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COMPARISON OF TWO FIELD DATA COLLECTION METHODS IN RECORDING AVIAN BEHAVIOR

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Abstract—Animal behavior research relies on the accuracy, amount, and detail of data that can be collected while observing the animals in natural or experimental scenarios. This study provides a quantitative evaluation of a new electronic methodology in the study of animal behavior, as applied to field observations on birds. We compared quantitative data collected via the digital application WhatISee to data collected via pen-and-paper, testing for differences in several behvioral variables. We predicted that, compared to the traditional pen-and-paper method, the digital method would allow focal birds to be followed for longer periods before disappearing out of sight and would capture larger numbers of rapid, short duration avian behaviors. We also tested the digital method's ability to detect inter-specific and inter-sexual differences in behavior. The results showed no significant differences between the data collection methods on the specific avian behaviors observed, suggesting that the digital application is equally effective for recording animal behavior in the field, compared to the traditional method. Critically, the data collected with the application were sensitive enough to detect species-specific differences in behavioral patterns among American Robins (*Turdus migratorius*), Common Grackles (*Quiscalus quiscula*), and European Starlings (*Sturnus vulgaris*), as well as sex-specific differences in House Sparrows (*Passer domesticus*), satisfying an essential requirement for this new approach to studying and comparing multiple species in future research on avian behavior.

When performing any type of research, the method of data collection influences the outcome of obtaining, transferring, and storing accurate data (Martin and Bateson 2009). Two commonly used methods of data collection are writing down the data with pen-and-paper or by pressing keys on a handheld computer (Fletcher et al. 2003). Both methods offer benefits and drawbacks, and researchers must choose the method most appropriate for their study.

Using paper-and-pencil is a simple, cheap, and flexible way to record data (Martin and Bateson 2009). Having data readily visible on paper may offer researchers the advantage of viewing information at a glance and being able to notice or consider comments denoting additional details or correcting errors made during data collection. However, recording behavioral data with pencil or pen-and-paper could hinder an observation session if looking away while writing causes the researcher to miss a behavior or, perhaps more critically when studying wild animals, to lose sight of the subject individual.

Collecting data using a handheld recorder enables the researcher to enter information more quickly by pressing only a few keys on the device instead of writing down large amounts of different types of data (Bass et al. 2007; Martin and Bateson 2009). In addition, electronic recorders usually organize data in a manner that can be transferred directly to a computer spreadsheet, minimizing human error from transferring the data (Fletcher et al. 2003; Gravlee et al. 2006; Martin and Bateson 2009).

One disadvantage of electronic handheld recorders is that it is possible for users to make a mistake by accidentally pressing the wrong key (Koster 2006; Bass et al. 2007). In turn, if the data collected are not displayed immediately, it may then be difficult to annotate, edit, or correct the data once they have been entered (Ice 2004). Other limitations of using electronic data loggers are that they can be costly (Johannes et al. 2000; Gravlee 2002; Bass et al. 2007), may require many hours for users to familiarize themselves with the software (Gravlee et al. 2006), and usually require the batteries to be recharged periodically (Gravlee 2002; Ice 2004; Bass et al. 2007).

Handheld digital recorders have been used successfully to collect data for studies as diverse as human family research (Bass et al. 2007), education (Tallett et al. 2008), and medical care (Kho et al. 2006; Granholm et al. 2008), as well as on different aspects of animal behavior (Liebenberg et al. 1999; Pascoe et al. 2000). Previous studies examining both methods have found handheld electronic data loggers to be more accurate (Tapp et al. 2006; Ludwig and Goomas 2007) and to have less missing data (Vivoda and Eby 2006; Jaspan et al. 2007) than pen-and-paper methods. In addition, many users preferred using the electronic data loggers than paper (Fletcher et al. 2003; Jaspan et al. 2006).

In our study, we examined whether a new digital application for logging data performs at the same, better, or worse level at recording the same types of animal behavior data in the field, using equivalent distances and observation times compared to the same types of observations recorded on paper. Our research comprises two Case Studies of wild bird behavior in the parks of New York City, USA. The first Case Study consists of two series of Observations. In Observation 1, two people simultaneously observed the same individual American Robins and recorded their behaviors, each researcher using a different data logging method, to allow comparisons of the different methods from the same subjects.

In Observation 2, we observed European Starlings and Common Grackles using the digital application and compared the durations of observations before the subject disappeared from sight (hereafter: observation duration) and these species' most common behaviors with those recorded by the digital application earlier for robins. This approach allowed us to determine if the digital method was sensitive to detect potentially biologically meaningful interspecific differences in animal behavior.

In Case Study 2 (hereafter: Observation 3), one person observed House Sparrows and alternated between the digital recording method and the paper method for different individuals, to compare quantitatively the data from the digital application to data from the paper method within the same species. These data also allowed for quantitative intraspecific comparisons to assess whether the digital method could detect biologically meaningful differences in behavior between the two sexes of this species (Nowicki and Searcy 2004).

This combination of personnel, temporal, and technical approaches allowed us to compare the two data recording methodologies across subject individuals of the same species and to assess the utility of the digital application in detecting species- and sex-specific differences in avian behavior. We specifically predicted that the electronic data logger would record longer observation durations than recording data on paper because the digital application would allow users to maintain a continuous visual contact with the subject bird without having to look away repeatedly to record data, as is necessary with the paper method. We also predicted that the digital application would be suitable to detect possible behavioral differences both within and between species.

METHODS AND MATERIALS

Study sites and species

We observed wild, free ranging urban birds that were unbanded or otherwise unmarked for individual identification. To reduce pseudoreplication, we walked between consecutive observation sessions at least 10 paces away from the site of the prior observation to reduce the likelihood of repeated observations of the same individuals.

We observed 74 American Robins, 15 in the grounds of the Bronx Zoo (New York, NY, USA, 40° 85' N, 73°87' W) and 59 in Central Park (New York, NY, USA, 40° 77' N, 73°97' W). We also observed 16 European Starlings, 1 at the Bronx Zoo and 15 in Central Park. In addition, we observed 15 Common Grackles, 1 at the Bronx Zoo and 14 at Central Park. Finally, we observed 80 House Sparrows, 32 in Central Park (40°77' N, 73°97' W), 42 in McCarren Park, Brooklyn (40°72' N, 73°95' W), and 6 in St. Vartan Park, in Manhattan (40°74' N, 73°97' W). All of these species are found in urban areas and parks and forage on the ground for invertebrates (Cabe 1993; Peer and Bollinger 1997; Sallabanks and James 1999; Lowther and Cink 2006). Robins, starlings, and grackles also forage in trees for fruit (Cabe 1993; Peer & Bollinger, 1997 Vanderhoff and Eason, 2007).

Defining Behavioral Categories

To identify and define the avian behaviors to include in the data recording sessions for Observations 1 and 2, the first author (CH) observed unmarked robins, starlings, and grackles for a total of 2 hours and attempted to record on paper every behavior in which they engaged. These behaviors included walk; probe; eat; adjust feathers/preen; stationary, look ahead; stationary, look to the side; stationary, look around; fly; vocalize; tail flip; drink; approach conspecific; respond to bird call; displaced by human; displace another bird; look at another bird; scratch; wing flap; displaced by bird; display feathers; bathe. We also included site categories for four different locations in order to describe where the bird was located during the observations (e.g., ground, tree, fence, other object). The following behaviors were not observed during any of the Observations and therefore were not analyzed: Displaced by bird, wing flap, displace another bird, and approach conspecific.

A catalogue of species-typical behaviors and their definitions (Peters et al. 2005) was generated for Observation 3 by adapting the previously developed template to the House Sparrow. A simplified ethogram was then used for the latter species, with behavioral types including looking around; fly/jump; walk/hop; vocalize; and other.

Data Collection

The electronic data logger selected for this study was a recently developed application named "WhatISee." (© Timothy Heuser, 2009) (hereafter: App or application). At the time of this research (2009-2010), the application was available for both iPhones and iPod Touch devices (™ Apple Inc.) for commercially priced download through the iTunes internet store.

The "WhatISee" App is based on a customizable home screen which contains five rows and five columns of generically labeled touch fields, which can be renamed by the user and organized into an extensive ethogram for a single individual subject observed (Fig. 1) or into specific rows and columns of behaviors and subject identities (for multiple, identifiable individuals, or different species).

At the onset of an observation session, the location of the observation site (latitude and longitude) is automatically recorded. The application has a timer and alert intervals can be set by the user so that at each interval, the device would either produce a beeping noise or, for the iPhone, vibrate, or do both.

Once the user presses a field, which corresponds to a certain behavior, the time and the label information pertaining to that behavior is stored in a spreadsheet format within the application. During or after the observation session is complete the user can view and edit the data. Next, the user can send the data as a text file attachment to an e-mail account, either using data-access through the cell phone service provider for the iPhone or through WiFi access points for both the iPhone and the iPod Touch.

Digital Method. For Observations 1 and 2, of robins, and of robins, starlings and grackles, respectively, we coded each of the twenty five squares of the WhatISee App to correspond to one behavior. During Observation 3 of house sparrows, the observer (always the second author SW) used the modified ethogram and the same WhatISee App.

Figure 1. A generic representation of the default App screens. The e-mail address, file names, and behavioral and subject categories can all be edited to customize the recording session.

Paper Method. For Observations 1 and 2, the pen-and-paper method of data collection was carried out by writing the names of the specific behaviors on a sheet of lined notebook paper, which was later transferred to a data sheet. The observer's name, species name, location of observation, observer distance from bird, date, and time were all noted. The starting location and initial behavior of the bird were also recorded. The data sheet contained blank lines corresponding to each of the 10 s instantaneous sample scans (see procedure) and we held a list of the behaviors on a separate sheet of paper for reference. For Observation 3, an ethogram was generated in the form of a checklist. Each row corresponded to a 30 s interval, and the behaviors were checked off as they occurred.

Procedure

For both Observations 1 and 2, we used instantaneous sampling (Engel 1996) at 10 s intervals between sample points. The sampling interval on 10 s was chosen in order to give us a more accurate measurement of behavioral bouts (Martin and Bateson 2009). Observations were terminated when the bird flew away or if the observer lost sight of the bird.

During Observation 1, two observers (CH and a research assistant) worked together. Both watched the same individual robin while each observer used a different data logger to record the observations. After analyzing data from a preliminary set of observations of robins done by CH, we had determined that the majority of observations lasted 90 s or less. Therefore, we only attempted to observe the robins for 90 s during Observation 1. The observer using the App set the timer to vibrate at 10 s intervals. The observer recording on paper used a digital watch as a timer. The assignment of the recording method to each observer was done on a random basis.

During Observation 2, one observer (CH) recorded the behaviors of several individual robins, starlings, and grackles with only the App. We used the same recording procedure and ethogram as in Observation 1. These sets of observations allowed us to ascertain whether the electronic data logger was sensitive enough to consistently record and assess possible differences in behavior between these three avian species. The birds' behaviors were recorded for up to 5 minutes in order to record a wide range of behaviors. We did not record the sex of robins, grackles, and starlings for Observations 1 and 2.

Observation 3 involved recording the behaviors of House Sparrows. The sex of subjects was determined based on plumage traits; male sparrows can be identified by a black patch on the throat, referred to as a "badge" (Moller 1988). The sex of subjects was recorded in order to assess the potential differences in behavior between the sexes associated with the approaching breeding season, such as greater rates of vocal displays by breeding males to initiate courtship (Nowicki and Searcy 2004). However, neither age nor breeding status was known for any of the subjects in any of the Observations.

Data were collected in Observation 3 by a single observer (SBW) when a subject was visible and approachable up to four meters away. Behaviors were recorded using either of the two recording methods, described in detail above. The recording method was alternated evenly (e.g., every 5-10 observations) throughout the duration of the study to control for order effects and to generate a balanced data set. Subjects were continuously observed for up to 5 min, or until the subject was no longer in sight. We used one-zero sampling (Martin and Bateson 2009), in which relative frequencies of behavior are determined by calculating the proportion of 30 s scans in which the house sparrows engaged in the behavior. The sampling method in Observation 3 differs from that used in Observations 1 and 2 because Observation 3 was initially part of a separate study.

Statistical analyses

Observation 1. To determine if the observation durations of the robins differed significantly between observers, a paired t-test was performed on a subject basis. We also ran analyses of variance (ANOVA) with the difference in the data collected by the two observers as the dependent variable and with predictor variables of the observer (CH or assistant) and method of data collection to test if there was an interaction between observer identity and the type of data recording methodology that the observer used.

Observation 2. We compared the sensitivity of the digital data collection method between the three most common behaviors of robins, starlings, and grackles to determine if there was a consistent difference between the species. We performed a Bonferroni correction by dividing our α-level by our number of comparisons (Curtin and Schulz 1998), which gave us a corrected α level of 0.017. Statistical tests were two-tailed and performed using Statview 5.1.

Observation 3. The durations of behavioral observations were compared between the sexes and the recording methods using analysis of variance (ANOVA). Behavioral proportions were also calculated for comparisons between the recording methods, but this first required a statistical accounting for the potential non-independence of behavioral displays within subjects, such as correlated behavioral traits and rates, to satisfy the assumptions of independent tests. Therefore, a Principal Component Analysis (Jolliffe 2002) was applied as a useful way to collapse co-varying data that have multiple predictors which are biological and statistically non-independent, using JMP Version 8.0.2.

RESULTS

Observation 1

We found a significant difference in the duration of time that each observer was able to observe American Robins ($t_{21} = 3.83$, $p < 0.01$), with Observer 1 (CH) recording longer durations than the assistant. In contrast, we found no significant difference in observation duration between the two methods of data collection, for a given observer (Observer 1, $F_{1,20} = 3.06$, $p = 0.10$; Observer 2, $F_{1,20} = 1.68$, $p = 0.21$, Fig. 2). In addition, we found no interaction effect between the observer and the method used ($F_{1,20} = 0.02$, $p = 0.88$).

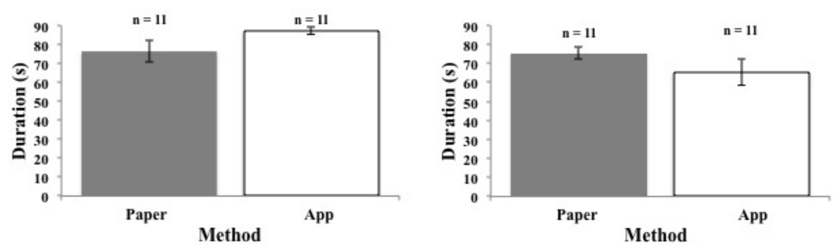

Figure 2. Comparison of observation durations of American Robins recorded on paper vs. digital application by Observer 1 (left) and Observer 2 (right). Means ± S.E. are depicted.

Observation 2

To determine whether recording with the App would allow the user to detect differences among American Robins, Common Grackles, and European Starlings, we compared their three most commonly recorded behaviors, "Stationary, Look Ahead", "Probe" and "Stationary, Look Around." We found a significant main effect of species in the proportion of time observed as "Stationary, Looking Ahead" ($F_{2, 60} = 24.99$, $p < 0.01$). An unpaired t-test (corrected α level of 0.017) revealed a significant difference, where robins engaged in these behaviors more often than grackles ($t_{50} = -4.37$, $p < 0.01$) and robins than starlings ($t_{46} = 6.08$, $p < 0.01$; Fig. 3a), and a non-significant difference between grackles and starlings ($t_{50} = 2.54$, $p = 0.02$). Finally, we found a significant main effect of species in the proportion of time performing the behavior "Stationary, Look Around" ($F_{2, 60} = 10.23$, $p < 0.01$). An unpaired t-test showed that starlings performed the behavior more often than robins, ($t_{46} = -5.09$, $p < 0.01$; Fig. 3b), but not significantly more often than grackles ($t_{24} = -2.06$, $p = 0.05$). There was no significant difference between robins and grackles ($t_{50} = 1.62$, $p = 0.11$). We found no significant difference in the frequency of the behavior "Probe" among the three bird species, ($F_{2,60} = 1.01$, $p = 0.37$) (Fig 3c).

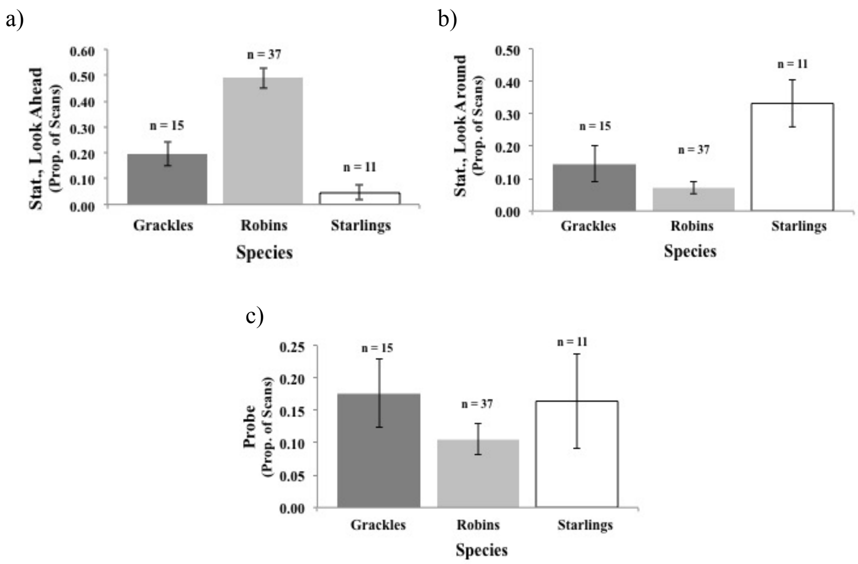

Figure 3. Interspecific comparisons of the proportions of time that three species were observed being stationary and looking ahead (a), stationary and looking around (b), and probing (c), as recorded via digital application. Means + S.E. are depicted.

Observation 3

For House Sparrows, there were no significant effects of data collection method on the proportion of observations recorded for flying or jumping ($F_{1, 78} = 1.08$, $p = 0.30$), looking around ($F_{1, 78} = 0.38$, $p = 0.54$), walking or hopping ($F_{1, 78} = 0.38$, $p = 0.54$), or performing unique or rare behaviors ($F_{1, 78} = 0.15$, $p = 0.70$), and, thus, overall were no statistical differences between recording methods in recording short- (e.g., calls) or long-duration behaviors (e.g., flying) (data not shown). There was no significant effect of sex on the proportion of observations recorded for flying or jumping ($F_{1, 78} = 0.14$, $p = 0.71$), looking around ($F_{1, 78} = 0.07$, $p = 0.80$), walking or hopping ($F_{1, 78} = 0.49$, $p = 0.49$), or performing unique behaviors ($F_{1, 78} = 3.33$, $p = 0.07$) (data not shown). However, there was a significant effect of sex on the proportion of observations spent vocalizing ($F_{1, 78} = 10.38$, $p < 0.01$; Fig. 4).

One-way analysis of variance revealed that there was no significant effect of data collection on the duration of observations ($F_{1, 78} = 2.10$, $p = 0.15$). There was also no significant effect of sex on the duration of observations ($F_{1, 78} = 0.02$, $p = 0.90$) (data not shown). There was no significant effect of data collection on either PC1 ($F_{1, 78} = 0.25$, $p = 0.62$) or PC2 ($F_{1, 78} = 3.03$, $p = 0.09$). There was no significant effect of sex on PC1 ($F_{1, 78} = 1.08$, $p = 0.30$) but there was a significant effect of sex on PC2 ($F_{1, 78} = 5.22$, $p = 0.03$) (Fig. 5).

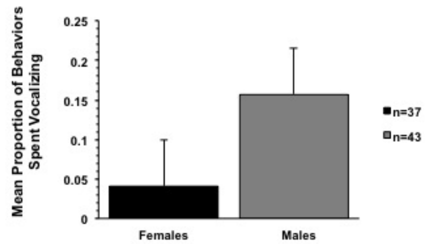

Figure 4. The mean proportions of observations during which male (n = 43) and female House Sparrows (n = 37) vocalized. Means + S.E. are depicted.

DISCUSSION

We predicted that the digital recording device would record longer observation durations than recording data on paper. In addition, we set out to ascertain the feasibility and suitability of the digital application to detect species-specific behavioral differences. Contrary to our predictions, in both case studies including Observations 1 and 3, the method of recording avian behaviors did not affect the observation duration. There was, however, a significant difference in observation duration between the two observers in Observation 1, independent of the data collection methods. The difference in observation times was most likely the result of differences in field experience with avian behaviors between the two observers; this conclusion could be tested futher via comparisons using the same type of data collection method (either paper or digital) with simultaneous recording of the same study subjects.

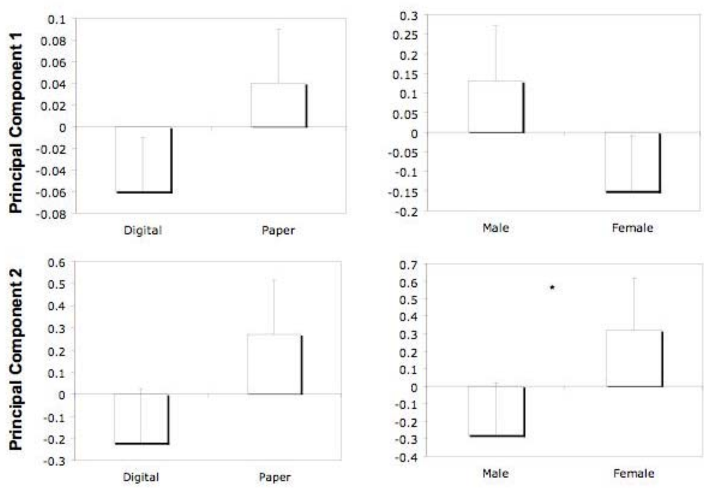

Figure 5. Comparisons of principal components describing House Sparrow behaviors in relation to recording method and sex. Mean of the principal components values + S.E. depicted. The only significant effect was for PC2 in relation to sex.

We found that the WhatISeeApp (application) detected behavioral differences between the different avian species. The behaviors "Stationary, Look Ahead" were performed significantly more often by robins than by starlings or grackles. Similarly, starlings engaged in the behaviors "Stationary, Look Around" significantly more often than robins or grackles. Given that birds rely on their vision to detect predators (Tisdale and Fernandez-Juricic 2009), our finding of more 'watching' type behaviors in robins and starlings as opposed to grackles could reflect increased vigilance due to higher predation risk because of these first two species' relatively smaller sizes. In their study of the prey species of wintering Sharp-shinned Hawks (*Accipiter striatus*) Roth II et al. (2006) found that these hawks mostly predated upon medium-sized birds, such as robins and starlings, and only rarely predated on grackles. The higher predation pressure of robins and starlings compared to grackles may account for their increased vigilance behavior.

Additionally, our finding that starlings performed the behavior "Stationary, Look Around," statistically more often than robins is consistent with the finding that the "head-up scan bout duration" of starlings was significantly higher than that of House Sparrows in trials examining vigilance behavior (Tisdale and Fernandez-Juricic 2009). Tilsdale and Fernandez-Juricic theorized that the longer scanning duration of starlings compared to house sparrows might be due to the larger size of the blind area in the starlings' vision compared to the sparrows. The scanning behavior of starlings has also been shown to function as a method to assess other flock members (Fernandez-Juricic 2005). That our findings are in accordance with the results of previous research suggests that the digital method of recording data is sensitive enough to detect small differences in the behaviors of different species.

The effect of sex on the proportion of time that House Sparrows spent vocalizing was consistent with the finding that males spend a great deal more time calling to females in the breeding season, a characteristic sex-specific courtship display in the this species (Anderson 2006). Communication and sexual displays are therefore confirmed to play an important part of the behavioral repertoire in the House Sparrow using the data sets compiled in this study from the different data collection methods. Again, as predicted, these sex-specific differences detected by the digital application form behaviorally salient sensitivity of the App based data collection protocol for wild living birds.

However, our analyses also revealed no statistical differences in the quantitative patterns of the behavioral data collected with the paper vs. the digital recording methods. The results reported here thus do not support our prediction that the digital recording method is more suited for observational research when compared to the traditional paper recording method. It appears that both methods are equally useful in detecting biologically meaningful behavioral differences, such as dimorphic calling rates, and that observers can use either depending on their experiences and preferences. This is one of the first studies that attempted to investigate the usefulness of the WhatISee application, and furthermore, is one of the first to use the iPhone in behavioral research.

Regarding the practicality and the relative ease of use, the two recording methods both had advantages and weaknesses. On the one hand, the paper-and-pencil method was simple to create and edit. On the other hand, it was awkward when trying to hold the timer in addition to the paper-and-pencil. The application method provided a way to store data in a lightweight, compact device, and allowed us to record data with just one hand. Also, the e-mail function gave us a way to permanently store all of the data.

However, the digital application also requires the user to spend some time familiarizing oneself with it before starting observation. Also, the user can only label 5 rows and 5 columns of the application interface and would be more efficient if users could label each of the 25 keys instead (a modification that may be suitable for the larger screen of iPads: T. Heuser, pers. comm.). Finally, it would be markedly helpful if the application automatically recorded the time when the observation ended as it is capable of recording the start time and the date. Overall, the WhatISee application provided a lightweight, compact, and efficient way to record animal behavior, and we would recommend it for use in behavioral studies.

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2009). However, none authors have ever gained any material benefits, acknowledgment, or income from this App's distribution through iTunes, and have no commercial or scientific ties with the developer. For assistance with data collection, we thank Tsering Doelker. Funding was provided by the HFSP (to MEH), PSC-CUNY (to MEH), and the ABC program (Director: Sheila Chase) and the President's and the Provost's Offices of Hunter College (CUNY) to all authors.

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