Role-reversal Experiment

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Definition

The role-reversal experiment is a social cognition paradigm in which two animals first work together on a cooperation task requiring complimentary roles and then switch roles to test the degree to which they take the perspective of their partner.

Introduction

Cooperation, a widespread phenomenon across animal species, ranges from simple actions that incidentally benefit another to complex behavior coordinated in time and space. One of the most complex forms of cooperation involves complementary roles, in which animals perform different actions that contribute to achieving a joint goal. Such complementary roles have been observed in the wild, particularly in the context of group hunting, in such distantly related species as chimpanzees, lions, and hawks,[2] and have recently been shown even between species of fish.[3] However, it is unclear whether individuals performing one role learn about the complementary role of their partner by working with and observing their partner, or whether they must perform the role themselves in order to understand their partner's contribution. Role-reversal experiments try to address this question using novel collaborative tasks to ensure that subjects are initially naïve to both roles.

[2] Dugatkin (1997)
[3] Vail et al. (2013)

Procedure

The basic role-reversal experiment tests pairs of subjects, which may include a subject and a conspecific or a subject and a human experimenter, and consists of two phases. Subjects first learn to perform one of the roles in the cooperative task (training). For example, in the classic "communication apparatus," partners sit on opposite sides of a platform with pairs of food cups.[4] One partner (the informant) can see the rewards but cannot access them; the other partner (the operator) cannot see the rewards but can pull a handle to make one pair of cups accessible, one to the operator and one to the informant. Thus, to be successful, the informant has to indicate the food location (by pointing or positioning themselves in front of the food) and the operator has to pull the corresponding handle. In another task by Fletcher and colleagues (2012), one partner has to push a ball down a ramp and the other has to direct it down to the next level in order to release rewards to both partners.

[4] Mason & Hollis (1962); Povinelli et al. (1992a); Povinelli et al. (1992b)

After pairs are proficient at the task, they switch roles so that they now have to perform the action that their partner did during training (role-reversal). Some studies include a third phase, in which roles are returned to the original setup. The ability to reverse roles is then measured as successful transfer (i.e., no drop in performance) when first switching roles or increased performance (e.g., higher percentage correct, decreased latency, fewer trials to criterion) either compared to the first subject in that role or to their own baseline training performance. Using the communication apparatus, rhesus monkeys showed a significant drop in performance from the last training session to the first role-reversal session[5] and did not perform better in their original role after having experienced the other role.[6] Chimpanzees have been found to transfer immediately from training to role-reversal using the same apparatus,[7]

[5] Povinelli et al. (1992b)
[6] Mason & Hollis (1962)
[7] Povinelli et al. (1992a)

but did not, in a different task, outperform a partner who had completed the role previously, despite their experience with the complimentary role.[8]

[8] Fletcher et al. (2012)

What do role-reversal experiments measure?

Povinelli and colleagues (1992a; 1992b) interpreted successful performance in role-reversal experiments, i.e., the ability to profit from experiences in one role when later switching to the role their partner had performed previously, as evidence of role- or perspective-taking. They argued that successful subjects must have used social attribution to infer the mental states of their partner, which facilitated their own performance when roles were reversed; thus, successful performance is taken as evidence of a theory of mind or "a simple form of cognitive empathy".[9]

[9] Povinelli et al. (1992a)

However, others have pointed out that subjects can learn about the second role while performing the first without having to know the partner's mental states. For example, Fletcher and colleagues (2012) suggest that successful performance instead provides evidence that subjects form a single mental representation of the collaborative task by integrating their understanding of the complementary roles. It is this "bird's eye view", they argue, that then facilitates performance when the roles are reversed.

Of course, the extent to which subjects are able to understand their partner's role while completing their own is limited by their ability to learn through observation. For example, if subjects learn about and copy not the partner's precise actions (imitation, e.g., pulling the proper handle) but rather the outcome of the partner's actions (emulation, e.g., food cups delivered to both partners), then observing the partner during training may not aid performance during role-reversal. Indeed, the outcomes in these tasks were straightforward and had been demonstrated, so subjects could be successful without learning the partner's specific actions. If so, differences in ability in the experiment across species may simply reflect differences in social learning strategies.[10] In fact, emulation or imitation may not be required at all; successful performance in this task may simply be due to local enhancement effects, in which the partner's action directs the subject's attention to the relevant part of the apparatus. In such a case it might not even be necessary that the subjects understand the necessity of their partner, which would indicate that these tasks are not measuring role reversal so much as how they understand the apparatus. Indeed, understanding their partner's complementary role was not necessary for subjects to successfully complete the tasks used to date.

[10] see Tennie et al. (2009)

Finally, failure to reverse roles in this paradigm may be the result of experimental factors, many of which are common problems in comparative cognition research. One issue with the studies to date is that subjects have had vastly different rearing and testing histories (e.g., juvenile rhesus monkeys that had been separated from their mothers at birth, to chimpanzees with extensive human contact and experience with numerous cognitive experiments), which limits the extent to which we can make cross-species comparisons. This is further complicated by the small sample sizes (a common problem in animal studies) and because researchers have used different criteria for successful role reversal (see above), which may measure different aspects of cognition. Further, one might assume that in a cooperation task such as this, the subjects' relationship with the partners would influence their behavior. Indeed, partners during training include everything from reliable human experimenters to trained conspecifics to conspecifics who learn their role at the same time (and are therefore presumably much less reliably good at the task), making it difficult to disentangle the role of the subjects' knowledge and skill.

There are also methodological differences. Aside from differences in procedure, even when an identical apparatus is used, the different dimensions and test setups can make it more difficult for subjects of some species pairs to see (and therefore presumably understand) what their partner is doing. Similarly, some required actions, such as pointing, may be frequently observed in one species (such as chimpanzees) but may need to be shaped through extensive training in another (such as rhesus[11]). Actions that require extensive training may not be fully understood by the partner based solely on observation, either, because rather than just apply a known behavior the subjects must first learn the behavior and then apply it correctly.

[11] Povinelli et al. (1992a); Povinelli et al. (1992b)

Conclusion

The role-reversal paradigm offers an interesting experimental approach to studying complex forms of collaboration in which animals complete different, complementary roles to achieve a joint goal. However, there is currently little consistency in the criteria used to measure successful role reversal or agreement on what success at the task (or lack thereof) actually means. Whether subjects understand that they need a partner in the first place (e.g., will they wait for or recruit a partner?), and how their relationship with the partner (e.g., is the partner a conspecific or a human? Are only socially tolerant pairs successful?) and their rearing and testing histories affect their performance in this task have not been addressed in depth. Further, it is not even clear whether animals' behavior would change if an understanding of the partner's complementary role was necessary to complete the task successfully, because it is not known whether they can solve the task without this knowledge. Although studies using this paradigm have thus far focused on primates, a wide array of other species are known to collaborate by performing complementary roles. Thus, a comparative approach will be key in order to better understand whether and how perspective taking is required for the evolution of complex coordination.

Cross-references

- Co-operation
- Coordination
- Empathy
- Emulation
- Imitation
- Perspective-Taking
- Theory of mind

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