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Establishment of a standardized daily behavior collection and analysis system for brain disease models of rhesus and cynomolgus monkeys and its application in autism spectrum disorder

Key words: **Monkey daily behavior ethogram; Monkey behavior collection protocol; Rhesus monkey; Cynomolgus monkey; Autism spectrum disorder (ASD)**

Research summary

- We established a standard daily behavior collection and analysis system (Fig. 1) , including behavioral data collection protocols (Fig. 2) and a monkey daily behavior ethogram (MDBE) (Table 3) for rhesus and cynomolgus monkeys, which are commonly used in model construction.

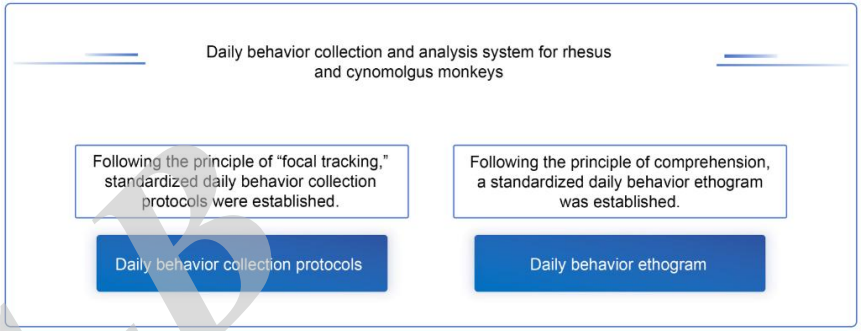


Fig. 1 Composition of daily behavior collection and analysis system for rhesus monkeys and cynomolgus monkeys



Fig. 2 Monkey daily behavioral data collection protocols

Table 3 Monkey Daily Behavior Ethogram (MDBE)

Basic behavior name	Basic behavior description	Basic behavior inclusion criteria	Index of basic behavior video clips	Composite behavior name and contents	Composite behavior definition
Walking	Moving slowly using all four limbs alternately	/	1-1	Voluntary locomotion (including walking, climbing, running, and jumping)	Target monkey initiates behavior autonomously, generating positional changes.
Climbing	Climbing along cage or crawls on ground using all four limbs	/	2-1		
Running	Moving rapidly using all four limbs alternately	/	3-1		
Jumping	Utilizing force through its hind limbs or all four limbs simultaneously to elevate its body from the ground, including vertical jumps and leaps to various locations	/	4-1		
Hanging	Hanging from cage top or side, with all four limbs off ground and no positional changes	/	5-1, 5-2	/	/
Standing	Standing on all four limbs or hind limbs without positional changes	/	6-1, 6-2	/	/
Voluntary vocalization	Making a sound in the absence of an obvious stimulus	/	7-1	/	/
Self-grooming	Using mouth, tongue, hands, and feet for self-grooming. Common forms include: 1) grooming fur with hands or feet; 2) licking fur with mouth and tongue.	/	8-1, 8-2	/	/

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Research Summary

- We established a sub-ethogram, i.e., ASD monkey core behavior ethogram (MCBE-ASD) (Table 4) for quantitative assessment of the core clinical symptoms of an ASD monkey model based on MDBE.

Table 4 Monkey Core ASD Behavior Ethogram (MCBE-ASD)

Core behavior name	Core behavior contents
Social interaction	Sexual behavior, mounting, failed mount, anogenital stimulation, grooming solicitation, social grooming, social play, aggressive behavior, submissive behavior, taking over, walking side-by-side, social contact, ventral contact, social proximity, social following, passing contact, and bumping
Stereotyped behavior	Swinging, pacing, rocking, back-flipping/body-flipping, spinning, bouncing, digit-sucking, self-grasping/clasping, and saluting
Restricted interest	Displaying unusual, focused, and narrow interest in specific objects or environments (excluding food) while lacking interest in other objects/domains

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- We demonstrated the high reproducibility (≥95%) of the system through experimental data and compared the differences in behavioral patterns among rhesus monkey individuals.

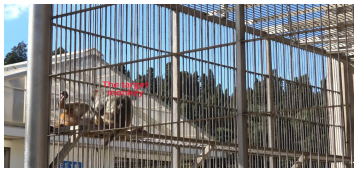
Innovation points

- **Standardization**

- MDBE covers all observable and measurable daily behaviors of rhesus and cynomolgus monkeys that we found in the literature, covering the behavioral phenotypes of monkeys housed in both single cages and social groups. These behaviors can be used in juveniles, adolescents, adults, and elderly monkeys and apply to both females and males.
- For each basic behavior, MDBE provides a clear description and inclusion criteria.

- **Hierarchical structure**
  MDBE contains a hierarchy of basic behaviors and composite behaviors, which facilitates a better under-standing and systematic analysis of the characteristics and patterns of the model monkey‘s daily behavior.

- **Visualization**
  For the basic behaviors in MDBE, 1-3 typical video clips are included as references.



Social grooming



Social play



Restricted interests



Pacing

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