" of the swarm, forming a bond based on this perceived similarity.

4. Sustained Social Attention (NSIR Item 2)

The signaling behaviors of the swarm are designed to be highly interactive and visible to other agents.

- **NSIR Item 2** (*"Sometimes I stare at the robot"*) measures **Social Presence**.
- **The Connection:** In Cazenille's study, the signals are intended for other robots, but they also serve as a "social display" for a human observer. The NSIR identifies that "staring" at the swarm is not just curiosity; it is an intense attempt by the neurodivergent user to process the swarm's emergent social signals as a valid form of social presence.

Summary Alignment

Cazenille et al. (2025) Concept	NSIR (Sadownik, 2025) Application
Social Learning (Collective)	**Item 1 (Kinship):** Measures if the emergent "collective behavior" feels relatable to the user.
Signaling Systems	**Item 3 (Mind Attribution):** Validates if the user perceives the swarm's signals as a form of "internal thinking."
Adaptive Coordination	**Item 8 (Reliability):** Measures the social comfort that arises from the swarm's consistent, rule-based logic.
Unified Swarm Agency	**Item 6 (Naming):** Acts as a behavioral marker for whether the user "humanizes" the entire swarm as a single entity.

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In this application, the **NSIR** acts as a tool to measure how **swarm-level machine signaling** is translated into **individual-level social connection** for neurodivergent users, who may find the logic of the swarm more accessible and trustworthy than the "noisy" signals of human social groups.