ウェブサイト公開用

（様式 10）
（海外特別研究員事業）

令和　　元年　９月　２１日

海 外 特 別 研 究 員 最 終 報 告 書

独立行政法人 日本学術振興会 理事長　殿

採 用 年 度　平成 29 年度
受 付 番 号　281
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（氏名は必ず自署すること）

海外特別研究員としての派遣期間を終了しましたので、下記のとおり報告いたします。
なお、下記及び別紙記載の内容については相違ありません。

記

1. 用務地（派遣先国名）用務地：マックスプランク鳥類学研究所　（国名：　ドイツ国　）

2. 研究課題名（和文）※研究課題名は申請時のものと違わないように記載すること。
社会的一夫一妻制鳴禽類雌雄の求愛行動から見るつがいの絆形成・維持の機能と仕組み

3. 派遣期間：平成　29 年　9 月　1 日　～　令和　元年　8 月　31 日

4. 受入機関名及び部局名
Department of Behavioural Neurobiology, Max Planck Institute for Ornithology

5. 所期の目的の遂行状況及び成果…書式任意　**書式任意（A4 判相当 3 ページ以上、英語で記入も可）**
（研究・調査実施状況及びその成果の発表・関係学会への参加状況等）
（注）「6. 研究発表」以降については様式 10－別紙 1～4 に記入の上、併せて提出すること。

Progress report and achievements

This study aims to understand how mutual multimodal courtship communication affects pair-bonding and its maintenance in socially monogamous birds. My study species, blue-capped cordon-bleus (*Uraeginthus cyanocephalus*) perform multimodal courtship display comprised of dance and song in both males and females. During these displays, they hold a piece of nesting material, then bob up and down and sing. In the past study, we discovered that their visual courtship display includes quite rapid step-dancing during bobbing. This specific "tap-dance" presumably produces non-vocal sounds and/or vibrations in addition to song (Ota et al. 2015, 2017). We have also found that this species is characterized by slight sexual dimorphisms in song traits (Geberzahn and Gahr 2011) and dance performances (Ota et al. 2015). Considering that cordon-bleus are a socially monogamous and biparental songbird, the mutual multimodal courtship display is assumed to play an important role for pair-bonding and its maintenance.

Throughout the fellowship I have mainly performed the following three experiments. (1) Behavioral analysis and brain lesion experiment to understand the production mechanisms and its functions of multimodal courtship display. (2) Vibration measurement to understand the functions and roles of vibrational signal in cordon-bleu courtship communication. (3) A fieldwork in Tanzania to observe courtship display of wild cordon-bleus.

(1) Behavioral analysis and brain lesion experiment

- Behavioral analysis

Cordon-bleus sing two types of songs. One is the song accompanied by dance display which is usually produced in paired condition. This song is called directed song because the dance display and postures usually directed to the potential partner. The other is the song without dance display. This is usually produced in isolate condition and therefore the song without dance display is called undirectd songs. Since cordon-bleu directed songs are always overlapped with non-vocal sounds by dance display, it is easily distinguished from undirected song.

To understand how cordon-bleus perform such complex courtship display, I conducted detailed behavioral analysis of song and dance. I measured the latency from the start of singing to the start of first bobbing (bobbing latency) and test if they coordinate song and dance, and if there are individual differences. I also compared song traits between directed and undirected songs to examine the effect of dance display on song structures.

As a result, I found that there were significant individual differences on bobbing latency (fig. 1). It indicates that each cordon-bleu coordinates dance with song and has own timings for starting dance display while singing.

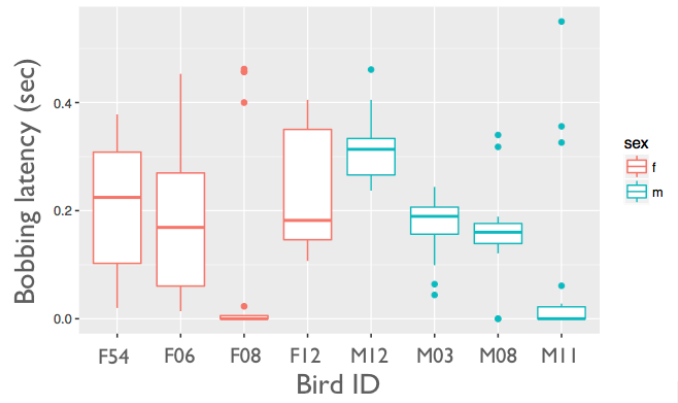

Fig. 1. Individual differences of bobbing latency.

I also revealed differences in acoustic structures between directed and undirected songs (Fig. 2). Directed song duration was longer and the tempo was faster than undirected songs. I also found that sequence linearity of directed song was lower than undirected song. It indicates that directed songs are more stereotyped than undirected songs.

These results were presented at the conference (IBAC 2019, Brighton, UK).

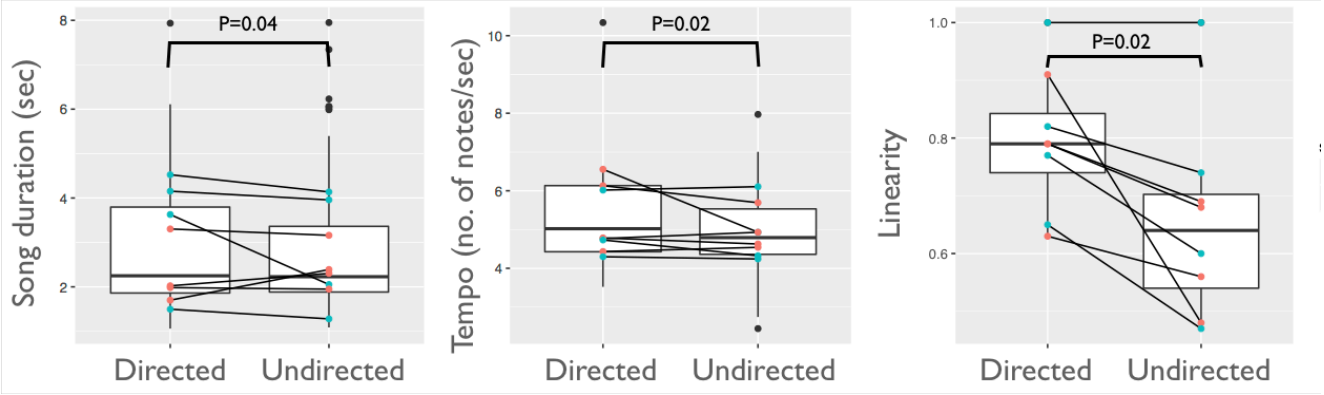

Fig. 2. Comparison of dance duration, song tempo, sequence linearity between directed and undirected songs. Mean individual values (red: females, blue: males) and their within-individual changes are indicated.

- Brain lesion experiment

Based on the results of behavioral analysis (1), I have investigated the effect of brain lesion on cordon-bleu courtship display. I focused on HVC nuclei which is known to play an important role for song production and controlling the temporal structure of song. Although many studies have investigated the role of HVC in singing behavior, the relationship between HVC and dance display has been overlooked. Therefore in this experiment I focused on the effects of HVC lesion on both dance and song display and its coordination.

I found that song structures clearly changed after HVC lesion: they lost distinct syllables and song tempo got unstable (Fig. 3a). This result is quite similar to past songbird studies. In contrast, tap-dancing display was still observed. Bobbing latency got decreased after HVC lesion (Fig. 3b) and HVC lesioned bird lost specific timing for starting bobbing in song (Fig. 3c). However, there were no significant differences in dance performances (i.e., bobbing speed and number of taps in one bobbing) between before and after HVC lesion.

These results were presented at the conference (IOC 2018, Vancouver, Canada)

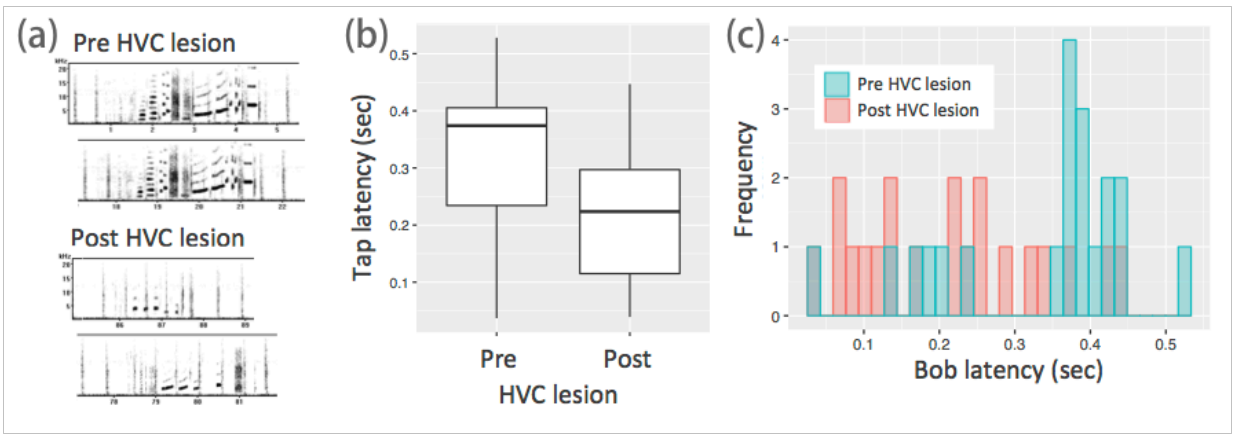

Fig. 3. (a) Spectrograms of cordon-bleu song before and after HVC lesion. (b) Box plot compares tap latency before and after HVC lesion. (c) Histogram of bobbing latency. Blue indicates before HVC lesion and red indicates after HVC lesion.

(2) Vibration Measurement

Cordon-bleus' courtship display can produce vibrations via perch in addition to visual and non-vocal acoustic signals. I previously found that they intensify their dance performances (i.e., the number of steps in one bobbing, Ota et al. 2015) when their mate stayed on the same perch, which suggests that they use vibrational signals via perch in the context of sexual communication. To understand the role of vibrations in cordon-bleu courtship display, I quantified the vibrations using accelerometers attached under the perch (Fig. 4). I found that the vibration amplitude positively correlates with the number of steps in one bobbing (Fig. 5). It implies that cordon-bleus use vibrational signals to convey their motivation and quality to potential mates. Using multiple modalities during courtship display might be useful for effective communication and can lead to reproductive success.

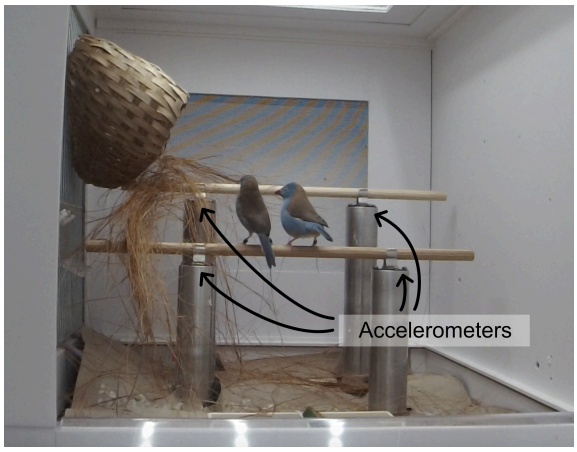

Fig. 4. Recording box conditions. Accelerometers were equipped under branches.

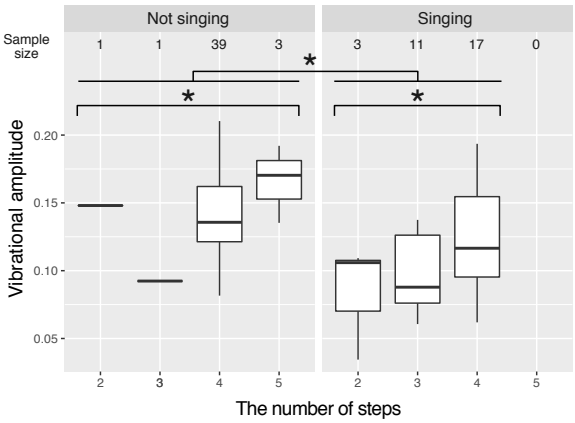

Fig. 4. Effects of the number of steps on vibrational amplitude either while not singing (left) or during singing (right).

These results were presented at the conference (Biotremology 2019, Riva del Garda, Italy).

(3) Fieldwork in Tanzania

Since signal efficacy is often affected by surrounding environments, knowing wild environments is important for understanding animal communication systems. My previous findings of cordon-bleus are based on experiments using captive birds, so that their wild behavior is still veiled in mystery. In this study, I conducted behavioral observations of cordon-bleus courtship display in Tanzania (Fig. 6). I succeeded in recording the courtship display of wild cordon-bleus and found that wild cordon-bleus also perform tap-dance like display as well as captive birds. They usually performed the dance display on thin branches of acacia trees, and held either a piece of grass or feather. It means that our previous findings using captive birds are not an artifact and multimodal signals are efficient in cordon-bleu courtship communication under fluctuating wild environments.

Fig. 6. A photo of a wild male blue-capped cordon-bleu.

These results were presented at the conference (ABS 2019, Chicago, US).