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研究課題名(和文) Comparing emotional attention in humans and chimpanzees: Is the touchscreen dot probe task an effective tool?

研究課題名(英文) Comparing emotional attention in humans and chimpanzees: Is the touchscreen dot probe task an effective tool?

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研究成果の概要(和文)：本研究ではまず、ドットプローブ課題を用いてチンパンジーとヒトを対象に、感情表出顔に対する注意バイアスを調べた。その結果、両種ともに注意バイアスは見られなかった。その一方で、視覚探索課題では、チンパンジーにおいて恐怖顔に対する注意バイアスを始めて証明した。これは、視覚探索課題では、恐怖顔の妨害刺激から注意をそらすことが難しいため、より効果的に恐怖顔に対する注意バイアスを検出できたからだと考えられる。本研究の結果から、チンパンジーでみられた恐怖顔に対する注意バイアスは、認知処理過程の比較的後期に行われていることも示唆され、ヒト以外の霊長類にも共有されていることが示された。

研究成果の学術的意義や社会的意義

The project revealed that chimpanzees give attentional priority to threatening faces at a relatively later stage of processing. This suggests a bias towards threatening faces is a shared characteristic, which can be traced back to at least the last common ancestor between Old World monkeys and apes.

研究成果の概要(英文)：The dot probe task compared attentional orientation towards emotional faces in chimpanzees and humans. Both species showed no attentional bias towards threatening versus neutral faces. This suggested that the task was not so effective at measuring emotional attention. However, a visual search task provided the first demonstration of an attentional bias towards threatening faces in chimpanzees, with more efficient search for threatening than neutral face targets. This was due to greater difficulty in disengaging attention from threatening face distractors, consistent with human research. The visual search task appeared to be more effective at measuring emotional attention.

研究分野：Psychology

キーワード：Chimpanzees Humans Evolution Attentional bias Facial expression Threat Dot probe task Visual search task

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様式 C - 19、F - 19 - 1、Z - 19 (共通)

1. 研究開始当初の背景

For primates, the ability to rapidly detect and respond to danger in their environment is essential for survival. Two of the most evolutionary relevant threatening stimuli are snakes and threatening faces [1, 2]. Attentional priority is given to threatening stimuli over neutral stimuli, which is known as an ‘attentional bias’. However, the mechanisms involved in attending to threat are not fully understood.

In humans, it has been proposed that two behavioural systems have evolved to respond to fear-relevant stimuli, the *predatory defence system* and the *social submissiveness system* [3]. The predatory defence system evolved earlier in response to threat from snakes. The social submissiveness system evolved later, driven by increasing group size, in response to social threat expressed by threatening faces. The predatory defence system involves *facilitated attention*, in which attention is initially orientated towards threatening stimuli and is processed in a more *automatic* manner. The social submissiveness system involves greater *difficulty in disengaging attention* from threatening stimuli and is processed in a more *strategic* manner [4] (Fig. 1).

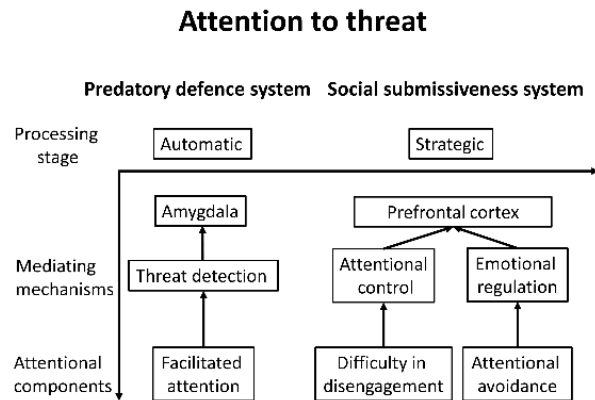


Figure 1. Possible framework of attention to threat including predatory defence and social submissiveness systems (Adapted from [3, 4]).

2. 研究の目的

The main aim of this project was to evaluate the effectiveness of the dot probe task [5] at comparing emotional attention between humans and chimpanzees. Dot probe study A aimed to compare indirect attention using a touchscreen. Dot probe study B aimed to compare direct attention using eye tracking. However, a preliminary dot probe eye tracking study with chimpanzees found no difference in initial fixation towards threatening versus neutral faces. Therefore, it was decided to pursue the touchscreen visual search task [6] as a more promising measure of emotional attention. A comparison between the dot probe task and visual search task was expected to reveal more about the mechanisms underlying emotional attention in humans and chimpanzees.

3. 研究の方法

(1) Dot probe task

Participants

Eight adult chimpanzees and fourteen adult humans participated in the study at the Primate Research Institute, Kyoto University. Human participants were tested under identical laboratory conditions as the chimpanzees.

Method

A touchscreen dot probe task was used to examine attentional bias towards threatening faces in chimpanzees and humans. In the task, two types of stimuli (threatening and non-threatening faces) were presented simultaneously a short distance apart for 150 ms. This duration is thought to be optimal for *facilitated attention* towards threat in humans and involves more *automatic* processing [7]. The stimuli then disappeared and a black dot (probe) appeared randomly in place of either the threatening face (congruent trials) or the non-threatening face (incongruent trials). It is assumed that if attention is biased towards one stimulus type, response times (RTs) to detect the dot located in the same spatial location as that stimulus type will be relatively faster.

Faster RTs to touch the dot appearing before threatening (scream and bared teeth) than non-threatening faces (neutral and scrambled) were predicted in both species and would suggest *facilitated attention* towards threat.

Statistical Analysis

Generalized Linear Mixed Model (GLMM) analyses were performed on the relationship between RTs and congruency for each stimuli pair comparison. Fixed effects were congruency and stimuli pair comparison and random effects were chimpanzee/human and session.

(2) Visual search task

Participants

Five adult chimpanzees participated in the study at the Primate Research Institute, Kyoto University.

Method

In the matching-to-sample visual search task [8] a ‘target’ face with one type of expression (threatening: scream or bared teeth) was presented on a screen amongst a set of ‘distractor’ faces featuring another type of expression (neutral) and vice versa. Homogeneous distractors featured identical faces and heterogeneous distractors featured different faces with the same expression. The task was to touch the target face on each trial. If the type of facial expression biased attention, search efficiency was expected to differ between expressions. Search efficiency was measured by recording the RTs to detect the target. Set size (the number of stimuli in a search array) consisted of three, five or eight items.

More efficient search for threatening face targets presented amongst neutral face distractors than vice versa was predicted. A *parallel search* strategy involves rapid detection of the target without focused attention on individual items (*automatic* processing). In this case, RTs were not expected to vary with increasing set size. A *serial search* strategy involves focused attention on each item in turn (*strategic* processing). In this case, RTs were expected to slow with increasing set size.

Statistical Analysis

Generalized Linear Mixed Model (GLMM) analyses were performed on the relationship between RTs and target stimuli for each set size (three, five and eight items). Fixed effects were target stimulus and set size and random effects were chimpanzee and session.

4 . 研究成果

(1) Dot probe task

Results

In both chimpanzees (**Fig. 2**) and humans (**Fig. 3**) a similar attentional bias pattern was observed, with faster RTs for threatening faces (scream and bared teeth) versus scrambled faces but not threatening faces versus neutral faces.

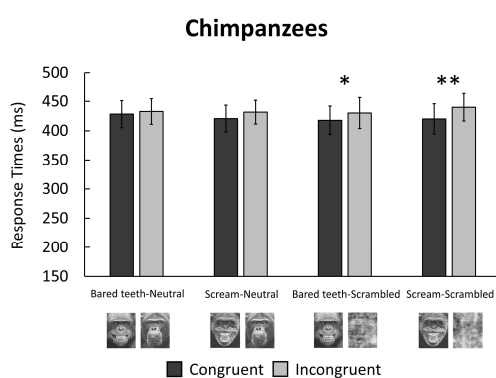


Figure 2. Mean RTs (ms) for congruent and incongruent trials. Error bars indicate the standard error of the mean (SEM). * $p < .05$; ** $p < .01$.

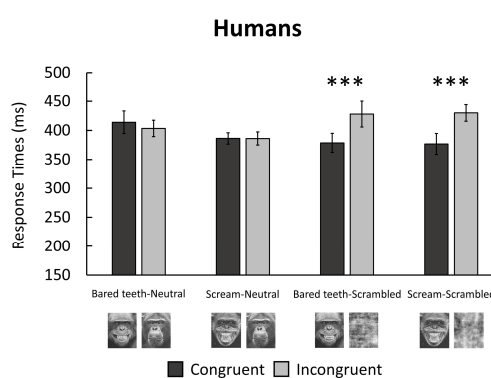


Figure 3. Mean RTs (ms) for congruent and incongruent trials. Error bars indicate the standard error of the mean (SEM). *** $p < .001$.

Discussion

The similar bias pattern observed in chimpanzees and humans indicated a general bias towards faces, rather than threatening faces specifically [9]. The lack of a bias towards threatening faces suggested that *facilitated attention* and *automatic processing* is not involved in the perception of threatening faces. These results are consistent with a recent dot probe study in chimpanzees [10]

but not with studies in bonobos and monkeys which have shown a bias towards threatening faces [11-13]. This is likely due to differences in the stimuli and presentation times used. Overall, the touchscreen dot probe task was *not* an effective measure of emotional attention in the two species.

(2) Visual search task

Results

Search was more efficient (faster RTs) for threatening face targets amongst neutral face distractors than vice versa. The effect was stronger for scream (direct threat) than bared teeth faces (indirect threat) [14] (**Fig. 4**).

Discussion

A *serial search* pattern (RTs slowed with increasing set size) indicated that the chimpanzees processed the threatening faces in a *strategic* manner. This suggested that chimpanzees had greater *difficulty in disengaging* from the threatening than neutral face distractors, leading to slower RTs to detect the neutral targets. These results are consistent with similar studies in humans [15-17]. Overall, the touchscreen visual search task *was* an effective measure of emotional attention.

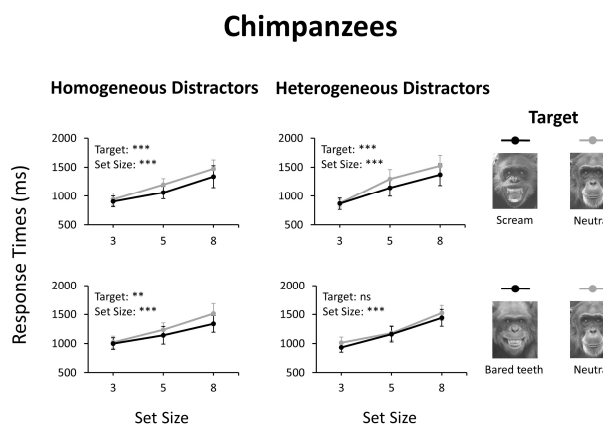


Figure 4. Mean RTs (ms) as a function of set size for each facial expression target. Error bars indicate the standard error of the mean (SEM); ns = not significant; ** $p < .01$; *** $p < .001$.

General Discussion and Conclusion

The project demonstrated (either directly or in comparison with other human studies) that humans and chimpanzees give attentional priority to emotional over neutral faces at a relatively later stage of cognitive processing [15-17]. This bias was reflected in *difficulty to disengage attention* from threatening faces (visual search task) rather than *facilitated attention* towards them (dot probe task). Together, these studies provided partial support for the evolution of a *social submissiveness system* [3] (**Fig. 5**).

In conclusion, the visual search task appeared to be more effective than the dot probe task at measuring emotional attention in the two species. The visual search study helped to bridge the current gap in knowledge between similar human [15-17] and monkey studies [18]. Overall, the project provided further support that an attentional bias towards threatening faces is a shared characteristic, which can be traced back to at least the last common ancestor between Old-World monkeys and apes.

In future studies, it would be useful to use a larger number and variety of stimuli. Also, in the dot probe task, stimuli should be presented for different durations to identify the timeline at which an attentional bias may emerge. In addition, a more diverse range of species should be tested. This would help us to understand to what extent the findings generalize across all primates.

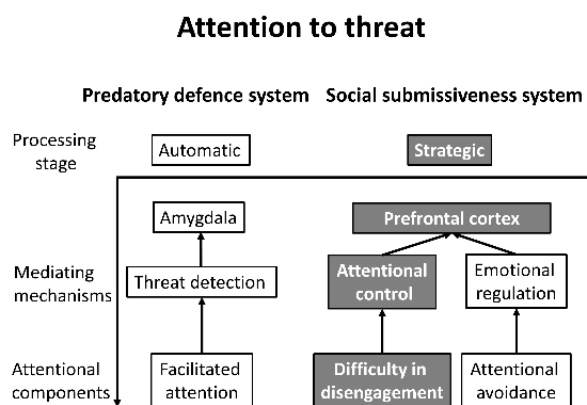


Figure 5. The main findings of the project (highlighted in grey) provide partial support for the social submissiveness system [3, 4].

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5. 主な発表論文等

〔雑誌論文〕 計1件（うち査読付論文 1件/うち国際共著 0件/うちオープンアクセス 1件）

1. 著者名 Duncan A. Wilson, Masaki Tomonaga	4. 巻 13(11)
2. 論文標題 Exploring attentional bias towards threatening faces in chimpanzees using the dot probe task	5. 発行年 2018年
3. 雑誌名 PLoS ONE	6. 最初と最後の頁 e0207378
掲載論文のDOI（デジタルオブジェクト識別子） 10.1371/journal.pone.0207378	査読の有無 有
オープンアクセス オープンアクセスとしている（また、その予定である）	国際共著 -

〔学会発表〕 計6件（うち招待講演 3件/うち国際学会 3件）

1. 発表者名 Duncan A. Wilson
2. 発表標題 Exploring attentional bias towards threatening faces in chimpanzees
3. 学会等名 Animal Welfare and Behaviour Group, University of Bristol (UK) (招待講演)
4. 発表年 2019年

1. 発表者名 Duncan A. Wilson
2. 発表標題 Exploring attentional bias towards threatening faces in chimpanzees using the dot probe task
3. 学会等名 European Federation for Primatology/Primate Society of Great Britain International Conference, Oxford (UK) (国際学会)
4. 発表年 2019年

1. 発表者名 Duncan A. Wilson
2. 発表標題 Exploring attentional bias towards emotional faces in chimpanzees using the dot probe task
3. 学会等名 53rd International Society for Applied Ethology Congress, Bergen (Norway) (国際学会)
4. 発表年 2019年

1. 発表者名 Duncan A. Wilson
2. 発表標題 Exploring attentional bias towards emotional faces in chimpanzees using the dot probe task
3. 学会等名 14th International Conference on Environmental Enrichment, Kyoto (Japan) (国際学会)
4. 発表年 2019年

1. 発表者名 Duncan A. Wilson
2. 発表標題 Evaluating the effectiveness of the dot probe task as a measure of emotional attention in chimpanzees
3. 学会等名 Centre for Behaviour and Evolution, University of Newcastle (UK) (招待講演)
4. 発表年 2018年

1. 発表者名 Duncan A. Wilson
2. 発表標題 Evaluating the effectiveness of the dot probe task as a measure of emotional attention in chimpanzees
3. 学会等名 Adaptive Behaviour Research Group, University of Sheffield (UK) (招待講演)
4. 発表年 2018年

〔図書〕 計0件

〔産業財産権〕

〔その他〕

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6. 研究組織

氏名 (ローマ字氏名) (研究者番号)	所属研究機関・部局・職 (機関番号)	備考
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