Female monkeys more dominant in groups with relatively more males

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Female monkeys are more dominant when they live in groups with a higher percentage of males. This is caused by self-organisation. This surprising discovery was made by researchers at the University of Groningen. What makes the study particularly interesting is that the researchers used a computer model which can simulate interaction between monkeys. Their findings will be published on July 16 in the open-access journal *PLoS ONE*.

Many animals living in groups have a social hierarchy, a so-called 'pecking order'. Monkeys, too, have a social hierarchy. Highest in the pecking order is the most dominant monkey, who consistently wins aggressive interactions (such as biting) with other group members. At the bottom of the hierarchy is the lowest-ranking monkey, who consistently loses interactions with other members of the group. Monkeys have to fight for their place in this hierarchy every day.

The position of females in the hierarchy varies among different monkey species. In most species females are ranking below the males. This is no wonder, because they are usually much smaller than males. However, in the case of the Lemur species of Madagascar the females are dominant, in bonobos, males and females roughly equal each other in dominance, and among a lot of other species (macaques and the grivet, for instance) females are weakly dominant.

"This means that the most dominant females rank above approximately a third of the males," says Charlotte Hemelrijk, theoretical biologist at the

University of Groningen and the first author of the article (which she wrote together with her former PhD student, Dr. Jan Wantia and a Swiss anthropologist, Dr. Karin Isler).

Until now, it was unknown how this female dominance develops. Researchers in Groningen therefore created a virtual world, Domworld, with which they could simulate the interactions between monkeys.

Surprisingly, the computer model predicted females to be more dominant in a group with a relatively large number of males. To verify this prediction, the researchers analyzed data of aggression of a large amount of literature in which primate behaviour is described in order to calculate for the first timefemale-dominance among many different groups and monkey species. Their analysis showed the predictions of the computer model to be accurate. "This is an interesting way of conducting research," says Hemelrijk. "You discover something unexpected in the virtual world and then you test your findings in the real world."

So why are females more dominant in groups with a higher percentage of males? Two competing theories about the development of dominance exist, explains Hemelrijk. "According to the first theory, dominance is inborn. A monkey with good genes is bigger and will therefore win aggressive interactions more easily. The second theory states that dominance develops through self-organisation. An individual monkey wins an aggressive interaction by chance. As a consequence, the monkey's self-confidence grows and it also wins other aggressive interactions. It's a self-reinforcing effect," says Hemelrijk.

If the first theory were correct, one would expect dominant females to be relatively bigger in size compared to male members of their species than less dominant females of other species. The researchers found this not to be the case. Instead, the second theory turns out to perfectly explain female dominance, as the relation between female dominance

and the percentage of males can only be found among monkey species living in groups with aggressive behaviour that is sufficiently intense and frequent.

"Male aggression is more intense than that of females. In groups with more males, males are more often defeated by other males. Consequently, high-ranking females may be victorious over these losers. Furthermore, the presence of more males in the group leads to more interactions between males and females, causing more chance winnings by females. Through a self-reinforcing effect, these females will go on to win more frequently in later interactions and grow more dominant," says Hemelrijk.

According to the researcher, the study casts new light on monkeys. "The assumption was always that the degree of female dominance over males -or male dominance over females- was static, but it turns out to be much more dynamic and complex than expected." Dominance also plays a factor of importance in human interaction, says Hemelrijk. "It would not surprise me if self-organisation would prove to play a role in the development of dominance between the sexes among human beings too."

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