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# Drinking behavior in nursery pigs: Determining the accuracy between an automatic water meter versus human observers

Allison M. Meiszberg
*Iowa State University*

Anna K. Johnson
*Iowa State University*, johnsona@iastate.edu

Larry J. Sadler
*Iowa State University*, ljsadler@iastate.edu

J. A. Carroll
*United States Department of Agriculture*

Jeff W. Dailey
*United States Department of Agriculture*

*See next page for additional authors*

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**Abstract**
Assimilating accurate behavioral events over a long period can be labor-intensive and relatively expensive. If an automatic device could accurately record the duration and frequency for a given behavioral event, it would be a valuable alternative to the traditional use of human observers for behavioral studies. Therefore, the objective of this study was to determine the accuracy in the time spent at the waterer and the number of visits to the waterer by individually housed nursery pigs between human observers scoring video files using Observer software (OBS) and an automatic water meter Hobo (WM, control) affixed onto the waterline. Eleven PIC USA genotype gilts (22 ± 2 d of age; 6.5 ± 1.4 kg of BW) were housed individually in pens with ad libitum access to a corn-based starter ration and one nipple waterer. Behavior was collected on d 0 (day of weaning), 7, and 14 of the trial using 1 color camera positioned over 4 attached pens and a RECO-204 DVR at 1 frame per second. For the OBS method, 2 experienced observers recorded drinking behavior from the video files, which was defined as when the gilt placed her mouth over the nipple waterer. Data were analyzed using nonparametric methods and the general linear model and regression procedures in SAS. The experimental unit was the individual pen housing 1 gilt. The GLM model included the method of observation (WM vs. OBS) and time (24 h) as variables, and the gilt nested within method was used as the error term. Gilts consumed more water ($P = 0.04$) on d 14 than on d 0. The time of day affected ($P < 0.001$) the number of visits and the time spent at the waterer regardless of the method. However, the OBS method underestimated ($P < 0.001$) the number of visits to the waterer (3.48 ± 0.33 visits/h for OBS vs. 4.94 ± 0.33 for WM) and overestimated ($P < 0.001$) the time spent at the waterer (22.6 ± 1.46 s/h for OBS vs. 13.9 ± 1.43 for WM) compared with WM. The relationship between the 2 methods for prediction of time spent at the waterer and number of visits made by the gilts was weak ($R^2 = 0.56$ and 0.69, respectively). Collectively, these data indicate that the use of the traditional OBS method for quantifying drinking behavior in pigs can be misleading. Quantifying drinking behavior and perhaps other behavioral events via the OBS method must be more accurately validated.

**Keywords**
automatic, behavior, drinking, Hobo, pig, validation

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**Authors**
Allison M. Meiszberg, Anna K. Johnson, Larry J. Sadler, J. A. Carroll, Jeff W. Dailey, and Nadege Krebs

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# Drinking behavior in nursery pigs: Determining the accuracy between an automatic water meter versus human observers[1,2]

A. M. Meiszberg,* A. K. Johnson,* L. J. Sadler,* J. A. Carroll,†[3] J. W. Dailey,† and N. Krebs‡

*Department of Animal Science, Iowa State University, Ames 50011-3150; †Livestock Issues Research Unit–ARS-USDA, Lubbock, TX 79403; and ‡Pork Industry Institute, Department of Animal and Food Sciences, Texas Tech University, Lubbock 79401-2141

**ABSTRACT:** Assimilating accurate behavioral events over a long period can be labor-intensive and relatively expensive. If an automatic device could accurately record the duration and frequency for a given behavioral event, it would be a valuable alternative to the traditional use of human observers for behavioral studies. Therefore, the objective of this study was to determine the accuracy in the time spent at the waterer and the number of visits to the waterer by individually housed nursery pigs between human observers scoring video files using Observer software (OBS) and an automatic water meter Hobo (WM, control) affixed onto the waterline. Eleven PIC USA genotype gilts (22 ± 2 d of age; 6.5 ± 1.4 kg of BW) were housed individually in pens with ad libitum access to a corn-based starter ration and one nipple waterer. Behavior was collected on d 0 (day of weaning), 7, and 14 of the trial using 1 color camera positioned over 4 attached pens and a RECO-204 DVR at 1 frame per second. For the OBS method, 2 experienced observers recorded drinking behavior from the video files, which was defined as when the gilt placed her mouth over the nipple waterer. Data were analyzed using nonparametric methods and the general linear model and regression procedures in SAS. The experimental unit was the individual pen housing 1 gilt. The GLM model included the method of observation (WM vs. OBS) and time (24 h) as variables, and the gilt nested within method was used as the error term. Gilts consumed more water ($P = 0.04$) on d 14 than on d 0. The time of day affected ($P < 0.001$) the number of visits and the time spent at the waterer regardless of the method. However, the OBS method underestimated ($P < 0.001$) the number of visits to the waterer (3.48 ± 0.33 visits/h for OBS vs. 4.94 ± 0.33 for WM) and overestimated ($P < 0.001$) the time spent at the waterer (22.6 ± 1.46 s/h for OBS vs. 13.9 ± 1.43 for WM) compared with WM. The relationship between the 2 methods for prediction of time spent at the waterer and number of visits made by the gilts was weak ($R^2 = 0.56$ and 0.69, respectively). Collectively, these data indicate that the use of the traditional OBS method for quantifying drinking behavior in pigs can be misleading. Quantifying drinking behavior and perhaps other behavioral events via the OBS method must be more accurately validated.

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## INTRODUCTION

Behavioral observation is a type of tool used to quantify animal biological responses. Behaviors and postures can be classified as behavioral events, whereby the behavior performed by an animal is relatively short in duration (for example, drinking), or behavioral states, that by definition last a longer period of time (such as lying; Martin and Bateson, 1993). To facilitate the collection of behavioral events and states, ethologists are able to choose between different sampling rules: ad libitum, focal and scan sampling, and continuous (Martin and Bateson, 1993). Each sampling rule has challenges and benefits; for example, scan sampling becomes ap-

[1]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the USDA or the ARS of any product or service to the exclusion of others that may be suitable.

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[3]Corresponding author: jeff.carroll@ars.usda.gov

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propriate when the observer wishes to record behavioral states, but data could be lost if a scan sample is used to record behavioral events like drinking due to its shorter duration (Altmann, 1974; Mitlöhner et al., 2001). Continuous observation is, therefore, preferred to acquire drinking behavior, but this is time-consuming and labor-intensive (Arnold-Meeks and McGlone, 1986; Jensen et al., 1986). Furthermore, behavioral methodology, like physiological methodologies, should be selected and validated based on the objectives of a given study (Mitlöhner et al., 2001). Therefore, if an automatic device could accurately record time spent at a waterer and the number of visits to a waterer, it would be a valuable alternative to the traditional use of human observers for behavioral studies and could reduce the labor and expenses associated with the collection of behavioral data.

The main concern with drinking behavior is that in most papers, drinking behavior does not actually describe water ingestion. Water ingestion would require weighing the pig. Human observers have been measuring the frequency and duration of visits (contacts or mouth around the waterer) to assess what calibrated water meters can now record accurately (the frequency and the duration of actual water flow, respectively). Though visits and actual water flow are different concepts, for the purpose of this study we adopted a conventional terminology: frequency of visits and duration of visits. Although both of these activities can be considered measures of drinking behavior, water flow measured by calibrated devices is a more accurate measure and was considered the control in the current study.

Therefore, the objective of this study was to determine the accuracy in the time spent at the waterer (duration of water flow) and the number of visits to the waterer (frequency of water flow) by individually housed nursery pigs between human observers scoring video files using observer software (**OBS**) and an automatic water meter Hobo device (**WM**, control) affixed onto the waterline. In addition, the amount of water consumed and wasted by individual pigs provided with ad libitum access to a nipple waterer was recorded.

## MATERIALS AND METHODS

Animals were housed and used in accordance with the common recommendations (FASS, 1999), and the project was approved by the Animal Care and Use Committee of the ARS Livestock Issues Research Unit.

### *Animals, Housing, and Facilities*

Eleven PIC USA Cambrough-22 genotype gilts (22 ± 2 d of age and 6.5 ± 1.4 kg of BW) were obtained from a single source farm and were considered to have a high health status (negative for porcine reproductive and respiratory syndrome and pseudorabies). Research was conducted at the Livestock Issues Research Unit swine facility of ARS, which is a conventional Double LL nursery building situated near Lubbock, TX.

At weaning, gilts were moved from the source farm to the Double LL nursery and housed individually for 16 d in stainless-steel pens (Vittetoe Inc., Keota, IA) that provided 0.7 $m^2$ of floor surface per gilt (1.2 m long × 0.6 m wide × 0.8 m deep). All pens were within 1 climatically controlled room with Filter-eeze Maxima white plastic flooring (BCM Mfg. Ltd., Calgary, Alberta, Canada), and each pen had one feeder (Smidley Marting Mfg. of Iowa Inc., Britt, IA). The feeders (0.7 m high × 0.3 m wide × 0.3 m deep) had 2 feeding holes that measured 0.2 m long × 0.1 m wide × 0.1 m deep each. Gilts had ad libitum access to a corn-based starter ration that met approved nutritional standards (21.29% CP, 1.36% lysine, and 3,289.49 kcal of ME; NRC, 1998). Each pen had 1 nipple waterer (Lixit L-80 model, Lixit Corporation, Napa, CA; length: 23 mm; diameter: 9.4 mm), placed 0.3 m above the floor. Water flow rates were recorded daily, and the average flow rate across all pens was 13.9 mL/s. Water meter Hobo (F-S3 series Flow switch, Gems sensors and controls, Plainville, CT) recorded the daily water usage for each gilt, and water spillage was gathered in collection troughs placed under each drinker. The amount of water wasted was measured daily at 1200 h with a graduated cylinder. The amount of urine present in the collecting trough could not be determined, but most pigs were defecating in the opposite corner, suggesting that most of the urine was in the opposite corner as well. The water consumed was obtained by subtracting the water wasted from the water used. Lights were left on continually and produced on average 423.5 lx (Foot Candle/Lux Meter, Extech, Waltham, MA).

### *Behavioral Quantification*

***OBS.*** Two experienced observers continuously observed video files (n = 11) of gilt behavior for the number of visits to the waterer and the time spent at the waterer. Individual gilt behavior was collected from video files using the Noldus Observer (The Observer, Ver. 5.0.25 Noldus Information Technology, Wageningen, the Netherlands). The number of visits to the waterer over a 24-h period and the duration of time in seconds spent at the waterer for each gilt were acquired on d 0 (day of weaning), 7, and 14 of the trial. The 2 observers scored the same 2-h time period for the number of visits and time spent at the waterer. The observers reached a 99% agreement on both measures before scoring the video files.

***WM Device.*** Eleven precalibrated WM were affixed onto the water line 0.5 m above the waterer. Every water release and the duration of the water release were automatically recorded by the WM on d 0, 7, and 14 of the trial. The WM was considered the control because it objectively and accurately records activation of the waterer and actual water release (precalibrated Gems sensors controls, Plainville, CT).

### Behavioral Equipment and Acquisition

Drinking behavior for all the gilts was continually recorded for a 24-h period beginning at 1200 h. The gilts were placed in their pen from 1 to 15 min before the start of the study. One color camera (WV-BP 332, Panasonic Matsushita Co. Ltd., North America, Secaucus, NJ) with an adjustable focal lens (1.8 to 3.6 mm, Computar, Japan) was positioned over 4 attached pens and recorded onto a RECO-204 DVR (Darim Vision, Pleasanton, CA) at 1 frame per second. For the OBS method, a drinking event was defined as follows: a visit to the waterer started when the gilt placed her mouth over the nipple waterer and terminated when the gilt removed her mouth from the waterer.

### Climatic Measures

Three Hobo Pro data loggers (Hobo U9 State Logger, Onset, Bourne, MA) measured environmental temperature within the swine facility. Data loggers were affixed 0.46 m above the pen floor at equal distance down the length of the entire room. Ambient temperature (°C) was recorded in 15-min intervals. Daily measurements were averaged for each day of the trial to determine daily maximum, minimum, and average values. Overall, the average temperature for the trial was 27.9°C (minimum 26.0°C; maximum 28.8°C).

### Statistical Analysis

The experiment was a complete randomized design. The experimental unit was the pen containing 1 gilt. The amounts of water wasted and of water consumed were analyzed using the GLM procedure (SAS Inst. Inc., Cary, NC) to test the effects of the day. The hourly duration of drinking and the number of visits to the waterer were tested for normality (Kolmogorov-Smirnov test) and equal variances (Bartlett's test). No mathematical transformation allowed achieving normal distribution of the data, and the variances were not equal. Therefore, a new variable was created (the difference between OBS and WM for the time spent at the drinker and number of visits) and analyzed using the Wilcoxon-signed rank test, nonparametric analog to the paired *t*-test. The alternative hypothesis tested with the Wicoxon-signed rank test is that 2 distributions differ only with respect to the median (the median being the middle value in a list of increasing values) and that one distribution is skewed compared with the other. The difference (OBS − WM) for the frequency of visits and time spent at the waterer was calculated. The sign of the difference indicates its direction; therefore, a positive difference means that OBS overestimates WM. If the Wilcoxon-signed rank test showed that the median difference between pairs of observations was different from zero (or that 1 treatment constantly overestimated the variable compared with the other treatment), the GLM procedure in SAS was used to provide the least squares means. The GLM model included method used (OBS vs. WM, considered the control standard), time of day (0000 to 2300 h), day (0, 7, and 14), and their interactions. The pig nested within method was used as the error term. Differences between least squares means were established using Tukey posthoc tests. The regression procedure in SAS was used to determine if data obtained by OBS could predict the hourly drinking behavior as measured by WM. A *P*-value of $P < 0.05$ was used for significance.

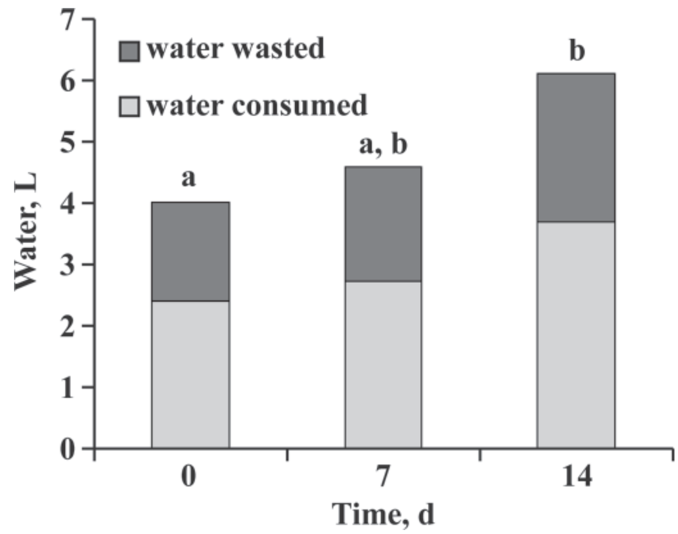


**Figure 1.** Effect of day (after weaning) on the amount of water wasted ($P = 0.23$) and of water consumed ($P = 0.04$) by individually housed 22-d-old pigs. The amount of water wasted represented 40.2, 40.4, and 39.3% of the total water used on d 0, 7, and 14, respectively, and was measured using a calibrated automatic water meter Hobo device (Onset, Bourne, MA). [a,b]Means with different letters (for water consumed) differ, $P < 0.05$.

## RESULTS

The amount of water wasted was not different ($P = 0.23$) among days. However, the amount of water consumed increased as pigs became older ($P = 0.04$; Figure 1). The time spent at the waterer and the numbers of visits at the waterer were affected by the time of the day. Pigs spent more ($P < 0.001$) time at the waterer in the early afternoon (43.10 ± 1.44 s/h at 1200 h) with time spent at the waterer decreasing over the night hours and reaching a minimum at 2200 h (1.50 ± 1.44 s/h). Starting at 0200 h, time spent at the waterer began to increase again (Figure 2). Pigs visited the waterer more often ($P < 0.001$) in the early afternoon (10.8 ± 0.33 visits at 1200 h) and less at night (0.31 ± 0.33 visits at 2200 h), and again an increase was noted at 0200 h (Figure 3). Collectively, these data indicate that the time spent at the waterer and the number of visits to the waterer were affected by time of day. There was no time × method interaction, but the method affected the results.

When comparing the 2 methods (OBS vs. WM) the median difference between the 2 treatments was different (W = 60658; $P < 0.001$) from zero for the hourly

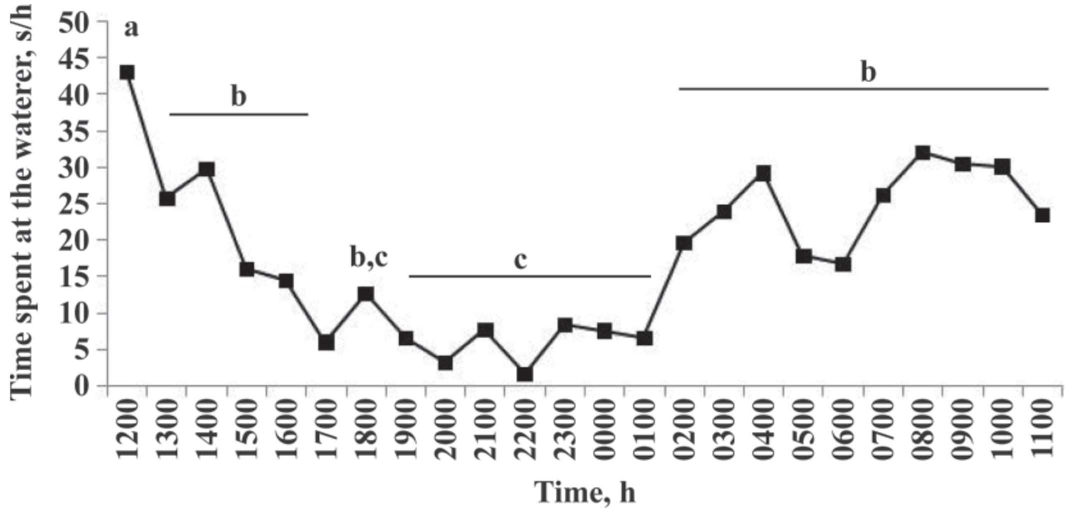


**Figure 2.** Effect of time of the day on time spent at the waterer (n = 11; SE = 1.44; $P < 0.001$) by individually housed 22-d-old pigs. [a–c]Means with different letters differ, $P < 0.05$.

time spent at the waterer (Figure 4); thus, OBS was overestimating the variable compared with WM. The average time at the waterer was 13.9 ± 1.46 s/h when scored by the WM and 22.6 ± 1.43 s/h when scored by the OBS. The regression analysis for the duration of drinking (s/h) was WM = 3.90 + 0.44 OBS. The slope was different ($P < 0.001$) from zero, and the coefficient of determination $R^2$ was 0.56.

The median difference between the 2 treatments was also different (W = −44,181, $P < 0.0001$) from zero for the number of visits to the waterer, so OBS was underestimating the variable compared with WM (Figure 5). The average number of visits was 4.94 ± 0.33/h when scored by the WM and 3.47 ± 0.33/h when scored by the OBS. The regression analysis for the number of visits/h was WM = 0.14 + 1.39 OBS. The slope was different ($P < 0.001$) from zero, and the coefficient of determination $R^2$ was 0.69.

## DISCUSSION

Water was called the forgotten nutrient by Brooks (1998) in regard to the limited attention it has received in comparison with dietary nutrients (NRC, 1998). Water is the most essential nutrient for life, and an inadequate supply can result in devastating consequences such as overheating, dehydration, and in the extreme case, death (Almond, 2007). The amount of drinking-related activities performed can depend on a plethora of factors, including palatability of the water (Roura et al., 2005), type of waterer (Torrey et al., 2008), exogenous environmental factors (Brumm, 2006), feed intake/quality (Thacker, 2001), and the health and physiological state of the individual pig (McGlone and Pond, 2003). The pig is considered to be a prandial drinker, and previous work has reported that throughout the growing period, pigs consume 75% of their

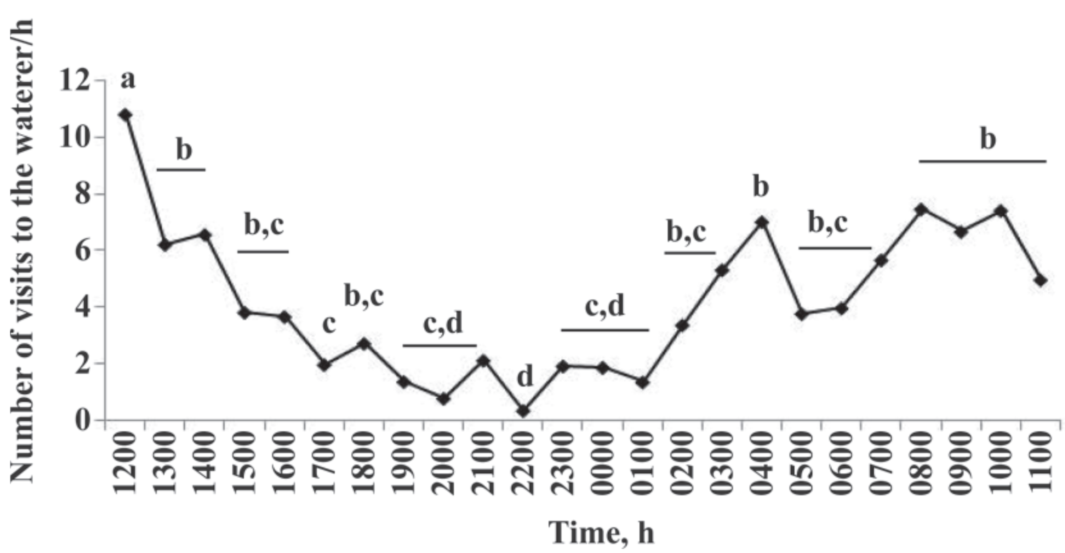


**Figure 3.** Effect of time of the day on number of visits (per hour) to the waterer (n = 11; SE = 0.33; $P < 0.001$) by individually housed 22-d-old pigs. [a–d]Means with different letters differ, $P < 0.05$.

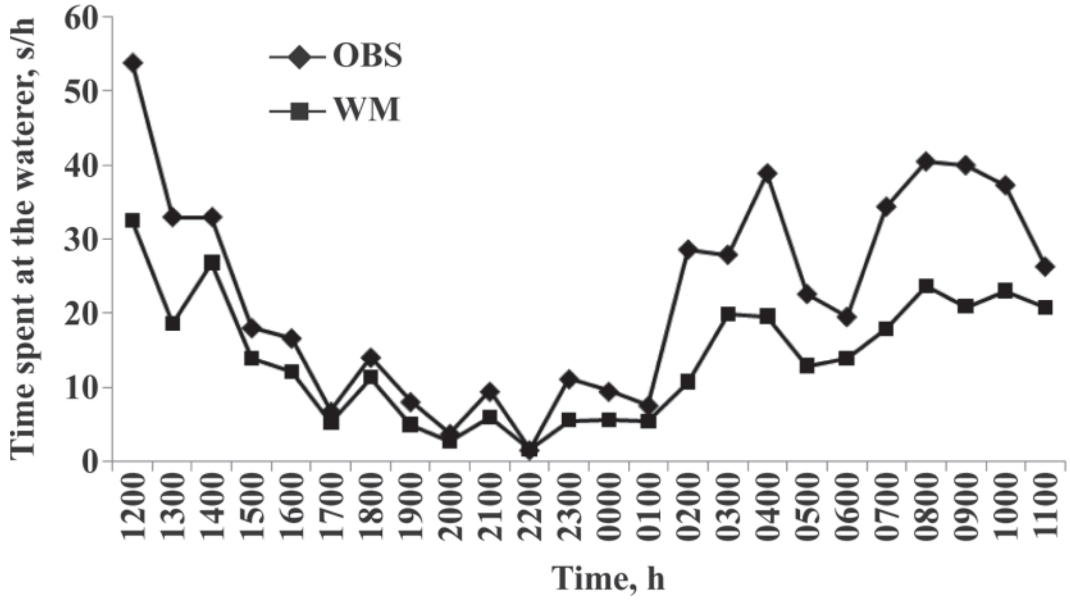


**Figure 4.** Effect of the treatment (OBS and WM) on the time (s/h) spent at the waterer (n = 11; SE pooled = 7.06; $P < 0.001$) by individually housed 22-d-old pigs. The OBS treatment used a human observer to record the number and duration of contacts with the waterer based on video observations. The WM treatment recorded the frequency and duration of actual water flow of the waterer.

daily water intake before, during, or after a meal (Bigelow and Houpt, 1988). Increased drinking duration has been correlated with increased eating duration in weaned pigs (Dybkjær et al., 2006). Furthermore, Hyun et al. (1997) observed that increased visits to the water source was correlated with increased time engaged in feeding-related activities, which resulted in improved ADFI and ADG in growing-finishing pigs. The existence of a drinking pattern and the specificity of drinking behavior are criteria that allow using drinking behavior as a predictor for health or production problems (de Mol et al., 1999). Friend (1973) showed that water intake varied with estrus, and Madsen and Kristensen (2005) showed that changes in drinking pattern preceded an outbreak of diarrhea in pigs 29 d after weaning. With an accurate water meter, water intake could be recorded automatically and generate alerts that could be used to help manage pig health and production, though the appropriate thresholds must be determined (Madsen and Kristensen, 2005).

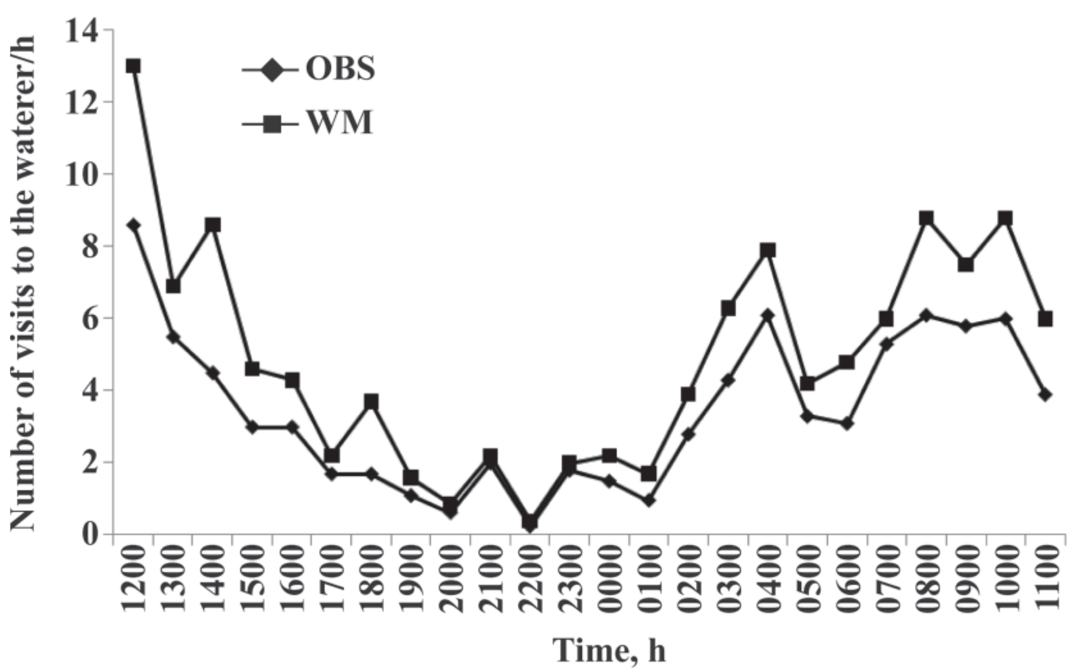


**Figure 5.** Effect of the treatment (OBS and WM) on number of visits (per hour) to the waterer (n = 11; SE pooled = 1.61; $P < 0.001$) by individually housed 22-d-old pigs. The OBS treatment used a human observer to record the number and duration of contacts with the waterer based on video observations. The WM treatment recorded the frequency and duration of actual water flow of the waterer.

In the current study, the water consumption of 22-d-old pigs using a nipple waterer started at 2.4 L/d on d 0 and increased by 54% to 3.7 L/d on d 14. The average water consumption was 2.9 L/d, which is within the same range as the 2.7 L/d reported by Maenz et al. (1994) in individually housed 28-d-old pigs using bowl-type drinkers. However, it is greater than the water consumption reported by Torrey et al. (2008; 0.87 L/d across 14 d) for 28-d-old pigs using the same nipple waterer as used in the present study, but the pigs used in Torrey et al. (2008) were group-housed. The average water wasted was 1.96 L (or 0.66-fold less than the water consumed) in the current study vs. 1.11 L (or 1.28-fold more) Some of the reported water usage/wastage numbers may be due to the way the pigs were housed; in this study it was 1 gilt per pen, whereas in Torrey et al. (2008), pigs were in groups of 3 pigs per pen, and this highlights the importance of the social environment on drinking behavior (Dybkjær et al., 2006) with pigs in groups drinking less with water wastage increasing due to aggressive behaviors that trigger additional water release (Pitts et al., 2000). In addition to establishing ranges for water consumption and wastage, this study confirmed that weaned gilts followed a diurnal drinking pattern even when lights were left on continuously. Gilts spent 90% of their total time at the waterer between 0200 and 1800 h, and in turn, 90% of their total visits to the waterer occurred in this same timeframe. Though miniature pigs exposed to a 0700 to 2000 h light period showed no specific drinking pattern (Musial et al., 1999), the findings of this study agree with previous results indicating that water intake for the pig follows a drinking pattern. The miniature pigs ate as much at night as during the day and also failed to display a drinking pattern. The greater metabolism of miniature pigs could explain a more continuous feeding behavior and therefore a more continuous drinking behavior. However, in full-size pigs, our results are concordant with previous findings. Bigelow and Houpt (1988) reported that 3-wk-old to 6-mo-old pigs were more motivated (operant conditioning) to drink 68% of their total water intake during the light period (0700 to 1900 h). Madsen and Kristensen (2005) reported a drinking peak between 1600 and 1800 h with the least water intake between 0300 and 0500 h when 4- to 8-wk-old pigs were housed in groups (15 to 30 pigs per drinking bowl). However, Madsen and Kristensen (2005) did not specify the light period. The peak in drinking behavior may however be relative; knowing that pigs have a peak of drinking behavior 20 h after weaning (Dybkjær et al., 2006), the peak could occur at 0100 h (during the dark period) if pigs were weaned at 0500 h.

Previous work measured drinking behavior using human observers in passive conditions, by observing the drinking behavior in pigs that were given free access to water (Toscano et al., 2007; Torrey et al., 2008). Motivation to gain access to water was tested using active operant techniques (Bigelow and Houpt, 1988). Velocity water meters cannot record water releases inferior to 3.89 L/min. However, positive-displacement flow meters are more accurate. They contain minute compartments in which a known amount of liquid moves with the flow of water. These water meters repeatedly fill and empty these compartments, and flow rate is calculated accurately based on the number of times these compartments are filled and emptied. Positive displacement flow meters have been used to record water disappearance and drinking patterns of individually housed miniature pigs (Musial et al., 1999) or pigs housed in pens of 30 to 250 (Madsen and Kristensen, 2005). Mathematical models based on accurate data collection (with positive displacement flow meters) allow water consumption to be monitored and hence health status of pigs (Madsen and Kristensen, 2005). Despite the existence of accurate electronic recording devices and techniques, many research projects still use human observers and a variety of scan sample intervals to record pig drinking behavior, the number of visits, and the time spent at the waterer through live or video observations (McGlone, 1991; Dybkjær et al., 2006; Toscano et al., 2007; Torrey et al., 2008).

In this study, differences were found between methods used (OBS and WM) for the number of visits to the waterer and the time spent at the waterer by individual gilts. The number of visits to the waterer ranged from 0.4/h to 13/h and 0.25/h to 8.6/h with WM and OBS respectively. Time spent at the waterer ranged from 1.5 to 32.4 s/h and 1.5 to 53.9 s/h with WM and OBS. These ranges agree with Toscano et al. (2007), who reported drinking frequencies of 10.9/h (3.26 visits/18 min) in finishing pigs (90.0 ± 0.71 kg) housed individually and provided free access to water. However, Torrey et al. (2008) reported that piglets housed 3 to a group at weaning spent 0.47% of their time at the waterer (1.83 s/h), which is 7.6 times less than what was found in the present study with the same type of drinker. This difference could be due to the greater pig/drinker ratio (Turner et al., 1999). Pigs may also spend less time at the waterer because they satisfy the tactile stimulation of the snout better by belly-nosing their littermates (Torrey et al., 2008), which was not possible in the present setting because pigs were housed individually and the bars of the pen were vertical, making oral nasal facial (**ONF**) behaviors difficult. Although drinking behavior is related to ONF behaviors, it should not be confounded with ONF behaviors.

Drinking behavior has often been defined as the mouth in contact with the waterer, which is the equivalent of ONF behaviors (rubbing, sniffing, licking, biting, touching the mouth, snout, or face with the bars, floor, or feed trough; Dailey and McGlone, 1997; Hulbert and McGlone, 2006) toward the drinker. The definition of drinking does not usually include water ingestion (Dybkjær et al., 2006; Toscano et al., 2007; Torrey et al., 2008). Torrey et al. (2008) tested the effects of different waterers on drinking behavior and water intake in weaned pigs housed in groups of 3 with 1 waterer using 5-min video (overhead view) scan samples, 6 h/d for 2 d after weaning. The authors found differences between treatments in the water intake (recorded from water meters) but not in the drinking duration (recorded by human observers). This may help explain why drinking behavior defined as ONF behaviors toward the waterer and recorded by human observers with overhead views does not relate to the actual water intake. The ONF hypothesis is supported by our study because data collected with the OBS method overestimated the time spent at the waterer and underestimated the number of visits to the waterer in nursery gilts compared with WM. Though there was a relationship between the measures collected by OBS and WM (the regression slope was different from zero), the coefficients of determination were low (<0.90), showing that OBS is not a good predictor of WM for the time spent at the waterer and for the number of visits at the waterer. The WM was able to record an almost unnoticeable interaction with the nipple that resulted in a very short flow of water, 1-s recording resolution. This nibble drinking is similar to the nibble feeding described by Bigelow and Houpt (1988) that considerably affected the feeding pattern. Moreover, Mundl and Malmo (1979) showed that head movement and tongue licking did not correlate in rats; therefore, viewed from above, the position of the head (or the mouth) may not change and count for 1 visit with the OBS method while water flow was interrupted and resumed several times, counting for several visits with the WM method.

The definition of drinking behavior used in the current study disregards the notion of bout (time between the end of one drinking event and the beginning of the next drinking event). Musial et al. (1999) showed that drinking bouts ranged from 99 to 702 s, whereas Dybkjær et al. (2006) used a 10-s bout interval based on previous findings from Lehner (1979). In the present study, all drinking sessions were recorded. Perhaps a definition of drinking behavior using actual water ingestion and the notion of bout would lead to a better accuracy with OBS, though we suggest that drinking behavior should not be recorded by human observers but by automatic recording devices. Practically, the WM could also be used to generate alerts when the drinking pattern changes, allowing for a better management of the pig herd health, productivity, and overall well-being.

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