This is the first of three annual reports for ***Bee-ing Human***, covering 2022/23. It includes an update on two work packages (WP1 and WP2). The WP1 update also includes an account of the design of the Digital Bee Book, the output for the whole project, which is determining how we are creating a born digital edition of Charles Butler. WP3 – 'Sound Experiments', led by Bennett Hogg – is at planning stage, including a collaboration with Cheeseburn; we will report on this next year. Please note that we held one international Advisory Board in 2023; we will now hold one each semester going forward. At our first meeting we shared an update on the project, and discussed how to draw on the combined expertise of our multidisciplinary (arts, humanities, animal science) and international board.

Contents

(1) WP1: Voices and Bees (born-digital edition)
(2) WP2: Bee Emotions (work in the laboratory)
(3) Working together

(1) WP1

The technical set-up of the project was divided into three phases: 1) Tiago Sousa Garcia set up the transcription workflow to facilitate the transition into encoding using the standard for digital textual editing (the Text Encoding Initiative Guidelines); 2) He explored and made decisions about the technical infrastructure supporting and powering the Digital Bee Book; 3) He implemented a minimum viable product of the Bee book.

Olivia Smith has now transcribed the 1609 and 1623 editions into a custom-modified markdown syntax, which will allow for an easy conversion into the TEI standard at the start of year 2 (September 2023). Tiago also organised a 2-day introduction to TEI workshop (attended by Jennifer Richards and Olivia, and open to other members of the faculty), in collaboration with advisory board member James Cummings. While Olivia was transcribing, Tiago explored multiple infrastructural options to support and power the Digital Bee Book. There were a series of requirements that guided his exploration and ultimate choice: the Digital Bee Book needs to be as lightweight and accessible as possible (in terms of hardware required by the end-user); potential hosting costs need to be kept to a minimum to ensure longevity, and data should be separated from its design to ensure that it can be easily deposited and will be accessible to other researchers. Tiago has decided to use static pages with additional user interaction provided through a minimal, lightweight Javascript framework (Svelte), with hosting provided by Github pages which is, currently, free. This decision has meant that Tiago has been able to create a minimum viable project of the Digital Bee Book. This currently ignores any design decisions and focuses solely on implementing the main concept of the book: the option to approach it through four different views (literature, music, science, and connections) which will shift and alter the content of the book to better suit user choice. For each of these views, Tiago has developed and implemented a flagship feature: for the literature view, the transformation of the TEI file into displayable and navigable data; for the music view, the display and playback of binaural recordings and encoded historical music; for the science view the visualisation and exploration of the raw data; and for the connections view a system to display and filter buzzwords (these are thoughts brought about by conversations among the team).

The first edition (1609) includes musical transcriptions of bee piping in the form of relatively simple woodcuts in black notation. This was transformed and greatly expanded in the second edition (1623), where the original 'bee song' was framed by a pair of new polyphonic, texted, strophic songs, in different modes and metres from each other: 'As of all states' and 'But all this while'. The combined song, *Melissomelos*, is disposed across two openings of the book, laid out in table-book format, with

one pair of voices orientated at 180-degrees to the other pair. The *Melissomelos* of 1623 is both a broadly naturalistic rendering *of* observed bee song and a densely allusive commentary *about* bees.

Magnus Williamson has now completed an initial transcription. Butler's proportional notation, misunderstood by the earliest editors, has been re-investigated in the light of his own *Principles of Music* (1636). This provides good *prima facie* evidence for the relative tempi of the different sections of *Melissomelos*. All readily-available surrogates have been consulted in order to resolve ambiguities in the typesetting of both 1623 and 1634 editions (such as placement and values of rests, and a small contrapuntal adjustment made by Butler to his Contratenor part). This initial transcription was then workshopped with, and recorded by the collaborators Ensemble Pro Victoria (London, spring 2023). In this process he identified numerous questions to be addressed in the next phase of research:

- Resolving ambiguous word underlay: the musical phrase lengths do not always correspond with the quantities and syllable counts of Butler's textual stanzas.
- Accentuation and pronunciation.
- Rendering of untexted (naturalistic) sections of *Melissomelos*: if sung, should these sections be sung to generic vowel(s), to a hum, using early-modern solmization syllables (ut-re-mi etc.), or rendered on an instrument? Each format raises questions around sonority, the number of participants, and the experience (and reception) of *Melissomelos* as a sound artefact. This song is of a different character, and serves a different purpose, from other Renaissance songs that incorporate animal noises.

Historical/contextual research

Magnus has also started to explore Charles Butler's training as a young musician. Butler is almost unique in leaving abundant traces of his music-theoretical knowledge but only meagre evidence of his competence as a practical musician. He received some musical education as a chapel clerk at Magdalen College, Oxford. In 2023/24, a parallel documentary investigation will consider Butler's later career in Hampshire, particularly his role as teacher at the Holy Ghost School, Basingstoke. Current writing on Butler does not appear to have explored his potential relationship with the Sandys family, whose mausoleum had been in the Holy Ghost chapel, and who continued to live (and worship) at The Vyne. Given the relative paucity of Butler's ecclesiastical benefices, the possibility of Sandys patronage needs to be considered and ruled in or out; this is a line of enquiry that Magnus will be pursue in 2024.

We now have a complete translation of Butler's *Rhetorica*; this will aid cross-literary/music analysis in 2023/24.

In 2023/24 Tiago will start a process of iterative design, which we will allow us to think about the usability, adaptiveness, and attractiveness of the Digital Bee Book. Jennifer will start the bibliographical description of the three editions, and the collation of copies, supported by Olivia, while, from September, Olivia will also start the process of encoding the literary text and collating the three editions (1609, 1623 and the phonetic edition of 1634, for which we have photographs), enabling us to understand the evolution of Butler's thinking, including as much data as possible in the encoded text for reusability and functionality; this will be helped by the group readings we are planning for 2023/24 (see 'Working Together'). To address the music questions above, Magnus is planning a series of workshops involving advisory board members, the full team and Ensemble Pro Victoria in February 2024. Finally, Tiago will develop the first of several 'experiences': small experimental approaches to the data and the research made by the time. Tiago's first planned experience will be a game-like application that will allow users to experience the training of bees in Vivek Nityananda's and Balumurali G.S.'s lab.

(2) WP2

Judgement bias tasks are an important experimental approach used to test for emotion-like states in non-human animals. Animals are trained to approach one stimulus expecting a reward and reject another stimulus that has no reward or associated with a punishment. They are than offered an ambiguous stimulus, midway between the two trained stimuli, to see how they respond. Animals that treat these ambiguous stimuli similarly to the rewarding stimuli are said to show optimistic biases. Those that treat these stimuli similarly to the non-rewarding stimuli are said to show pessimistic biases. These biases are thought to reflect internal affect states and have been compared to emotion-like states in other vertebrates when studied in a comparative cognitive framework. Judgement bias tasks have also been used in insects to study cognitive biases. These studies required bees to distinguish between rewarding and nonrewarding stimuli. That means that their behaviour could be explained by other factors not related to their judgement of ambiguity. These factors include the level of motivation to respond and the level of attention to a stimulus. Previous work from our lab developed a version of the task for bumblebees that removes these confounds. In this version of the task, both stimuli are rewarding but one is more rewarding than the other. The rewards are provided at different locations and the bee must actively choose which location it needs to approach. This active choice judgement bias task has also shown that shaken bumblebees do exhibit pessimistic biases in a visual task. However, the function of the states underlying the biases and whether these states are transmitted from one individual to another, as demonstrated in vertebrates has not been explored in invertebrates.

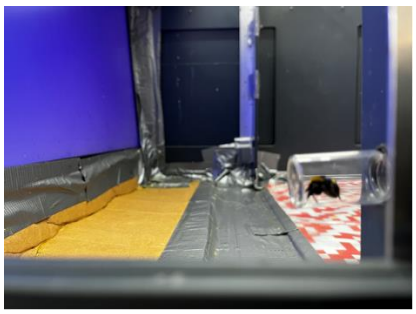

Figure 1. A bee foraging from one of the rewarding locations. Here the location is associated with one of the training colours (blue). The other location is associated with green colour and higher reward levels for this particular bee.

Vivek Nityananda's and Balu G. S.'s experiments in 2022/23 explored whether stress-induced negative affect states are transmitted from one individual to another in bumblebees through close interaction, akin to emotional contagion in birds and mammals. They explored whether bees who do not undergo stress inducing treatments (shaking, pinching etc.) exhibit pessimistic judgement biases towards ambiguous stimuli, after interacting with a stressed bee. They found that non-stressed bees did not exhibit any pessimistic biases after interacting with stressed bees suggesting that these states are non-transmissible (Fig. 2A). Surprisingly, when subjected to a different stress inducing treatment which mimics predator attack more naturally - pinching with forceps - most of the bees tested exhibited optimistic biases towards ambiguous stimuli. This was not significantly different from the optimistic choices made by non-stressed bees (Fig. 2B). Their results suggest the internal states that result from stress are highly dependent on the type of stress and that cognitive biases are non-transmissible in bumblebees.

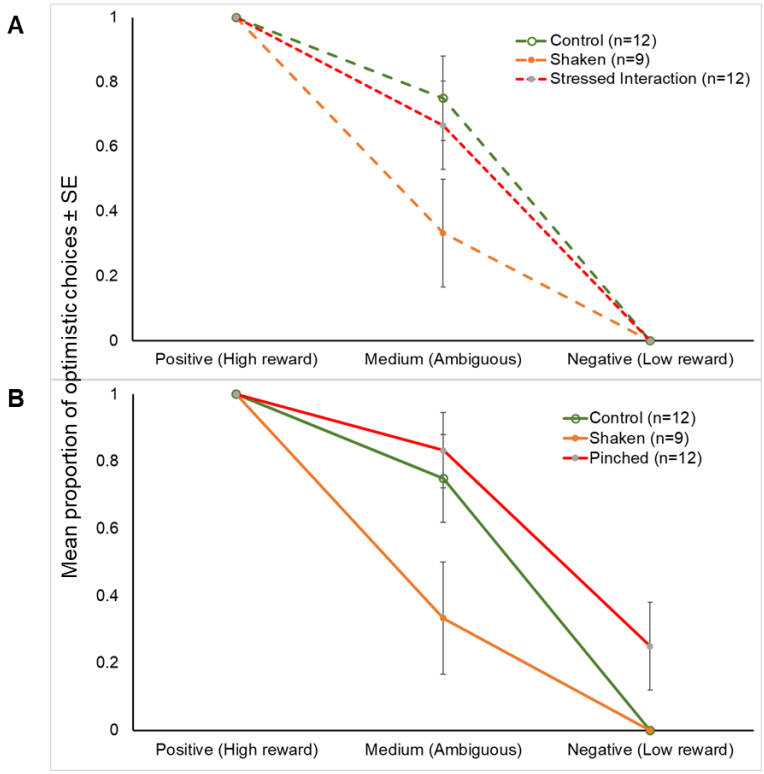

Fig. 2. Proportion of optimistic choices made by A) control, shaken and bees interacted with shaken bees and B) control, shaken and pinched bees in tests. Error bars represent the standard error of means.

In 2023-24, Balu and Vivek will first complete the control experiments looking at emotional contagion in bees. They will then begin investigating two further aspects of emotion-like states in bees. The first is how these states affect spontaneous preferences for flower colours in bees. The second will look at how these states affect reward consumption in bees.

(3) Working Together

Bee-ing Human is greater than the sum of its parts, and in 2022/23 we gave careful thought to how we should work together, co-creating our Digital Bee Book. We have used several methods, including describing each other's work at a public workshop: Transdisciplinary Peer Research Exchange. In July we hosted a workshop with artists, humanists and animal scientists to understand barriers to cross-faculty collaboration – with language emerging as the area for us to focus on in 2023/24. Vivek and Balu invited the full team to join them in the lab to see their experiments. Crucial to our collaboration are our monthly in-person meetings, at which we 'show and tell', and discuss key studies (e.g. Terence Cave, *Live Artefacts*, and Solvi and Baciadonna, 'Studying emotion in invertebrates', 2017). The team keep a collective diary, which we fill in following each meeting. In 2023/4 we will be reading Olivia's transcriptions of Butler's 1609 and 1623 editions; this will give us a shared knowledge base, further our interdisciplinary conversation, and help Olivia with the encoding.

Jennifer Richards 31/08/23