A Comparison of Simulated Recording Methods for Behavioural Observations

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Original Research paper

**Running title:** Comparison of behavioural recording methods

**Abstract:**

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**INTRODUCTION**

The measurement of behaviour has become a major area of scientific study for those involved in the animal industry. Behavioural studies are used as a tool to measure captive animal welfare, and are used more often than other welfare indicators such as glucocorticoid analysis (Fraser, 2009; Sands & Creel, 2004). For captive animals, behavioural research may also be used to investigate the prevalence of positive behaviours or stereotypy, or identify possible sources of stress (Ward, Sherwen & Clark, 2018). Studies of behaviour are also frequently conducted for wild animal populations, in order to better understand natural history or investigate the impact of human disturbance (Sand & Creel, 2004). Research on animal behaviour is now so well recognised that there are several journals dedicated to its study: *Animal Behaviour* and *Applied Animal Behaviour Science* are examples.

The methods used in animal behaviour research can be traced back to human studies. Scientists during the mid-twentieth Century often used a mixture of both human and animal models in order to answer questions in the fields of both behaviour and psychology. Based on the range of different techniques that were generated by earlier studies, Altmann (1974) summarised the behavioural research methods available. This paper became fundamentally important to those interested in behavioural research, and remains a keystone paper for researchers, with at least 15,000 citations, according to a recent search on Google Scholar. Whilst other authors, such as Martin and Bateson (2007) further refined the behavioural methods and their definitions, Altmann’s work is still regularly cited.

Since this initial review of behavioural methods, some behavioural sampling techniques became increasingly popular in animal literature, whereas others are rarely used. Several behaviour measurement techniques have received some criticism in terms of their repeatability (Bernstein, 1991). For example, ad libitum sampling may be useful for developing ethograms and for pilot studies, but has methodological flaws with regards to its lack of standardisation (Martin & Bateson, 2007; Rhine & Ender, 1983). However, ad libitum sampling is still used in animal behaviour literature, with a review by Mann (1999) identifying that between 53% and 59% of cetacean studies published in *Marine Mammal Science* used this sampling technique.

The use of pinpoint sampling, sometimes also as instantaneous sampling, is a commonly used method for observational study (Fernandez, Kinley & Timberlake, 2019; Stevens et al., 2013). The benefits of instantaneous sampling are that it is less intensive than continuous sampling, and therefore may be more feasible for researchers to conduct (Grenier et al., 1999; Martin & Bateson, 2007; Rhine & Flanigon, 1978). The methods are also a little more versatile, allowing researchers to make decisions as to how long intervals should be spaced. For example, some researchers might choose to use 15-second intervals, particularly when studying an active animal or when conducting observations of a key time period, such as when enrichment is provided (Fernandez & Timberlake, 2019). On the other hand, observers might choose to use much longer intervals, such as one, two or five minute intervals when their subjects are inactive or if they are observing for long time periods (Shora, Myhill & Brereton, 2020; Teixeira et al., 2017). It has been noted by some authors that shorter intervals tend to result in behavioural values that match more closely the continuous behaviour scores (Pullins et al., 2017).

One-zero or interval sampling, by contrast, seems to receive less representation in terms of behavioural research, and has been criticised in previous research (Altmann, 1974; Rhine & Flanigon, 1978). However, one-zero sampling has some of the same benefits of instantaneous sampling, in that interval length can be tailored in line with the requirements of the study. Additionally, one-zero sampling may actually gather more information than instantaneous sampling, as behaviours will be recorded as present regardless of when they occurred within a specified interval (Altmann, 1974). Leger (1977), for example, identified good agreement with continuous behaviour measures when using one-zero sampling at 15-second intervals for chimpanzees (*Pan troglodytes)*. This behavioural measure has also been frequently used in studies on human behaviour, for example in the classroom (Dunkerton, 1981; Omark et al., 1976).

Continuous recording is considered to be the gold standard for behaviour sampling, as this method records all occurrences of behaviour and their durations (Hämäläinen et al., 2016). In the past, this made continuous recording challenging for researchers, as an active animal that rapidly changed behaviour would have been difficult to gather representative data for (Tyler, 1979). Similarly the recording of multiple animals using a continuous method would have been incredibly difficult to conduct accurately (Altmann, 1974; Martin & Bateson, 2007). Use of modern technology has in part ameliorated some of these issues by allowing behaviour to be recorded and analysed later (Amato et al., 2013). However, continuous recording may remain challenging, even with camera availability. Both one-zero and instantaneous sampling overcome some of the issues associated with continuous recording by reducing the amount of input required by the researcher, while still aiming to keep the sample representative of the animal’s behavioural repertoire (Mitlöhner et al., 2001; Simpson & Simpson, 1977). However, one key question that must be considered is how closely do these techniques actually correlate with continuous recording.

Instantaneous sampling has a tendency to lose information in terms of behaviour duration and is unlikely to pick up any behaviours of short duration (events) (Martin & Bateson, 2007; Xiao et al., 2005). By contrast, one-zero sampling is better at recording all observable behaviours, but both behavioural frequency and duration could be easily misrepresented: there is no way to identify whether a behaviour recorded as present for one interval was seen once or thirty times during that time period (Saibaba et al., 1996).

Clearly, there is no single recording technique that can be used for all behavioural research: continuous sampling might be quite feasible for inactive animals yet would be implausible for active animals such as callitrichids. Both study techniques and interval lengths should be therefore tailored to best suit the species and circumstances of study (Hämäläinen et al., 2016). However, there appear to be relatively few comparisons of behavioural methods and interval lengths and their deviance from the continuous method data (Martin & Bateson, 2007). Such comparisons would be useful for researchers when choosing suitable recording techniques for their own studies, or when determining how much their own findings might deviate from their subjects’ actual behaviour.

**METHODS**

The aim of this study is to compare commonly used methods of behavioural data collection to the gold standard, continuous recording. Two different measures were selected for this study: these were one-zero sampling, and pinpoint (instantaneous) sampling. Both measures were set at three different interval lengths, which were of 15-second, 30-second and 60-second durations. This resulted in a total of six different measures being produced and compared to the contrived, continuous data sets.

Two different studies were developed, both of which used contrived data sets. The two studies focused on behavioural frequency and duration respectively.

***Behavioural frequency***

This study focused on the recording of event behaviours: behaviours of very short duration (Martin & Bateson, 2007). For the purpose of the simulation, the duration of all event behaviours was set to exactly one second. Next, three different frequencies of event behaviour were selected: these consisted of frequent (occurs after 2 seconds), moderate (occurs once every ten seconds) and infrequent (occurs every 30 seconds). Simulated data was developed for each of the three behavioural frequencies. These simulated data sets were 1 hour in length (3600 seconds). A randomisation programme was used to select times for behaviours to be included in the simulation.

Both instantaneous and one-zero sampling were used at the three different interval lengths on the contrived data sets. The output from these measures were converted into percentages and then used to compare against the percentage occurrence from the continuous recording technique.

***Behavioural duration***

This simulation was developed for state behaviours, which may be of some length. Three levels of behavioural duration were selected there were short (1 second), medium (5 seconds) and long (30 seconds). The observation period was set to one hour in length (3600 seconds). During each minute, each behavioural duration was set to occur at least once. A random number generator was used to determine where ach behavioural duration would occur.

Each of the three behaviours was measured using one-zero and instantaneous sampling at the three interval lengths. Correlations were made against the contrived, continuous behaviour.

**RESULTS**

**From Simon Tuke to Everyone: 01:14 AM**

**https://r4ds.had.co.nz/**

**From Simon Tuke to Everyone: 01:39 AM**

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**DISCUSSION**

**CONCLUSIONS**

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