BIOASSAY WITH THE SUBTERRANEAN TERMITE *RETICULITERMES*; FOOD PREFERENCE AND MOVEMENT OVER FOUR DAYS IN A Y-TUBE, CHOICE ARENA

by

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(Under the Direction of Brian T. Forschler)

ABSTRACT

Reticulitermes workers were exposed to three 1-cm^3 wood blocks of pine, poplar, red oak or redwood placed into no-, two-, and four-choice bioassay designs. Preference ranking obtained using four formulas in addition to one resistance class and two standardized visual rating scales. Termites were also placed into y-tube design composed of substrate-, food-, and empty-chambers and their movement pattern recorded using sensors and video. Results indicated that no-choice design can determine aversion; four-choice design the most preferred wood; and two-choice design the fine details of preference ranking. The different consumption rate formulas did not influence results of the two-choice design. In the y-tube arenas, termites were observed aggregated in one of three chambers independent of food location and displayed preference in movement between two chambers. Video observations illustrated that certain individuals traveled more frequently than others and three mass-movements involving >50% of individuals moving from one chamber to another.

INDEX WORDS: *Reticulitermes*, Bioassay, Feeding preference, Aggregation, Self-organization

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DEDICATION

I would like to dedicate this paper to my family, friends and colleagues that have guided me in becoming who I am today.

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CHAPTER 1

REVIEW OF TERMITE BEHAVIOR IN BIOASSAY

1.1 Evolution and Biology of Termites

Isoptera to Blattodea The classification and phylogeny of termites have been a topic of debate among researchers for over a century (Imms 1920, Inward et al. 2007, Lo and Eggleton 2011, Legendre et al. 2015). Previously suggested affinities of termites include: Orthoptera, Dermaptera, Blattodea s.s., Embiidina, Psocoptera, and Neuroptera (Imms 1920). The presence of perforation in the tentorium, and casing of eggs inside an ootheca in *Mastotermes* have eventually placed termites into the well-established monophyletic superorder Dictyoptera along with Blattodea s.s. and Mantodea (Klass and Meier 2006, Inward et al. 2007, Lo and Eggleton 2011, Legendre et al. 2015). There has been agreement that termites and mantids each form a monophyletic group within Dictyoptera (Inward et al. 2007). However, the exact phylogenetic relationship among mantids, cockroaches, and termites has been contested (Nalepa and Lenz 2000, Lo and Eggleton 2011, Legendre et al. 2015). There have been a couple of suggested topologies of Dictyoptera based on morphological, behavioral, and molecular analysis. These include: 1) placing termites as sister group to cockroach-mantid clade, and 2) placing mantid as a sister group of cockroach-termite clade (Lo and Eggleton 2011, Legendre et al. 2015).

Researchers have long suspected a close tie between cockroaches and termites based on the similarities in their internal and external morphology (Lo and Eggleton 2011). In particular, the features found in the primitive termite genera *Archotermopsis* and *Mastotermes* have been seen as the key to illuminating termite evolution and phylogeny (Imms 1920, Nalepa and Lenz

2000). These observations include the presence of ooetheca and anal lobe on the wings in *Mastotermes* and similar structures of the mandible (worker), crop, gizzard, salivary gland, styli and reproductive organs between Blattidae and *Archotermopsis* (Imms 1920, Watson and Gay 1991, Nalepa and Lenz 2000, Lo and Eggleton 2011). The discovery of several symbiotic gut flagellates shared between *Cryptocercus* sp. and termites has further supported the close ties between termites and cockroaches (Cleveland et al. 1934). In addition, there were notable morphological similarities observed between the *Cryptocercus* nymphs and archotermopsid pseudergates (Imms 1920). Behaviorally, *Cryptocercus* display several primitive social behaviors (subsocial), including gregariousness, parental care of the young, and proctodeal trophallaxis, and are considered “one-piece type” dwellers similarly to archotermopsid species (Abe 1987, Park et al. 2002, Nalepa 2015). As a result, *Cryptocercus* has been commonly used as the model for understanding termite evolution.

The morphological phylogeny of termite alone, however, had been largely limited due to focusing on limited number of characters and lack of cladistics analysis (Lo and Eggleton 2011). Comprehensive molecular phylogenetic analyses observing dictyopteran relationships have illuminated the dictyopteran relationship and shown that placing termites in an independent order led to a paraphyletic relationship between termites and cockroaches (Inward et al. 2007, Legendre et al. 2015). These studies strongly supported the cockroach-termite clade within Dictyoptera and placed *Cryptocercus* as a sister taxa of termites, which together formed a sister clade to Blattidae (Inward et al. 2007, Legendre et al. 2015). The conjunction of morphological and molecular analysis stands as strong evidences for placing treating termites as a clade within Blattodea rather than in their independent order, Isoptera. Instead, termites are currently placed in the epifamily Termitoidae under the order Blattodea (Krishna et al. 2013)

Biology and systematics There are approximately 2,600 described termite species within 7 families and 281 genera, with majority falling under the family Termitidae (Kambhampati and Eggleton 2000). All termite species are considered eusocial insects as defined by the following conditions: division of reproduction and labor, cooperative brood care, and overlapping generations (Wilson and Hölldobler 2005). Termites are divided into two groups- the lower-termites (Mastotermitidae, Kalotermitidae, Archotermopsidae, Hodotermitidae, Rhinotermitidae) and higher-termites (Serritermitidae, Termitidae)- based on the presence or absence of flagellated protists in the gut to breakdown cellulose (Kambhampati and Eggleton 2000, Krishna et al. 2013). The lower- and higher-termites vary greatly in behavior, social organization, and life cycle. The level of organization in a termite colony can be represented as one-piece dwellers, subterranean galleries, and mound builders (Abe 1987, Nalepa 2015). Generally, the higher-termites display a more advanced form of organization, division of labor, and centralized nesting system. The lower termites display a great degree of reproductive flexibility. Examples include a few species of the primitive termite family Archotermopsidae, in which the soldiers have been reported to develop mature gonads, although their reproductive capabilities are yet to be reported (Imms 1920, Thorne 1997). Subterranean termites were reported to lack a permanent nest site and instead move between multiple food resources (Snyder 1916).

A subterranean termite colony is composed of specialized castes as defined by shape and size, with each responsible for particular tasks (Snyder 1916). The different termite castes include the larva, worker, soldier, nymph and reproductive (Snyder 1916). The larvae refer to young termites below the third instar without fully sclerotized mandibles (Grube and Forschler 2004). The workers are immature third or higher instar non-soldier, non-reproductive individuals that make up majority of the colony (~84.5% in *Reticulitermes*) and are responsible for important tasks such as foraging, construction, repairing, and grooming (Thorne 1996, Whitman 2006). As results, the workers are considered the most destructive form in a structure (Snyder 1916). The workers are also considered a “pseudo-sterile” caste, and each individual is capable of molting into a soldier, nymph (then alates), or neotenic reproductive (Lainé and Wright 2003). The soldier caste is a terminal stage characterized by large sclerotized mandibles and typically makes up approximately 1-3% of the colony in Reticulitermes (Snyder 1916, Thorne 1996, Grube and Forschler 2004, Janowiecki et al. 2013). The nymphs (or pseudergates) are intermediate stage that can develop into reproductive castes (primary, secondary) or go under regressive molt into a worker, and are not typically present in young incipient colonies (Lainé and Wright 2003, Grube and Forschler 2004, Janowiecki et al. 2013).

The reproductive caste can be divided into two groups: the alates (primary reproductives) and neotenic reproductive (Snyder 1916, Thorne 1997). The alates are the main dispersal strategy utilized by subterranean termites through annual swarm flights, during which a large number of these winged-adults emerge from an infested wood or structure (Snyder 1916). As a result, the primary reproductive caste is the only one with well-developed eyes (Snyder 1916). Once the alates are paired, the wings are shed and the delated pair(s) form nuptial chamber(s), after which mating occurs (Ye et al. 2009). Although there is evidence of polygyny young subterranean termite incipient colonies, monogyny appears to become established within the first year (Grube and Forschler 2004). Neotenic reproductives refer sexually mature individuals that are not derived from an alate and rather developed from nymphs without fully developing wings (secondary) or workers (tertiary) (Thorne 1997, Lainé and Wright 2003).

Eusociality: social hymenopterans and subterranean termites Due to their similarities in social structure to the social hymenopterans, termites have often been termed “white-ants” in literatures up to the early 20th century (Snyder 1916). However, termites and hymenopterans are widely separated phylogenetically and there are fundamental differences between the eusociality of the two insect groups (Imms 1920, Snyder 1916). In contrast to social hymenopterans that utilize haploid/diploid system, all termite castes are consisting of diploid individuals and all castes are made up of both sexes (Snyder 1916). Age polytheism is the main driver for task allocation in social hymenoptera, yet there is generally a lack of such evidence in termites and their polyethism has yet to be fully illuminated (Robinson 1987). Another distinguishing characteristic is the life cycle, and termites go through hemimetabolous development as whereas hymenopteran development is holometabolous (Snyder 1916, Robinson 1987).

1.2 Self-organization in insects

Decentralized systems have been observed in numerous disciplines, extending from molecular to organismal levels (Detrain and Deneubourg 2006, Feinerman and Korman 2017, Getzin et al. 2016, Miramontes and DeSouza 2008, Sumpter 2006). Self-organization plays key role in many biological systems including quorum sensing, fairy circles, insect mound building and social behavior of animals (Fuqua et al. 1994, Bonabeau et al 1997, Sumpter 2006, Getzin et al 2016). This process involves lower units in a group responding to local information and self-organizing (Bonabeau 1997, Jeanson et al. 2005, Amé et al. 2006, Detrain and Deneubourg 2006, Sumpter 2006, Canonge et al. 2009, Gelblum et al. 2015).The decentralized system has frequently been used as models in biotechnology, in which individual units in a system independently make a decision and additively accomplish a complex goal (Halloy et al. 2007, Sempo et al. 2006). Self-organization driving animal collective behavior mainly involves three properties of self-organization (Sumpter 2006). The first was ‘more than the sum of its parts’ which refers to reinforcement based positive feedback within a group that continuously add to a preexisting signal under rewarding conditions. This property was most frequently observed in reinforcement based trail-pheromone in ants (Sumpter 2006). The ‘central limit theorem’ explained the utility of randomness in certain individual behaviors, which proved effective in symmetrical construction. Lastly, the influence of a preexisting condition on individual response to was described as ‘sensitivity to initial conditions’.

Eusocial hymenopterans are frequently used as model for understanding the dynamics of self-organization (Seeley and Visscher 2004, Detrain and Deneubourg 2006). Eusocial Hymenopterans display complex social-organization during foraging activities and nest-site selection, which involve a small number of individuals that eventually leads to mass recruitment (Mallon et al. 2001, Seeley and Visscher 2004, Visscher 2007, Detrain and Deneubourg 2006, Gelblum et al. 2015). Group-decision making is also observed in subsocial insects as illustrated by the keystone individual concept (Modlmeier et al. 2014). Cockroaches have been frequently studied as a model of collective decision making due to their subsocial behaviours observed in several species (Deneubourg et al. 2002, Jeanson et al. 2005). The subsociality of cockroaches can be defined as gregariousness and certain degree of parental care of young (Nalepa and Bell 1997, Rivault and Cloarec 1998). The studies on cockroach collective decision making behavior have frequently observed the resting site selection behavior in a group of cockroaches. These studies suggested that the odors produced from cuticular hydrocarbons and frass have been determined as the main stimuli which influenced the behaviors of individual cockroaches to display a decision (Rivault and Cloarec 1998, Rivault et al. 1998, Lihoreau and Rivault 2011). Contrary to eusocial insects, no specific task allocation has been observed and all individuals involved in the experiment appeared to have made its own decision based on the cues available (Rivault and Cloarec 1998).

1.3 Laboratory work with termites

Termite feeding behavior is of great interest to researchers due to its potential to provide useful information for management tactics (Grace and Yamamoto 1994, Katsumata et al. 2008, Malik et al 2012, Owoyemi et al. 2013). Numerous studies have been conducted to evaluate termite feeding preference and test efficacy of aversive and toxic materials (Behr et al. 1972, Cornelius et al. 2004, Charoenkrung et al. 2007, Tsunoda et al. 2010, Eger et al. 2011). Termite feeding behavior is most frequently observed with laboratory feeding bioassay using a small, isolated group of termites, typically not exceeding 500 individuals (Smythe and Carter 1970, Oi et al. 1996, Lenz 2009, Hapukotuwa and Grace 2011). Previous studies have utilized several different bioassay arena designs (no, two-, multiple-choice) under various laboratory conditions (temperature, wood species and density) that impacted termite feeding behavior (Behr et al. 1972, Smythe and Williams 1972, Oi et al. 1996, Thorne 1998, Owoyemi et al. 2013, Green and Kartal 2014, Lee and Forschler 2016). In particular, the studies employing choice-designs have illustrated that termite displayed feeding preference, even as isolated groups (Grace and Yamamoto 1994, Kadir and Hale 2012, Lee and Forschler 2016). Crosland and Traniello (1997) have suggested that individual termites were capable of shifting tasks, which may be indicative the ability of isolated termite groups to achieve a group decision.

Self-organization in termites is regulated by various communication strategies (Stuart 1969, Costa-Leonardo et al. 2009, Bagnères and Hanus 2015). Previous studies indicated that termites displayed certain behaviors in the presence of cues such as tactile stimuli, vibration and pheromones (Heidecker and Leuthold 1984, Miramontes and DeSouza 2008, Hager and Kirchner 2014). Pheromones identified in termites include trail-pheromone, sex-pheromone and labial gland extracts (Reinhard et al. 1997, Saran et al. 2007, Sillam-Dussès 2010). These cues in conjunction induced complex behaviors such as construction, colony defense, foraging and recruitment (Stuart 1981, Traniello 1982, Thorne 1998, Bordereau and Pasteels 2010, Fouquet et al. 2014, Hager and Kirchner 2014, Wang et al. 2016). For subterranean termites, much of activity is confined to a complex network of tunnels (Thorne 1998). As a result, the details of *Reticulitmers* task allocation and foraging behavior have not been fully elucidated (Crosland et al. 1998).

The impact of using various bioassay-designs on termite wood preference ranking has yet to be scrutinized. In addition, little is known about the group-decision making process in isolated group of termites. We hypothesized that the various bioassay designs and units of measurement would provide the same preference ranking for the 4 types of wood. We also hypothesized that the number of visits would be equivalent between introduction- and food-chambers and lowest at empty-chamber and that each unique termite individual would appear in the y-tube equal number of instances.

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CHAPTER 2

WOOD PREFERENCE OF *RETICULITERMES VIRGINICUS* (BANKS) USING NO-, TWO-, AND FOUR-CHOICE DESIGNS AND SEVEN DIFFERENT MEASURES OF WOOD CONSUMPTION

2.1 Introduction

The preference that subterranean termites display for different food resources can provide information useful in understanding the ecology of sympatric species in addition to information useful for management tactics (Lukamandaru and Takahashi 2008, Kadir and Hale 2012, Owoyemi et al. 2013). The ranking of subterranean termite feeding preference can be influenced by experimental conditions such as bioassay design and calculation of consumption rate (Smythe and Carter 1970, Thorne 1998). Bioassay of termite wood consumption also is affected by a number of factors attributed to experimental conditions including the vigor of the termites used in the assay, wood and termite species being tested, the number of termites per arena, wood density and age, temperature, wood and substrate moisture content, and the placement and number of food choices (Smythe and Carter 1969, Smythe and Carter 1970, Behr et al. 1972, Smythe and Williams 1972, Oi et al. 1996, Thorne 1998, Lukamandaru and Takahashi 2008, Lenz 2009).

Termite wood preference has been examined using a variety of bioassay designs including no-choice, paired-choice, and multiple-choice designs employed alone or in combination (Smythe and Carter 1970, Su and La Fage 1984, Grace and Yamamoto 1994, Oi et al. 1996, Indrayani et al. 2006, Hapukotuwa and Grace 2011). Termite wood consumption rates also have been measured using a number of units. Standardized protocols provided by wood protection organizations, such American Wood Protection Association and American Society for Testing and Materials use a subjective visual rating scheme based on estimated percent consumption and other characteristics of 'damage' on a scale of 10 ("sound") to 0 ("failure") (ASTM 1974, Charoenkrung et al. 2007, Umphauk and Chaikuad 2008, AWPA 2009, Hapukotuwa and Grace 2011). There also are rating schemes that use a numerical scale with fewer categories (SNI 2006, Tsunoda et al. 2010, Eger et al. 2011, Shelton et al. 2013). Quantitative units employed in termite wood preference studies include wood weight loss (mg) and percent wood weight loss, (Smythe and Carter 1970, Morales-Ramos and Rojas 2001, Indrayani et al. 2006, AWPA 2009, Hapukotuwa and Grace 2011). The potential impact of the number of termites and time in bioassay has stimulated use of units such as mg of wood/number of termite/day and mg of wood/g of termite/day (Su and La Fage 1984, Thorne 1998). Su and La Fage (1984) also factored in a "control" unit aimed at the potential for error in drying and weighing wood in addition to providing a correction for mortality over the course of bioassay.

The plethora of designs and units of measure used in bioassay of termite food preference makes comparisons difficult. This study examined the impact of three different bioassay designs (no-choice, two-choice, four-choice), using four wood genera (Pinus sp., Populus sp., Quercus sp., Sequoia sp.) and seven different units of wood consumption (wood weight loss, percent weight loss, SNI resistance class, mg of wood/number of termites/day, mg of wood/g of termite/day, ASTM visual rating, AWPA visual rating) on ranking the feeding preference of the subterranean termite Reticulitermes virginicus (Banks). We hypothesized that the various bioassay designs and units of measurement would provide the same preference ranking for the 4 types of wood.

2.2 Materials and Methods

Termite collection Logs containing *R. virginicus* were collected from various sites in Clarke Co., Georgia and cut into 1-m bolts using a chain saw. Bolts were brought into the laboratory and stored at room temperature in 60 x 10 x 38-cm (*l:w:h*) galvanized metal trays. Termites were collected from the bolts on a daily basis by placing PVC pipes (17 x 10 x 0.5-cm; *l:dia:thickness*) containing moistened corrugated cardboard near shelter tubes that protruded from the bottom of the bolts (Forschler and Townsend 1996). Termites thus collected were and placed into plastic boxes (26 x 19 x 9-cm) containing wet filter paper and moistened pine slats (12 x 4 x 0.2-cm) at 26°C and 78% humidity, in total darkness, for no longer than four weeks before inclusion in bioassay. Termites were identified to species using soldier and/or alate morphological characteristics (Lim and Forschler 2012).

Wood preparation Four types of dimensional lumber purchased from a local lumber store representing four genera; *Pinus* (Pine), *Quercus* (Red Oak), *Sequoia* (Redwood), and *Populus* (Yellow Poplar), were cut into 1-cm^3 cubes. The majority of the wood used in this study was a mixture of heartwood and/or sapwood, although all poplar cubes were chosen to represent the heartwood of this species because preliminary bioassay showed it to be resistant to termite feeding. Wood cubes were oven dried for approximately 24 hours and allowed to cool to room temperature inside a desiccation chamber containing Drierite before weighing. Wood dry-weight was measured, prior to and after bioassay, using an electronic scale (Denver Instrument APX-323) to tenths of a milligram. Wood cubes were placed in distilled water for approximately 24 hours and after excess surface moisture was removed using a dry paper towel they were placed into bioassay. The termite-exposed wood cubes were collected and cleaned using a soft brush then oven dried and weighed, as previously described, to obtain a post-exposure dry-weight.

Bioassay design Three bioassay designs – no-choice, two-choice, four-choice – were used. An arena was composed of 3 or 5 round, plastic containers (3.6 x 5.2-cm; *h:dia*) arranged to provide a single central-chamber and two or four feeding-chambers. The central chamber had two, 0.5-cm diameter holes placed 1.7-cm above the base of the plastic container for the central-chamber and at the base for feeding-chambers. A 7-cm length of Tygon tubing (5-mm OD) was used to connect the feeding-chamber to the central-chamber via the aforementioned holes. The central-chamber contained a water-saturated mixture of sand and vermiculite (7:6) placed to a height that reached the bottom of the Tygon tube.

The no-choice and two-choice designs were composed of one central-chamber and two feeding-chambers, as illustrated (Fig. 1). The no-choice design had three cubes of the same type of wood in one chamber and the other feeding chamber was empty. The two-choice design provided a choice between two types of wood, with each feeding-chamber containing 3 cubes of the same wood type. The four-choice design had a central-chamber and four feeding-chambers each containing 3 cubes of a single wood type (Fig. 1).

Three hundred workers (3^{rd} instar or higher) were added to the central chamber of each arena at the start of bioassay. The number of termites introduced was estimated by weight based on the average weight of 5 groups of 10 workers (Su & La Fage 1984) while the number of surviving termites was determined by actual count. A 5-cm binder clip was placed on the Tygon tubing connecting the central to the respective feeding-chambers to prevent termites from reaching the wood choices for approximately 24 hours. Termites were allowed access to the wood, after the 24-h acclimation period, for 21 days at which time arenas were dismantled, the wood removed, cleaned and dried and the number of surviving termites recorded.

A replicate consisted of 11 arenas – one no-choice arena for each of the four wood types; six two-choice arenas accounting all possible paired combinations; and one four-choice arena. A series of control replicates were prepared using the same setup described for the choice tests without termites to account for change in wood weight outside of termite feeding. A total of 16 replicates were performed.

Calculation of consumption rate Wood consumption was measured using a Denver Instruments (Model APX-323) analytical scale to the nearest mg and calculated using four quantitative measures- wood weight loss (g), percent wood weight loss (%), mg of wood/number of termite/day, mg of wood/g of termite/day and the Indonesian "resistance index" based on percent wood weight loss (SNI 2006). Two visual rating systems also were employed the AWPA E1-09 and ASTM D335 (ASTM 1974, AWPA 2009). A rating for the standardized visual rating systems was obtained for a replicate by assigning a number, as prescribed by each system, to each of the three cubes of wood within an arena and taking an average. Wood weight loss was measured by subtracting the final dry-weight from initial dry-weight. Percent wood weight loss was calculated by multiplying 100 to the quotient of weight loss and initial dry-weight. The mg of wood/number of termite/day was calculated by wood weight ÷ 300 (the number of termites at the beginning of the bioassay) ÷ by the number of days (21) in bioassay (Thorne 1998). The mg of wood/g of termite/day was calculated according to the formula in Su and La Fage (1984).

Analysis Analysis of the no-choice design used ANOVA to compare consumption rates of the four wood types. If the ANOVA yielded a significant difference (p-value ≤ 0.05), a Protected Least Significant Difference (PLSD) test was conducted. Analysis of the two-choice design involved four ANOVAs where each two-choice arena containing the same wood type was grouped together (i.e. all arenas with pine) and the consumption rate of the same wood type analyzed (i.e. all pine consumption rates were analyzed together). If the ANOVA yielded a significant difference (p-value ≤ 0.05), a PLSD test was conducted. The data from the four-choice design was analyzed using a “two-way ANOVA”, with both replicate and wood type considered independent variables to examine independence between treatments (the four wood types) with replicate considered the “second factor”. Data from the no- and four-choice designs were assigned a preference ranking from 1 to 4 with 1 being most preferred using the PLSD statistical separation of means (Table 1). Data from the two-choice design was assigned a preference ranking from 1 to 4 using a comparison chart of PLSD results (Table 2). The previously described analyses were repeated with all units of measure using SAS 9.3 (SAS Institute 2011).

Calculation of numerical rankings We also obtained a strict numerical ranking (sans statistical tests) of wood preference. In the no- and four-choice designs, the four wood types were ranked based on the numerical hierarchy of the mean wood consumption data, with the highest numerical value receiving a ranking of 1 and lowest 4 (Table 3). In the two-choice design, wood types were assigned a 1 (preferred) or 2 (not preferred) based on the numerical hierarchy of the mean wood consumption data in each paired test (Table 4).

2.3 Results

Bioassay design and unit of measure influenced the ranking of termite wood preference, when examined by either statistical mean separation or numerical ranking of means (Tables 1, 3 and 4). The only consistent agreement with statistical and numerical mean ranking as well as displaying no effect of unit was the two-choice design (Table 4). Statistical separation of means in the no-choice and four-choice designs provided variable preference hierarchies depending on the unit of measure utilized (Table 1).

Examination of the data using statistical mean separation with the no-choice design showed that the quantitative units weight loss (g), mg wood/# termites/day, and mg wood/g termite/day resulted in a tie for the #1 ranking between pine and red oak, a #2 for redwood, and a #3 for poplar (Table 1). The qualitative units percent weight loss, SNI, and E1-09 resulted in ranking pine #1, a tie for #2 between red oak and redwood, and #3 for poplar. The no-choice design using the qualitative ASTM rating resulted in a statistically supported ranking of #1 for pine, and a three-way tie for #2 among red oak, redwood, and poplar. The numerical ranking of all quantitative units and the qualitative units % wt loss and SNI resulted in ranking pine #1, red oak #2, redwood #3, and poplar #4 while the ASTM and E1-09 resulted in a #1 for pine, a tie for #2 between red oak and redwood, and #3 for poplar.

The quantitative unit mg wood/# termites/ day provided a 1-4 ranking using mean separation with the four-choice data of pine, red oak, redwood and poplar, respectively. The four-choice design using PLSD provided support for ranking the quantitative units weight loss and mg wood/g termite/day of #1 for pine, #2 for red oak, and a tie for #3 between redwood and poplar. The qualitative units % wt loss and E1-09 resulted in ranking pine #1, a tie for #2 between red oak and redwood, and #3 for poplar using the four-choice design while the SNI and ASTM resulted in a ranking of #1 for pine, and a three-way tie for #2 among red oak, redwood, and poplar (Table 1). The strict numerical rankings using the four-choice data resulted in the same ranking across all 8 units; #1 for pine, #2 for red oak, #3 for redwood, and #4 for poplar.

In contrast, the preference ranking provided by the two-choice design whether by statistical mean separation or simple numerical ranking was the same regardless of unit (Table 4). The two-choice combinations always resulted in a statistically validated separation of preference of one wood over the other (Table 4). Pine was preferred whenever combined with any of the other three we tested (Table 4). Red oak was preferred over redwood and poplar; while redwood was always preferred over poplar (Table 4). Poplar was never the preferred wood type (Table 4). Table 2 summarizes the method we used to provide an overall ranking using the two-choice bioassay data of 1) pine, 2) red oak, 3) redwood, and 4) poplar.

2.4 Discussion

The data generated in this study of choice-feeding bioassays using a subterranean termite and four types of wood illustrated the impact of design and unit on ranking termite wood preference. The purpose was to identify a methodology that provided a level of confidence towards claiming biological relevance as evidenced by a consistent hierarchy of rank. It should be noted that Oi et al. (1996) showed termites displayed a preference when the choices were separated rather than next to one another in bioassay. In contrast termite choice-designs most often involve presentation of food choices in the same arena (Smythe and Carter 1970, Grace and Yamamoto 1994, Quijian et al. 2006, Katsumata et al. 2008, Manzoor and Malik 2009, Malik et al. 2012, Green et al. 2014). Therefore, our physical separation of choices may have facilitated establishment of a hierarchy of preference compared to studies employing a single arena.

These experiments proved that design had a greater impact on consistent preference ranking compared to unit of measure. The design comparison clearly demonstrated that with any of the units we analyzed the no-choice bioassays identified the least preferred wood type (except the ASTM), the four-choice design the most preferred, and the two-way design a consistent hierarchy of preference (Tables 1 and 4). The choice of a bioassay design should be determined by the hypothesis of the experiment. Therefore it is our recommendation if the purpose of the test is to identify wood aversion to employ a no-choice design. The identity of the most palatable choice can be illuminated by a multiple-choice design and if the intent is to obtain a preference rank then a two-choice bioassay design should be employed.

Determining aversion or resistance to termite feeding may arguably be the most frequent reason for performing a bioassay using termites and wood. We surveyed 3 peer-reviewed journals and 2 proceedings and found 80 papers published since 2005 that examined termite wood choice (Forest Prod. J., n= 10; Insects, n= 7; J. Econ. Entomol., n= 6; Proc. of International Research Group on Wood Protection, n= 36; and Proc. of Pacific Rim Termite Research Group, n= 21). The complete list of papers is available upon request from the authors (Appendix A). That selected literature survey showed that the no-choice design (84%) and percent weight loss (80%) was most often employed in bioassay. The majority of those papers were related to efficacy of wood treatments (58%) and natural durability of wood (27%). We also found standards for testing resistance to termite 'damage' that involve 5 different units of measure including, American Society for Testing and Materials (D3345-74), American Wood Protection Association (E1-09), European Standard (EN117, EN118), Japanese Industrial Standard (JIS K 1571), and Standar Nasional Indonesia (SNI 01.7207-2006). All the aforementioned standards call for using a no-choice bioassay design with only E1-09 suggesting a concomitant two-choice bioassay. It should be noted that the European Standard includes a piece of "culture wood" and therefore does not constitute a true no-choice test while the ASTM standard was withdrawn in 2011 in favor of the AWPA standard (EN 2005a, 2005b, ASTM 2011). All the aforementioned standards call for reporting results as either percent weight loss (JIS 2004, SNI 2006) or outline a visual rating scale (ASTM 1974, EN 2005a, 2005b, AWPA 2009).

Previous studies have shown that termites will feed on less preferred food in the absence of a choice (Smythe and Carter 1970, Oi et al. 1996) and our results support the use of a no-choice design for standardized testing of wood treatments (ASTM 1974, JIS 2004, EN 2005a, 2005b, SNI 2006, AWPA 2009) because the no-choice design consistently identified the least preferred wood, ostensibly the purpose of a Standardized Testing protocol (Table 1). All the units we examined with the exception of one, the ASTM, statistically identified poplar as the least preferred wood using the no-choice data (Table 1). The E1-09 rating and ASTM yielded different rankings because the ASTM had a lower number of rating categories and lacks a "sound" or 'no visual evidence of feeding' category. As a result, the ASTM data provided a three-way tie among red oak, redwood and poplar, whereas the E1-09 separated red oak and redwood from poplar. The data, therefore, does not support the use of the ASTM for statistical determination of the least preferred wood choice. An alternative approach would be to use ASTM with the caveat that a rating of 10 be reserved for choices that show no visible evidence of feeding and a 9.5 for those that display between 10 and 9 (effectively changing it from a 5 to a 6 point scale).

Another reason for conducting bioassay of termite wood choice is to establish a hierarchy of preference (Cornelius et al. 2004, Manzoor and Malik 2009, Hapukotuwa and Grace 2011, Malik et al. 2012). The four-choice data illustrate that multiple choice tests consistently identified the most preferred wood yet the only unit that identified a statistically validated hierarchy of preference was mg wood/ # termites/day (Table 1). Interestingly, the four-choice design consistently, regardless of unit, identified a hierarchy of preference (pine, read oak, redwood, poplar from most to least preferred) using a simple numerical ranking - without statistical validation (Table 3). If the purpose of the bioassay is to statistically validate a preference hierarchy our data unequivocally demonstrate through consistency of results that the two-choice bioassay design is the most appropriate approach, regardless of unit (Table 4). A wood preference hierarchy can be established from the outcome of multiple two-choice tests by using the ranking method illustrated in Table 2.

The question of the most appropriate unit to use in a termite food choice bioassay should be dictated, in part, by the research objectives. Statistical validation of results is a hallmark of the modern scientific method. Termite feeding tests aimed at obtaining statistical separation of preference also should attempt to utilize the most objective unit of measure that is biologically relevant to the test conditions. It is our opinion, for the sake of argument, that the requirement of objectivity eliminates qualitative units that rely on a subjective visual estimate of consumption such as the AWPA, and E1-09. The quantitative units we examined can be listed in order of complexity (number of 'correction factors' involved) as weight loss, percent weight loss, mg wood per number of termites per day and mg wood per gram of termite per day (Tables 1 and 4). The latter unit is arguably the most 'accurate' measure of termite wood consumption because it accounts for a number of potential sources of error (Su and La Fage 1984). Yet, only the unit mg wood/ number of termites/ day provided a statistically validated preference rank using the four-choice design that matched the rankings obtained with a series of two-choice tests (Table 1). We, however, hesitate to recommend use of any single quantitative unit to obtain a biologically relevant preference rank because the main 'problem' with termite bioassay data is variability (Tables 1 and 4) (Grace and Yamamoto 1994, Thorne 1998, Hapukotuwa and Grace 2011). The mean separation we obtained using mg wood/ termite/ day may be an artifact related to the small numerical values generated by that unit (Tables 1 and 4).

A conundrum faced by researchers when designing a bioassay is providing a defensible conclusion based on a pragmatic number of replicates given constrains imposed by time, effort and supplies. Variability in a data set can be addressed by increasing the number of replicates

(Robertson et al. 2007). Our recommendation to use a two-choice design to validate a preference ranking of termite food choice illustrates the issue. A two-choice bioassay with four types of wood using 15 replications with 300 termites would require 90 arenas and 27,000 termites to test all possible combinations while the same comparison conducted using a 4-choice design would require 15 arenas and 4,500 termites. Large scale, industrial, screening programs could use a series of four choice bioassays to identify the most preferred choices followed by a series of two choice tests once the candidate substrates are narrowed down to 3 or 4. Our results indicate that ranking mean consumption rates using a numerical hierarchy determined termite aversion to poplar in the no-choice design, the preference of pine in the four-choice, and a detailed preference ranking sequence in the two-choice bioassays (Table 3). In fact, numerical ranking of means provided the same ranking sequence as the two-choice design using any unit in the no-choice and four-choice designs. The numerical ranking of means in no- and four-choice designs may serve as a quick substitute in providing a basic understanding of termite feeding preference using a large number of choices.

In summary, bioassay design had a greater impact on preference rankings compared to the units used to measure consumption. The no-choice design can identify wood treatments that deter termite feeding using any unit we examined aside from the ASTM rating scale. A 4-choice design can identify the most preferred wood employing any of the units we surveyed. Paired or two-choice bioassays can provide consistent results that could be used to construct a hierarchy of preference. We recommend using the simplest quantitative measure - weight loss - for standardized testing protocols rather than a subjective visual ranking because a quantitative unit provides an objective measure easily compared between studies.

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Figure 1: Illustration of the No-, Two-, and Four-choice bioassay arena arrangements. Chambers (3.6 x 5.2-cm; h:dia) were connected by Tygon tubing (5-mm OD).
(Key: C= Central-chamber, F= Feeding-chamber)

Cross-section:

Central-chamber (C) contained sand-vermiculite and feeding chambers

No- and Two-Choice Design:

No-choice design had one empty feeding-chamber and two-choice had

Four-Choice Design:

Each feeding chamber contained three wood cubes of the same type

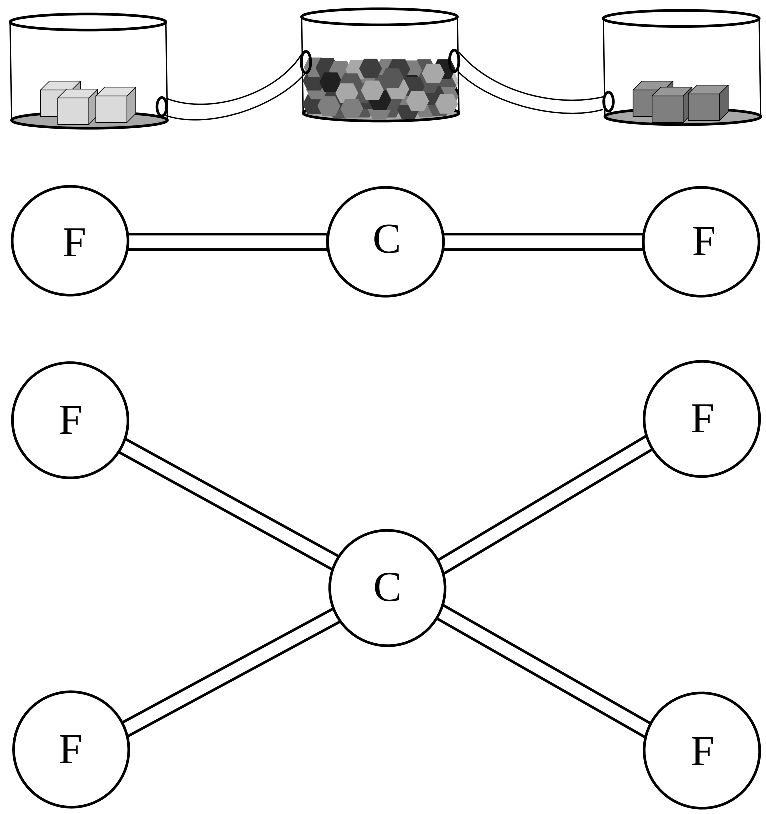

Table 1: Mean unit of meausre (Avg ± SD) by wood type with the PLSD-associated preference rank for the No- and Four-choice bioassay designs.

	Wt loss (g)		mg wood/ # termite/day		mg wood/ g termite/day		Percent wt. loss		Resistance Class (SNI)		ASTM rating		E1-09 rating	
No-Choice														
Pine	**0.364** ± 0.153	A*	**0.058** ± 0.024	A	**28.27** ± 10.63	A	**20.82** ± 8.960	A	**4.250** ± 1.340	A	**5.500** ± 2.270	A	**6.810** ± 1.510	A
Red Oak	**0.300** ± 0.165	A	**0.048** ± 0.026	A	**24.62** ± 9.900	A	**9.920** ± 3.630	B	**3.190** ± 0.830	B	**9.000** ± 0.000	B	**8.000** ± 0.760	B
Redwood	**0.155** ± 0.060	B	**0.025** ± 0.010	B	**17.56** ± 8.940	B	**9.290** ± 4.920	B	**2.750** ± 1.130	B	**9.000** ± 0.000	B	**8.000** ± 0.530	B
Poplar	**0.005** ± 0.007	C	**0.001** ± 0.001	C	**0.530** ± 0.950	C	**0.270** ± 0.330	C	**1.000** ± 0.000	C	**10.00** ± 0.000	B	**9.880** ± 0.230	C
Four-Choice														
Pine	**0.318** ± 0.117	A	**0.050** ± 0.019	A	**26.02** ± 5.970	A	**17.98** ± 6.270	A	**4.250** ± 0.860	A	**5.750** ± 1.980	A	**6.750** ± 0.710	A
Red Oak	**0.083** ± 0.053	B	**0.013** ± 0.008	B	**5.340** ± 3.680	B	**2.700** ± 1.240	B	**1.310** ± 0.480	B	**9.250** ± 0.460	B	**8.810** ± 0.530	B
Redwood	**0.029** ± 0.031	C	**0.005** ± 0.005	C	**1.520** ± 3.250	C	**1.190** ± 1.080	B	**1.060** ± 0.250	B	**9.880** ± 0.350	B	**9.190** ± 0.530	B
Poplar	**0.005** ± 0.008	C	**0.001** ± 0.001	D	**1.230** ± 2.620	C	**0.290** ± 0.430	C	**1.000** ± 0.000	B	**10.00** ± 0.000	B	**9.630** ± 0.230	C

* Results of PLSD are indicated within a column and by bioassay design by capital letters with different letters signifying statistically different values ($P < 0.05$).

Table 2: Explanation of the ranking of termite wood preference from the two-choice design data. Letters obtained from PLSD mean separation were used to assign a 1 (preferred) or 2 (not preferred) to the wood type in the first column when compared to pairing with the other three wood types listed in that same row. PLSD results and rankings listed in this Table apply to all units of measure examined in this study.

Key: Pi= Pine, Ro= Red Oak, Rw= Redwood, Po= Poplar

	Rankings						
	Pairing 1		Pairing 2		Pairing 3		Sum*
Pine	v. Ro	A (1)	v. Rw	A (1)	v. Po	A (1)	3 (1)
Red Oak	v. Pi	B (2)	v. Rw	A (1)	v. Po	A (1)	4 (2)
Redwood	v. Pi	B (2)	v. Ro	B (2)	v. Po	A (1)	5 (3)
Poplar	v. Pi	A (2)	v. Ro	A (2)	v. Rw	A (2)	6 (4)

* The Sum Ranking (in parenthesis) was determined by adding values in each row and issuing the lowest sum with a higher ranking.

Table 3: Comparison of the termite wood preference rankings by bioassay design, unit of measure and wood type obtained from numerical ranking of means without statistical validation.

	Wt loss (g)	mg wood/ # termite/day	mg wood/ g termite/day	Percent wt loss	Resistance Class (SNI)	ASTM Rating	E1-09 Rating
No-Choice							
Pine	1*	1	1	1	1	1	1
Red Oak	2	2	2	2	2	2	2
Redwood	3	3	3	3	3	2	2
Poplar	4	4	4	4	4	3	3
Four-Choice							
Pine	1	1	1	1	1	1	1
Red Oak	2	2	2	2	2	2	2
Redwood	3	3	3	3	3	3	3
Poplar	4	4	4	4	4	4	4
Two-Choice							
Pine	1	1	1	1	1	1	1
Red Oak	2	2	2	2	2	2	2
Redwood	3	3	3	3	3	3	3
Poplar	4	4	4	4	4	4	4

*Rankings were given based on numerical hierarchy of mean unit of measure.

Table 4: Mean unit of measure (Avg ± SD) and the preference rank for the two-choice bioassay design by wood type based on numerical ranking of means.

	Wt loss (g)		mg wood/ # termite/day		mg wood/ g termite/day		Percent wt loss		Resistance class (SNI)		ASTM rating		AWPA E1-09 rating	
Pine vs.	**0.276** ± 0.148	*1**	**0.044** ± 0.024	*1*	**21.39** ± 9.790	*1*	**15.34** ± 8.470	*1*	**3.750** ± 1.440	*1*	**7.130** ± 1.550	*1*	**7.000** ± 0.530	*1*
Red Oak	**0.101** ± 0.085	*2*	**0.016** ± 0.014	*2*	**7.050** ± 7.050	*2*	**3.190** ± 1.810	*2*	**1.440** ± 0.630	*2*	**8.880** ± 0.830	*2*	**8.630** ± 8.690	*2*
Pine vs.	**0.352** ± 0.149	*1*	**0.056** ± 0.024	*1*	**28.76** ± 6.680	*1*	**20.34** ± 8.390	*1*	**4.310** ± 0.870	*1*	**5.130** ± 1.550	*1*	**6.750** ± 0.460	*1*
Redwood	**0.052** ± 0.071	*2*	**0.008** ± 0.011	*2*	**2.510** ± 3.590	*2*	**2.080** ± 2.460	*2*	**1.250** ± 0.580	*2*	**9.750** ± 0.460	*2*	**9.130** ± 0.230	*2*
Pine vs.	**0.346** ± 0.156	*1*	**0.055** ± 0.025	*1*	**25.41** ± 8.230	*1*	**19.80** ± 9.030	*1*	**4.310** ± 1.25	*1*	**6.250** ± 1.390	*1*	**6.750** ± 0.460	*1*
Poplar	**0.007** ± 0.011	*2*	**0.001** ± 0.002	*2*	**1.410** ± 2.420	*2*	**0.410** ± 0.650	*2*	**1.000** ± 0.000	*2*	**10.00** ± 0.000	*2*	**9.500** ± 0.380	*2*
Red Oak vs.	**0.280** ± 0.095	*1*	**0.045** ± 0.015	*1*	**23.54** ± 3.750	*1*	**9.960** ± 3.540	*1*	**3.060** ± 0.770	*1*	**8.750** ± 0.710	*1*	**7.630** ± 0.520	*1*
Redwood	**0.045** ± 0.036	*2*	**0.007** ± 0.006	*2*	**2.230** ± 3.330	*2*	**2.590** ± 2.160	*2*	**1.190** ± 0.540	*2*	**9.880** ± 0.350	*2*	**9.500** ± 0.270	*2*
Red Oak vs.	**0.294** ± 0.106	*1*	**0.047** ± 0.017	*1*	**22.22** ± 4.030	*1*	**10.38** ± 3.710	*1*	**3.190** ± 0.750	*1*	**8.000** ± 1.070	*1*	**7.500** ± 0.760	*1*
Poplar	**0.004** ± 0.007	*2*	**0.001** ± 0.001	*2*	**0.580** ± 1.560	*2*	**0.190** ± 0.320	*2*	**1.000** ± 0.000	*2*	**9.880** ± 0.350	*2*	**9.560** ± 0.320	*2*
Redwood vs.	**0.175** ± 0.080	*1*	**0.028** ± 0.013	*1*	**17.58** ± 7.260	*1*	**11.83** ± 9.320	*1*	**3.130** ± 1.310	*1*	**8.500** ± 0.930	*1*	**7.880** ± 0.640	*1*
Poplar	**0.004** ± 0.008	*2*	**0.001** ± 0.001	*2*	**0.510** ± 0.980	*2*	**0.230** ± 0.400	*2*	**1.000** ± 0.000	*2*	**10.00** ± 0.000	*2*	**9.630** ± 0.230	*2*

* The numbers in italics represent the numerical ranking for the wood combination from the two-way arena based on the hierarchy of the mean unit of measure.

2.6 Appendices

Appendix A

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CHAPTER 3

RETICULITERMES FLAVIPES (KOLLAR) MOVEMENT AND BEHAVIOR OVER FOUR DAYS IN A Y-TUBE ARENA PROVIDING CHOICE AMONG TUNNELING SUBSTRATE-, FOOD- AND EMPTY-CHAMBERS

3.1 Introduction

Group decision-making, a process underlying social behavior in insects, is considered a decentralized procedure in which lower units respond to local information and self-organize (Bonabeau 1997, Jeanson et al. 2005, Amé et al. 2006, Neubourg 2006, Sumpter 2006, Canonge et al. 2009). The behaviors displayed by eusocial hymenopterans are frequently modeled for understanding the dynamics of self-organization where foraging and nest-site selection involve a small number of individuals that eventually leads to mass recruitment (Mallon et al. 2001, Seeley and Visscher 2004, Visscher 2007, Detrain and Deneubourg 2006, Gelblum et al. 2015). Group behavior can also be recognized in animals not generally considered eusocial as illustrated by the keystone individual concept (Modlmeier et al. 2014). A model for self-organization in subsocial insects is the behavior in cockroaches which occurs as the result of the incidental accumulation of cuticular hydrocarbons causing positive feedback leading to aggregation (Rivault and Cloarec 1998, Deneubourg et al. 2002, Canonge et al. 2009, Rivault and Cloarec 1998, Rivault et al. 1998, Amé et al. 2004, 2006, Jeanson et al. 2005, Lihoreau and Rivault 2011, Grodzicki and Caputa 2005, Millor et al. 2006). Active recruitment has also observed in the communal lepidopteran *Malacosoma americanum* where independently foraging individuals leave a recruitment signal if an abundant resource is located (Costa 1997). A review by Sumpter (2006) discussed three properties of self-organization driving animal collective behavior. The first, ‘more than the sum of its parts’ refers to reinforcement based positive feedback that continuously adds to a preexisting signal under rewarding conditions. The ‘central limit theorem’ explains the randomness in certain individual behaviors, which prove effective in tasks such as symmetrical construction. Lastly, the influence of a preexisting condition on individual responses is described as ‘sensitivity to initial conditions’.

Decision-making in termites is influenced by information obtained by tactile stimuli, vibration and pheromones (Stuart 1969, Costa-Leonardo et al. 2009, Bagnères and Hanus 2015, Heidecker and Leuthold 1984, Miramontes and DeSouza 2008, Hager and Kirchner 2014). Pheromones identified in termites include compounds that illicit trail, sex and phagostimulant repsonses (Reinhard et al. 1997, Saran et al. 2007, Sillam-Dussès 2010). The expression of complex behaviors such as construction, mate location, colony defense, foraging and recruitment are generally considered the result of semiochemical parsimony and the details are not, yet, fully elucidated with recent, exciting work involving the higher termites from the Family Termitidae – or (Bruinsma 1979, Stuart 1981, Traniello 1981, Bordereau and Pasteels 2010, Fouquet et al. 2014). The lower termites including the one-piece nesting Kalotermitidae and the intermediate nesting subterranean termites (Rhinotermitidae) have the same, basic suite of pheromones but certainly less reason to have a trail-following signal (Saran et al. 2007, Sillam-Dussès et al. 2009, Bordereau and Pasteels 2010). There is a lack of appreciation for the fact that lower termites would, within the confines of their network of tunnels, have a different role for the same compound used by above-ground foraging insects (Sillam-Dussès et al. 2007, Bordereau and Pasteels 2010).

Subterranean termites are most frequently observed with laboratory bioassay using groups, rarely exceeding 500 individuals that are taken from organized colonies containing 10's of thousands of individuals (Howard et al. 1982, Haagsma and Rust 1995, Forschler and Townsend 1996, Lenz 2009, Hapukotuwa and Grace 2011). Crosland and Traniello (1997) suggested that *Reticulitermes* were capable of temporal polyethism and their work has been used to justify fragmenting colonies in the laboratory and expecting colony-level relevance. This is reflected and validated in feeding preference bioassays that employ a choice-design (Grace and Yamamoto 1994, Kadir and Hale 2012, Lee and Forschler 2016). Yet understanding the basis of task allocation and partitioning in subterranean termites may be useful in explaining the source of the high variation most often displayed in bioassay (Grace and Yamamoto 1994, Thorne 1998, Katsumata et al. 2007, Lenz 2009, Hapukotuwa and Grace 2011).

Little is known about self-organization in *Reticulitermes* placed in bioassay. This study examined the movement of *Reticulitermes flavipes* (Kollar) using motion-detecting sensors and video recordings in a y-tube arena providing three choices: substrate (introduction/nest-chamber), wood blocks (food-chamber) and nothing (empty-chamber). We hypothesized that the number of termite-visits to the introduction/nest- and food-chambers would be equivalent and lowest at empty-chamber illustrative of a group choice. We also hypothesize that individual termites would appear in the y-tube on a predictable schedule with certain termites being more active than others.

3.2 Materials and Methods

Termites Termites were collected using methods described in Forschler and Townsend (1996), maintained prior to inclusion in the test using the methods described in Lee and Forschler (2016) and identified to species according to Lim and Forschler (2012).

Arena Design The experiment employed a y-tube choice arena made of 3 round, clear plastic containers (3.6 x 5.2-cm; *h:dia*) arranged with one introduction-chamber (IC) connected by a y-tube to one food-chamber (FC) and one empty-chamber (EC) (Figure 1). An 11-cm length of Tygon tubing (0.5-cm OD) was connected each chamber that lead to a clear, plastic y-tube (0.5-cm x 1.5-cm; *OD:arm length*). A water-saturated mixture of sand and vermiculite (7:6) was placed in the IC to provide a tunneling substrate, moisture source and 'nest' site. Three 1-cm^3 cubes of *Pinus sp.* were dried for 24 h, weighed using an electronic scale (Denver Instrument APX-323) to 0.1 mg, then soaked in water for 24-hours had excess surface moisture removed using a paper towel, and placed in the FC. The base of the FC, EC and y-tube were scored using sand paper to present a surface permitting firm footing for the termites.

Reticulitermes flavipes (Kollar) workers (3^{rd} instar or higher) were counted by weighing 5 groups of 10 to obtain a mean weight (Su and LaFage 1984) and 150 (plus one soldier) were placed in the IC at the beginning of bioassay. Termites were prevented from reaching the y-tube for the first 24 hours of the bioassay by placing a 5-cm binder clip on the Tygon-tubing leading from the IC. Arenas were dismantled at the end of 4 days at which time the number and distribution of surviving termites recorded, and dry weight of wood measured. An arena was considered a replicate and a total of 33 replicates were performed.

Motion sensor A motion detecting apparatus was constructed using optical tube liquid sensors (TT electronics OPB350 / OCB350 Series) connected to an Arduino Mega 2560 R3 and Arduino Ethernet Shield. The Arduino Ethernet Shield was installed to hold a micro SD card (8 GB) for data storage. The power (5V), ground (GND) and analog slots (A0, A2, A4) on the Shield were connected to a breadboard using male/male jumper wires to accept respective outputs from three optical sensors. Optical sensors were installed on each arm of the y-tube where it connected to the Tygon and labeled according to the connected chamber; IC (introduction-sensor, IS), FC (food-sensor, FS) or EC (empty-sensor, ES). A piece of Tygon-tubing (1.5 x 0.5-cm; *l:w*) was placed at the base of each optical sensor to raise the Tygon-tubing 5-mm to better align the bottom of the tube with the bulb on the optical sensor.

A program was prepared using Arduino software to detect a drop in voltage below a prescribed threshold (Appendix A) (Arduino 2015). The program took a voltage reading each second and recorded a “1” for all instances of obstruction (voltage reading below the threshold) or otherwise a “0”. Individual sensors were calibrated by subtracting the average voltage drop of 10, observed, termite passages from the default voltage reading (no obstruction).

Aggregation site The distribution of termites between chambers was visually estimated and recorded at 24, 48, 72 and 96 hours. The 96-h count was the actual number of termites in a chamber at the end of bioassay which was accomplished by placing binder clips on the tubes leading to each chamber prior to dismantling a replicate. The number of individuals in each arena was counted and/or visually estimated into six categories: 0 (no termites), 1 (1-10), 2 (11-20), 3 (21-50), 4 (51-90), and 5 (>90). A chamber with a score of 5 was considered the aggregation site for the next 24-h period. Aggregation site was considered absent (N/A) if no chamber was scored a 5 during a visual observation. The aggregation site data was taken at 24 hour intervals and the assumption was that the distribution of termites was maintained until the next reading. The day one distributions were determined by the fact that all termites started the bioassay in the IC.

Wood Consumption Termite wood consumption was calculated using wood weight loss (g) taken from the wood blocks that were oven dried for 24-h prior to and after bioassay (Lee and Forschler 2016). Mean wood weight loss (g) was compared using Mann-Whitney-Wilcoxon Test for replicates continuously aggregated in the FC and those that were not.

Frass depsotion Images of frass spots deposited on the FC and EC for each replicate were prepared by scanning bases of the chambers using a photocopier. The scanned images were converted from greyscale to black and white using Adobe Photoshop CS5.1 with threshold level set at 128, which provided images with black background and frass spots marked white. The number of white pixels (frass spots) in each image were counted using ImageJ. A t-test was conducted to compare the number of frass spot pixels between the FC and EC for all replicates and by aggregation site.

Sensor data correction The video termite moment data was also used to reference the sensor data (series of obstructions) with the actual number of termites observed passing that sensor at that time. The data comparing sensor and video recordings was placed in a fitted function that was considered a correction factor. The correction factor was applied to the sensor data to better represent the actual number of termites that passed a sensor (Appendix B). The corrected sensor data provided an "Estimated number of Termites Passing a Sensor" (ETPS).

Analysis Change-point analysis was conducted on the sensor data using SAS 9.3 (SAS 2011) to estimate two change points (CP1, CP2) identified by the greatest rate of change in slope using a beta (1-3, fitted slope) for each of phase (first, second and third phases). Change-point analysis used median sensor readings across all replicates by sensor (IS, FS, ES) and sum of the three (IS+FS+ES; IFES) in 1 hour increments. Mood's Median Test was conducted using RStudio V1.0.136 (R 2017) to rank traffic level (median sensor reading per hour) by Day (i.e. which day had highest and lowest traffic). Traffic level ranking was obtained for total traffic and individual sensor data (IS, FS, ES).

The entire data set was examined using Mann-Whitney-Wilcoxon Test conducted using RStudio V1.0.136 (R 2017) for paired comparisons (IS-FS, IS-ES, FS-ES) of median 2 hour-increment sensor data. The same analysis was conducted using replicates grouped by aggregation site. A paired Mann-Whitney-Wilcoxon Test was conducted for each replicate using the number of 5-min sensor readings to obtain a median for each 30-min periods. The 30-min period median data were analyzed in 2-hour increments with statistical significance determined at $p<0.05$.

Video recording Termite movement in the y-tube during bioassay was video recorded for 8 randomly selected replicates using a Canon Vixia HG20 video camera with an Impact DVP SWA38-37 wide angle lens. The 150 termites in those replicates were painted with a mixture of paint removed from Decocolor paint pens and acetone (2:1) using a blunted insect pin. Individual termites received a unique combination of three colors, placed on the dorsal side of the thorax, upper and lower abdomen. Lighting was accomplished using a microscope light (Lumina of Chiu Technical Corporation Model F0-150) and the directional movement (i.e. IC⇄EC) of each individual - termed Traffic-Flow (TF) - was placed into an Excel spreadsheet by time. The number of individual Termites Observed Passing a Sensor (TOPS) was recorded for the first four hours and the first 15-min of each subsequent hour for a total of 96 hours per replicate. Cumulative Termites Observed Passing a Sensor (CTOPS) was used to model of trail-pheromone concentration for the first four hours with dissipation after 30-min as suggested by Cornelius and Bland (2001). This model assumes that termites continuously lay consistent amount of trail-pheromone while moving across chambers and trail concentration in each tube would be represented by the CTOPS. CTOPS was measured by cumulatively adding TOPS values in 1-second increments and subtracting a value 30-min past its occurrence. The distribution of termites (number of individuals in each chamber) was also recorded in 1-second increment for the first four hours.

3.3 Results

Aggregation Site All replicates were considered aggregated in the IC at the start of the test and the daily estimates of termite distribution showed that at 24, 48 and 72-h most replicates had, and remained, aggregated in the FC (n= 17). This was followed by replicates that consistently aggregated in the EC (n=7) and one replicate in the IC. The remaining 8 replicates provided at least one 24-h reading with no definitive aggregation of which 6 aggregated in FC for at least 2 days while 1 replicate spent two 24-h periods aggregated in EC. A single replicate provided a daily distribution of FC, NA and EC from Days 2-4 respectively and was the only replicate that aggregated in more than one chamber during the course of the bioassay (Table 1). The visual estimates of termite distribution obtained at 96-h, when the replicates were dismantled, were consistent with the numbers counted at the end of the bioassay validating the visual estimates (t-test p= 0.49). There were 10 replicates that changed aggregation sites between the 76 and 96-h readings including 5 that went from EC to NA, 2 each for FC to NA and NA to FC and 1 that moved from EC to FC (Table 1).

Wood Consumption The mean wood weight loss (g) for all replicates was **0.126** ± 0.043 (Table 2). Mean wood weight loss from replicates continuously aggregated in the FC (n=17) was **0.131** ± 0.045 and those that aggregated elsewhere (n=16) was **0.117** ± 0.024 which were statistically similar (p= 0.557) (Table 2). This indicates that aggregation behavior did not influence wood consumption.

Frass Deposition The mean amount of frass deposition as indicated by number of white pixels for all replicates was **2441.9** ± 1198.8 in the FC and **724.0** ± 559.6 in the EC (Figure 2). Mean number of frass spot pixels from replicates continuously aggregated in the FC (n=17) was **2574.0** ± 1357.4 in the FC and **646.1** ± 445.9 in the EC, and from replicates continuously aggregated in the EC (n=7) **2221.9** ± 907.9 in the FC and **931.0** ± 851+6 (Figure 2). In the replicate aggregated in the IC, the amount of frass spot pixels was 1235 in the FC and 316 in the EC (Figure 2). The number of frass spot pixels was higher in the FC than EC (p= 8.41E-09). This indicates that termites deposited more frass in the FC regardless of aggregation site.

Correction Factor Our original assumption was that a "1" recorded by a sensor set on a 1-second schedule corresponded to the passage of a single termite past that sensor. The results, using the 1-for-1 assumption, provided a median of 865.5 movements per hour through all 3 sensors/arena over the four days of bioassay (day 1=780.0/hr; day 2= 1026.5/hr; day3= 928.3/hr; day 4= 835.0/hr). The video showed that a "1" recorded by a sensor did not always correspond to the passage of one termite. The optical sensors inflated the record of traffic as defined by the 1-for1 assumption because of a termite moving slowly (taking more than one second to pass through the beam) or stopping on a sensor for a certain period resulted in continuous obstruction that produced a string of 2 or more 1's that required interpretation. This issue was resolved by applying a correction factor (Appendix B), that interpreted 2-6 continuous obstructions as a "1" and 7 or greater using the formula $\sqrt{x}/2$, where "x" is the value of the string of 1's in the sensor data set. The correction factor reduced the sensor data from 800+ ETPS per hour for all three sensors to approximately half: 472.3/h. A paired Mann-Whitney-Wilcoxon Test resulted in no separation (p<0.05) between ETPS and TOPS for all 15-min periods in any sensor. This result supported use of the corrected sensor data to estimate the number of termite passages for the entire data set.

Sensor Data Overall movement within a replicate by day provided medians of 463.4, 505.7, 476.9, and 439.0 IFES per hour for Days 1-4 respectively (Figure 3). The median IFES was highest on Day 2 (Mood's Median Test, rank=1), followed by 1, 3 (rank= 2) and 4 (Rank

=3). Median hourly ETPS by sensor and day for IS was 150.1, 144.0, 129.7, and 115.1, (Days 1-4 respectively) (Figure 3). The median IS ETPS was highest on Days 1 & 2 (rank=1) followed by Day 3 (rank=2) and Day 4 (rank=3). The median hourly ETPS by day at the FS was 202.6, 215.0, 208.7, and 184.6 (Days 1-4 respectively) (Figure 3). The median FS ETPS was highest on Days 2 & 3 (rank=1) followed by Days 1 & 3 (rank=2). The median hourly ETPS by day at the ES was 98.5, 129.6, 125.7, and 111.0 for Days 1-4 respectively (Figure 3). The median ES ETPS was highest on Days 2-3 followed by Day 4 (rank=2) and Day 1 (rank=3).

The change points for median IFES were 1.8h (CP1) and 39.0h (CP2) with first phase (0-1.8 hours) slope of -40.01, second phase (1.8-39.0 hours) slope 3.16 and third phase (39.0-96 hours) slope -2.19 (Table 3). This indicates termite activity was initially high for the first hour but dropped sharply by the second hour when it slowly increased for the next 37 h before beginning a slow decline that lasted through the remainder of the bioassay. The change points for median IS were at 2.7h (CP1) and 5.8h (CP2) with first phase (0-2.7 hours) slope of -57.38, second phase (2.7-5.8 hours) slope 2.24 and a third phase (5.8-96 hours) slope -0.43 (Table 3). This indicates that similar to IFES, termite activity was initially high at the IS for the first two hours but dropped sharply after the third hour then slowly increased for the next 3h before beginning a slow decline through the remainder of the bioassay. The change points for median FS were at 11.2h (CP1) and 44.0h (CP1) with first phase (0-11.2 hours) slope of 6.99, second phase (11.2-44.0 hours) slope 0.55 and third phase (44.0-96 hours) slope -0.93 (Table 3). This indicates increase in termite activity at the FS for the first 11h and a continued but slower rate of increase for the next 33 h before beginning a slow decline for the remainder of bioassay. The change points for median ES were at 25.4h and 63.9h with first phase (0-25.4 hours) slope of 3.08, second phase (25.4-63.9 hours) slope 0.27 and third phase (63.9-96 hours) slope -1.57

(Table 3). This indicates an increase of activity at the ES (at a lower rate than FS) for the first 25 h followed by a slower rate of increase for the next 28 h before beginning a slow decline for the remainder of bioassay.

The sensor data examined using paired Mann-Whitney Wilcoxon tests to obtain rankings (1-3) by 2-hour periods indicated that the ETPS during the first 2 hours was highest at IS, second FS and lowest ES. During the next 8 hours (3-10h), IS and FS were equivalent and ES lowest. From 11-18h, FS was highest, IS second and ES lowest. For the remainder of bioassay (19-96h), FS was highest and IS and ES equivalent (Appendix C). In the replicates continuously aggregated in FC, ETPS during the first 2 hours was highest at IS, second FS and lowest ES. IS and FS was equivalent from 3-10h and ES lowest. From 11-46h, FS was highest and IS and ES equivalent. In the following 24h (47-70h), FS was highest, IS second and ES lowest, with exception of 49-52h and 63-66h. ETPS at FS was highest and IS and ES equivalent from 71-88h. For the remainder of bioassay (89-96h), IS and FS were equivalent and ES lowest (Appendix C). The rankings obtained from replicates continuously aggregated in ES showed the IS had the highest ETPS with FS second and ES lowest during the first 2 hours of bioassay. The ETPS for the IS and FS were equivalent and ES lowest over the next 6 hours while the FS was highest from 9-20h, and IS and ES equivalent. All three sensors were equivalent over the next 6 hours. These results show ETPS was equivalent for IS and FS at the beginning of bioassay when termites were aggregated in the IC. The ETPS for FS thereafter was consistently highest among FC aggregated replicates and equivalent to ES among EC aggregated replicates.

Examination of ETPS by replicate using paired-Mann-Whitney Wilcoxon tests by 2-hour periods illustrated high variability among replicates (Appendix C). A description of traffic patterns established in each replicate can be found in Appendix C and graphic illustrations in

Appendix D. The overall pattern of movement that emerges from the ETPS indicates that termites travelled from the IC to the FC on the first day after which traffic was essentially equivalent between FS and either IS or ES for the remaining days (Appendix C). There were 14 replicates where ETPS was equivalent between FS and IS after Day 1, 13 replicates where ETPS was equivalent between FS and ES and the remaining 6 provided shifts in traffic pattern (Appendix C). The ETPS data match the aggregation site information and indicate that most replicates moved from IC to FC on Day 1 and then travelled preferentially, within replicates, to either the IC or EC with the combined data giving the impression is equitably (Appendix C).

Video Data The mean number of individuals observed, per replicate, during the first 4 hours was 81.9 which represents 53.6% of the termites in a replicate (Table 4). The number of termites observed during first 4-hours was, however, variable, between replicates, ranging from 9.3%, to, 99.4% (Table 4 & 5). The mean number of termites seen across all replicates between 1-5 times in the first 4h was 57.6 (38.4%) and the mean number for each successive category decreased; 6-10 times was 13.5 (9%), 11-20 times 8.4 (5.6%), 21-30 times 1.2 (0.9%) and >30 times 1.0 (0.7%) (Figure 4). There were 46% of the available termites that were never observed while 47% were observed less than 10 times. The proportion of individual termites seen across all replicates more than 10 times was 7%.

The mean proportion of termites, per replicate, observed over 4 days from the 15-min data was 87.6% (127.8) with proportions within replicates ranging from 57.6%, to 100% (Table 4 & 5). The mean number of individual termites seen 1-5 times in the 15-min/h data set (96h) was 51.3 (27.9%) a mean that decreased with each successive category; those observed 6-10 times was 27.1 (14.8%),11-20 times 25.3 (13.7%), 21-30 times 13.0 (7.1%) and >30 times 11.1

(6.1%) (Figure 5). Fifteen percent of the available termites were never observed while half (52%) were recorded <10 times.

Mean TF/15-min in the first four hours was 16.5 between IC⇄FC, 8.6 IC⇄IC, 4.9 IC⇄EC, 2.7 FC⇄EC, 1.2 FC⇄FC, and 0.5 EC⇄EC (Figure 6). The highest mean TF in the first four hours was IC⇄FC followed by IC⇄IC, where termites passed the IS but turned around in the Y-tube without encountering another sensor. The mean number of TF/15-min on Day 1 was 20.5 for IC⇄FC, 6.5 IC⇄IC, 3.4 IC⇄EC, 4.5 FC⇄EC, 1.8 FC⇄FC, and 0.4 EC⇄EC, (Figure 6). The mean number of TF/15-min on Day 2 (15-min/h) was 20.1 IC⇄FC, 6.8 FC⇄EC, 3.4 FC⇄FC, 2.5 IC⇄EC, 2.0 IC⇄IC and 0.8 EC⇄EC (Figure 6). Mean TOPS/15-min in Day 3 was 17.0 between IC and FC, 5.3 FC⇄EC, 1.8 FC⇄FC, 1.4 IC⇄IC, 1.4 IC⇄EC and 0.8 EC⇄EC (Figure 6). Mean TOPS/15-min in Day 4 (15-min/h) was 19.1 between IC and FC, 5.3 FC⇄EC, 2.1 FC⇄FC, 1.5 IC⇄IC, 1.5 IC⇄EC and 0.4 EC⇄EC (Figure 6). Mean TF/15-min for IC⇄FC was highest in 7 (of 8) replicates and made up 48.0% of all movement from 1-4h and 54.9%, 56.5%, 61.4% and 63.8% for Days 1-4 respectively (Figure 7). The TF in the remaining replicate was greatest between FC⇄EC (43.9% of all TF) (Figure 7).

The mean number of termites seen for the first time using the 15-min data set decreased by Day 7.8, 2.3, 0.5 and 0.2 (Days1-4, respectively) (Figure 8). The mean number of unique individuals observed per 15-min segment was 23.6, 23.7, 18.7 and 19.6 on Days 1-4 respectively. There was a mean number of TOPS per 15-min of 40.8, 38.5, 29.6 and 30.8 on Days 1-4 respectively (Figure 8). All measures of termite activity decreased, as indicated by Mood's Median Test, starting Day 2 in bioassay (Figure 3 & 7).

The CTOPS observation for the first four hours resulted in high variability among replicates. The CTOPS of each replicate is available in Appendix E. The overall pattern that emerged was either consistently highest CTOPS at IS (n= 4 replicates) or equivalent between IS and FS (n=3) or ES (n=1) by 4h (Appendix E). Majority of termites in 6 replicates, ranging from 56-100% of individuals, remained in IC by 4h, and 80-90% of individuals moved into FC in 2 replicates (Table 1).

3.4 Discussion

Laboratory experiments with subterranean termites are notorious for providing data sets with variability attributed to influences that range from colony-level factors to vigor of the test subjects (Katsumata et al. 2007, Lenz 2009). The bias attributed to any disruption caused by separating individuals from a colony numbering in the thousands into smaller groups for bioassay have been dismissed based on studies that described a plastic response to task switching (Crosland and Traniello 1997). The preponderance of support for the lack of impact from polytheism are studies where termites placed in choice-design bioassay display a choice (Cornelius et al. 2004, Manzoor and Malik 2009, Hapukotuwa and Grace 2011, Malik et al. 2012, Lee and Forschler 2016). The current examination of traffic patterns in a y-tube arena was designed to illuminate patterns of group decision-making in the obligate eusocial subterranean termite *Reticulitermes flavipes*.

The bioassay began with all termites in the IC and at the first (24h) observation period 88% (29/33) of the replicates displayed a distribution that aggregated in one of the three chambers (Table 1). Termites were aggregated in 90% of the daily observations over the course of the last 3 days with FC being the most frequently recorded aggregation site, 70% of the time (Table 1). Termite aggregation behavior in the FC can be explained in part as a response phagostimulant hydroquinone (Reinhard et al. 1997, Reinhard et al. 2002). However, our daily observation showed that 24% of the replicates aggregated in IC (n=1) or EC (n=7) illustrating that *Reticulitermes* aggregation behavior is independent of a feeding site stimulus. The low frequency of aggregation in IC (n=1), despite the 24-h acclimation period, may be related to a response to alarm pheromones inherent to introducing disconnected, naïve termites into an arena (Schwinghammer and Houseman 2006, Gautam and Henderson 2012, Wang et al. 2016). The aggregation signal is likewise not a response to a concentration-dependent accumulation associated with numbers of termites in a chamber as illustrated by the first 4 hours data set that showed both slow accumulation of individuals into FC (n=1 replicate) and quick mass-movements (n=2) (Appendix E). Frass deposition also did not appeared to influence termite aggregation behavior as indicated by higher number of frass spots in the FC than EC even among replicates continuously aggregated in the EC. The "shifts" in aggregation site between our daily observations periods (n=8) indicate the aggregation behavior is a response to an ephemeral, not-persistent signal (Table 1).

The choice of aggregation site did not influence wood consumption indicating termites aggregated in IC or EC made sufficient visits to FC to eat as much as those aggregated in FC (Table 2). The ETPS data corroborated this suggestion because replicates aggregated in the EC and IC showed statistically higher values for the FS compared to the IS while replicates aggregated in FC provided equivalent values for the ES and IS (Appendix C). However, when FC- aggregated data were viewed by replicate there were 2 that had higher ETPS for EC and 11 had higher ETPS for the IC demonstrating a preference in TF within a replicate (Appendix C). The statistically higher ETPS on Day 1 at IS was the only consistent trend found in the inter-replicate data set due to the presence of all termites in the IC at the start of the test (Table 1, Appendix D). The sum of median ETPS at FS and ES during the first hour was 199 compared to 257 at IS indicating that 15% of the TF out of the IC entered the Y-tube but did not proceed to another sensor (Appendix D). Twenty-seven of 33 replicates showed a bias in ETPS between the FC and one other chamber suggesting directed traffic into/through the Y-tube (Appendix C).

Trail following in our bioassay arena associated with the concentration of a pheromone would have been evidenced by directed TF after a threshold number of ETPS at a particular sensor. The CTOPS data did not show any relationship between trail and aggregation site (Appendix E). The two replicates that displayed aggregation behavior by 4h had CTOPS at FS of 21 & 47 prior to a mass-movement. However, this behavior was not observed in four replicates despite having a CTOPS at FS ranging from 28-151 by 4h (Appendix E). There is a possibility that *Reticlitermes* selectively lay trails in response to local stimuli, as observed in some species of higher termites, and *Reticulitermes* have shown sensitivity to plant volatiles (Malaka 1987, (Grace and Campora 2005). However, we have observed in one replicate the first termites to appear in the y-tube went straight from IC to EC, indicating that alternative cues to volatiles released from wood may be utilized as well (Appendix E). Our data also showed instances of a termite leaving a chamber entering the y-tube then returning to the same-chamber, a behavior that was observed at least once during all days of the bioassay in all replicates (Figure 6). A mean proportion of 19.1% of TF/15-min resulted in the turn-around behavior in a replicate.

We observed 3 instances, in 2 replicates, where termites moved en masse (40%, 51%, 64%) from one chamber to another in a time span ranging from 15 to 25-min (Appendix E). Dispersal behavior has been well documented in cockroaches as a result of threshold concentration of salivary secretions (Faulde et al. 1990). Similarly Saran et al. 2007 observed a "repellent" concentration of (3Z, 6Z, 8E)-Dodecatrien-1-ol in a trail-following experiment using *Reticulitermes hesperus*. These mass-movements showed directed TF, with a mean proportion of 51.3% of individuals that moved from one chamber to another without entering/exploring the third, and resulted in 100+ individuals aggregated in one chamber. The occurrence of mass-movement in a replicate may indicate an recruitment event by key stone individuals or alarm disturbance (Stuart 1981, Schwinghammer and Houseman 2006, Gautam and Henderson 2012, Modlmeier et al. 2014, Wang et al. 2016). In addition, the second mass-movement at 73h (Replicate 23) was characterized by >100 individuals leaving FC and entering IC within a 15-m period. This result showed that mass-movements are not exclusive to the start of bioassay and that they can occur within a short time frame most likely in response to an ephemeral signal. However, the mass-movement events did not leave a characteristic sensor signature because termites displayed a consistent level of ETPS/30-min. We could expect a mass-movement with directed TF resulting in a 1:1 ratio between two sensors with approximately 68-113 ETPS/sensor/30-min characterizing the event. The median ETPS for IS, FS and ES were 70, 98 and 68/30-m respectively, with ranges that fell within the ETPS recorded for the three events we witnessed (Figure 3 & Appendix E).

Termites in at least two replicates were aggregated in FC by the 4h which indicated presence of a detectable cue and response to initial conditions (Sumpter 2006). Our design provided a clear binary choice (FC vs. EC) and given the short length of the tube, it is likely that volatiles released by the pine blocks were detected by the termites. It known that subterranean termites direct galleries during construction based on chemical cues, moisture content and temperature (Grace and Campora 2005). As a result, termite movement across chambers at the start of bioassay (1-4h) was skewed to one chamber and did not show properties of ‘central limit theorem’ (Figure 6 & Appendix C). Although the median data give an impression of aggregation in FC and made equivalent visits to IC and EC, the data are not normally distributed which is a central feature of self-organizing systems (Appendix C & D) (Sumpter 2006). The ETPS data when examined by replicate show TF always directed to the FS (FC⇄EC or FC⇄IC) with not a single replicate showing high TF IC⇄EC (Appendix C).

In summary, our data demonstrated the variability associated with termite bioassay that resulted in each replicate illustrating a “personality” with few consistencies. The variability in parts can be explained by random-selection of individuals from a much larger group, as suggested by the difference in frequency of appearance by individuals in a replicate. Furthermore, the proportion of more frequently appearing individuals varied by replicate (Table 5). The only consistency was that most replicates established an aggregation site and directed TF, but our data did not provide evidence for directed movement to concentration based trail signal. We instead observed behaviors that may be associated with signals that induce ‘pick-up and move’ (mass-movement) and aggregation independent of food.

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Figure 1: Illustration of the bioassay arena arrangement employed in this study. Chambers (3.6 x 5.2-cm; h:dia) were connected by Tygon tubing (5 x110-mm *OD:l*).

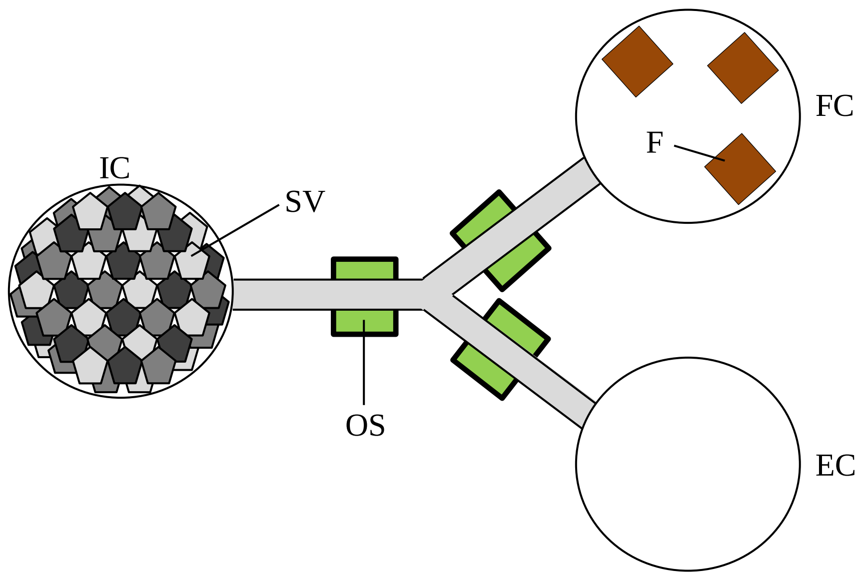


Table 1: Aggregation site (IC, FC, EC) by day and replicate based on the visual observations (scored 0-5) of termite distribution at 0, 24, 48, 72, and 96* hours (* the 96h reading was the result of actual counts at the end of the bioassay). The 4h** reading was result of actual counts in the video recorded replicates and the number in parenthesis refers to actual number of termites in the chamber. A chamber with a score of 5 was determined the aggregation site for each day. All termites were present in Intro at the beginning of bioassay. "N/A" refers to absence of a chamber scored a 5. Replicate number corresponds to Appendices C & D.

Rep	0h	4h**	24h	48h	72h	96h*
Rep 1	IC	-	FC	N/A	N/A	FC
Rep 2	IC	-	FC	N/A	FC	FC
Rep 3	IC	-	FC	FC	FC	N/A
Rep 4	IC	-	FC	FC	FC	FC
Rep 5	IC	-	FC	FC	FC	FC
Rep 6	IC	-	N/A	FC	FC	FC
Rep 7	IC	IC (133)	FC	FC	FC	FC
Rep 8	IC	-	FC	N/A	N/A	N/A
Rep 9	IC	-	FC	FC	FC	FC
Rep 10	IC	-	FC	FC	FC	FC
Rep 11	IC	-	FC	FC	FC	FC
Rep 12	IC		FC	FC	FC	N/A
Rep 13	IC	-	FC	N/A	EC	N/A
Rep 14	IC	-	FC	FC	FC	FC
Rep 15	IC	-	EC	EC	EC	N/A
Rep 16	IC	IC (145)	N/A	FC	FC	FC
Rep 17	IC	-	FC	FC	FC	FC
Rep 18	IC	-	EC	EC	EC	FC
Rep 19	IC	IC (150)	FC	FC	FC	FC
Rep 20	IC	-	FC	FC	FC	FC
Rep 21	IC	-	EC	EC	EC	EC
Rep 22	IC	-	N/A	FC	FC	FC
Rep 23	IC	FC (135)	IC	IC	IC	IC
Rep 24	IC	-	FC	FC	FC	FC
Rep 25	IC	-	FC	FC	FC	FC
Rep 26	IC	-	FC	FC	FC	FC
Rep 27	IC	-	FC	FC	FC	FC
Rep 28	IC	-	EC	EC	EC	N/A
Rep 29	IC	-	EC	EC	EC	N/A
Rep 30	IC	-	EC	EC	EC	N/A
Rep 31	IC	N/A (84)	EC	EC	EC	EC
Rep 32	IC	FC (120)	EC	EC	N/A	FC
Rep 33	IC	IC (122)	FC	FC	FC	FC

Table 2: The mean wood consumption (wood weight loss, g) ± SD of entire data set and by aggregation site. "Misc" refers to replicates in which aggregation site shifted or was absent (N/A) during one or more visual observation from Days 2-4.

	All Replicates (n=33)	Aggregated in FC (n=17)	Aggregated in EC (n=7)	Aggregated in IC (n=1)	Misc. (n=8)
Mean	0.126	0.134	0.133	0.081	0.108
±SD	0.037	0.045	0.026	-	0.010

Figure 2: Mean number of frass deposition (±SD) in the FC and EC as indicated by white pixels representing frass spots for all replicates (All Reps) and by aggregation site (Introduction, Food, Empty). N/A refers to replicates that lacked an aggregation site during at least one visual observation and shifted from between two chambers.

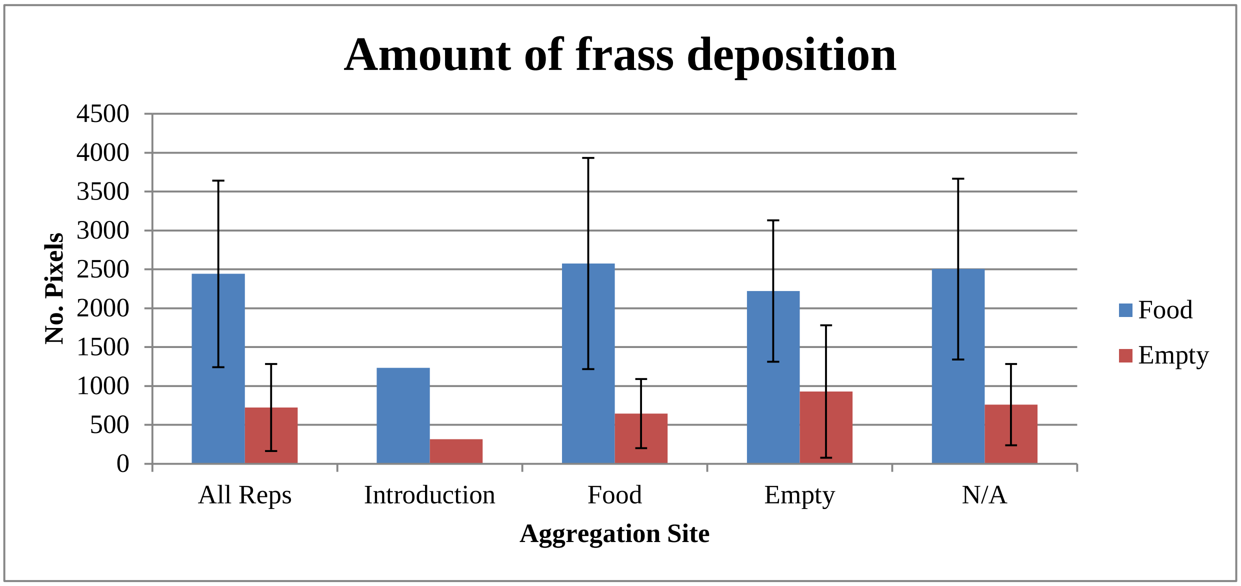


Figure 3: Median activity/hour ± Standard Error by day (1-4) and sensor (Intro [IS], Food [FS], Empty [ES]. Total traffic refers to the sum of three sensor data. The letters above the graphs refer to the ranking results of medians by day using Mood's Median Test.

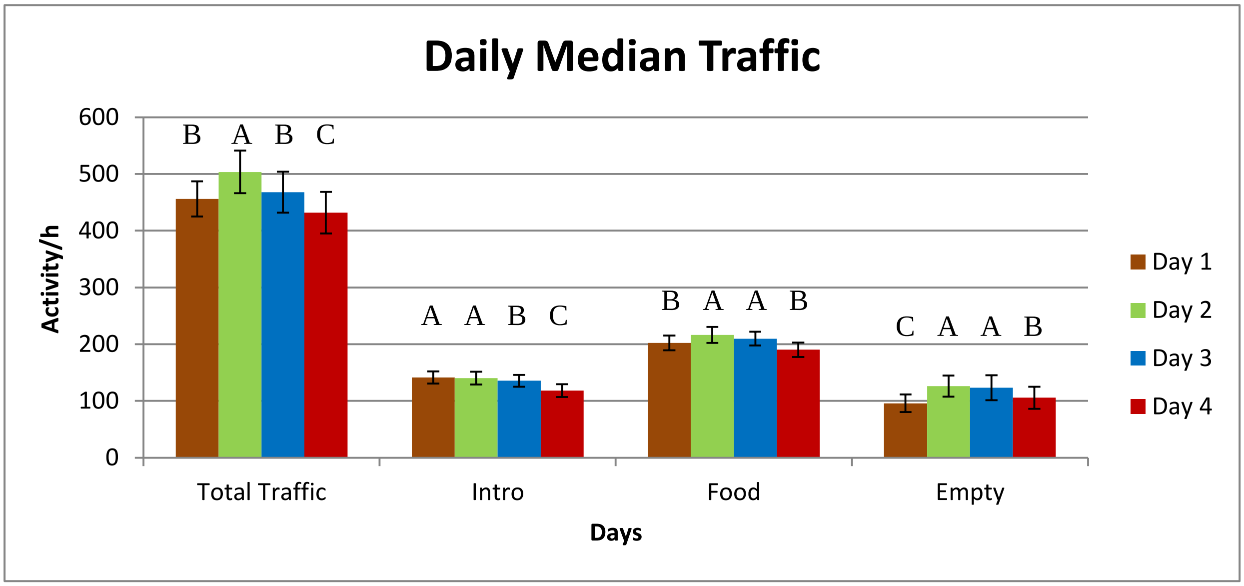


Table 3: The two change-points (CP) and slopes associated between the change points (± SD) by sensor (Intro [IC], Food [FC], Empty [EC]). Total traffic refers to the sum of three sensor data. "-" refers to no measurable SD.

Chamber	CP1	CP2	Y-intercept	Slope 1	Slope 2	Slope 3
Intro	**2.6**	**5.8**	**302.20**	**-57.38**	**2.24**	**-0.43**
	± 0.2	± 3.5	± 14.79	± 9.35	± 4.68	± 0.03
Food	**11.2**	**44.0**	**124.80**	**6.99**	**0.55**	**-0.93**
	± 0.8	± 2.3	± 4.81	± 0.71	± 0.14	± 0.07
Empty	**25.4**	**63.9**	**70.12**	**3.08**	**0.27**	**-1.57**
	± 1.1	± 1.6	± 2.49	± 0.17	± 0.09	± 0.11
Total Traffic	**1.8**	**38.9**	**489.60**	**-40.01**	**3.17**	**-2.19**
	± 0.5	± 1.6	± 19.7	-	± 0.3	± 0.15

Figure 4: Mean frequency of appearance (±SD) of termites in the y-tube in video recordings (n=8 reps) for the first 4 hours of bioassay. The frequency of appearance (x-axis) was categorized into 7 categories and the number of individuals in each category (y-axis) displayed.

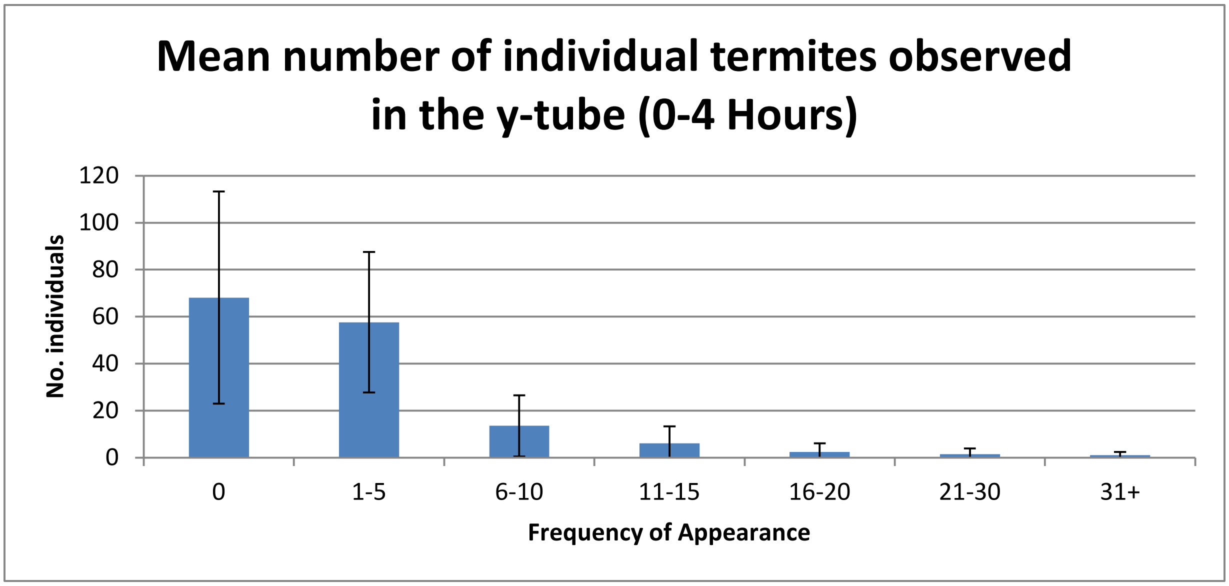


Figure 5: Mean frequency of appearance (±SD) of termites in the y-tube in video recordings (n=8 reps) for the 15-min/h observations (96 hours). The frequency of appearance (x-axis) was categorized into 7 categories and the number of individuals in each category (y-axis) displayed.

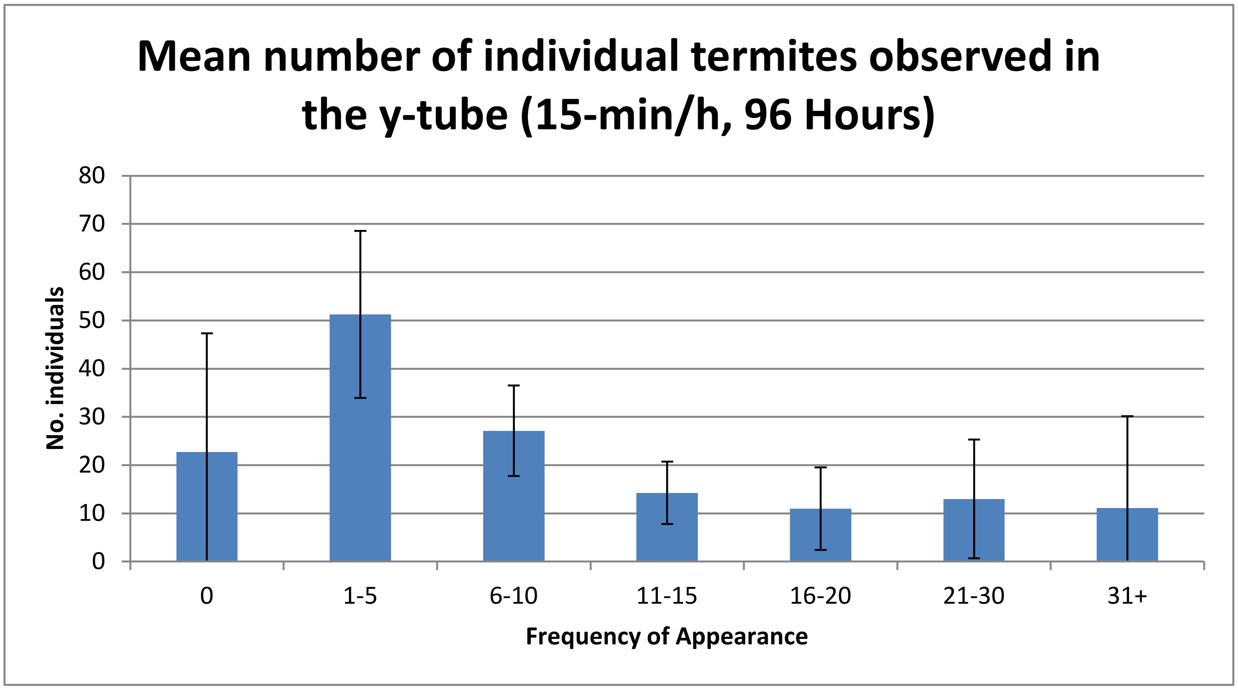


Table 4: The number of observation of previously unobserved unique individuals appearing in the y-tube by replicate by day. A mean value was also obtained by day. The data was collected using 15-min/h observations (for 96 h). Total refers to the number of unique termites individuals observed across all observation. The number of individuals in “4-hours” is included in Day 1. Replicate number corresponds to Appendices C & D.

Replicate	4-hours	Day 1	Day 2	Day 3	Day 4	Total
Rep 7	79	83	41	10	0	134
Rep 12	61	69	18	0	0	87
Rep 16	14	43	87	15	5	150
Rep 19	53	88	8	0	0	96
Rep 23	141	141	6	1	3	151
Rep 31	75	97	19	1	0	117
Rep 32	150	119	16	7	2	144
Rep 33	80	101	26	8	5	140
Mean	81.6	92.6	27.6	5.3	1.9	127.8

Table 5: The frequency of appearance of termites in the y-tube in video recordings (n=8 reps) for the 15-min/h observations (96 hours). The frequency of appearance (first column) was categorized into 7 categories and the number of individuals in each category by replicate (following columns) displayed. Replicate number corresponds to Appendices C & D.

Frequency of Appearance	Rep 7	Rep 12	Rep 16	Rep 19	Rep 23	Rep 31	Rep 32	Rep 33
0	16	63	0	54	0	33	6	10
1~5	71	63	59	61	15	46	43	52
6~10	37	18	28	20	15	24	35	40
11~15	20	2	15	9	13	14	20	21
16~20	2	2	25	2	16	12	18	11
21~25	1	0	20	0	18	6	11	9
26~30	2	1	4	0	17	3	7	5
>31	1	1	2	4	57	12	10	2

Figure 6: The mean number of TF per 15-min for the first four hours and by Day. The 15-min/h of 0-4h is included in Day 1. Each directed TF is labeled the two chambers termites moved between (Chamber A⇄Chamber B). For each movement, a termite left a chamber, entered the y-tube and subsequently entered another chamber.

Key: IC= Introduction-chamber, FC= Food-chamber; EC= Empty-chamber

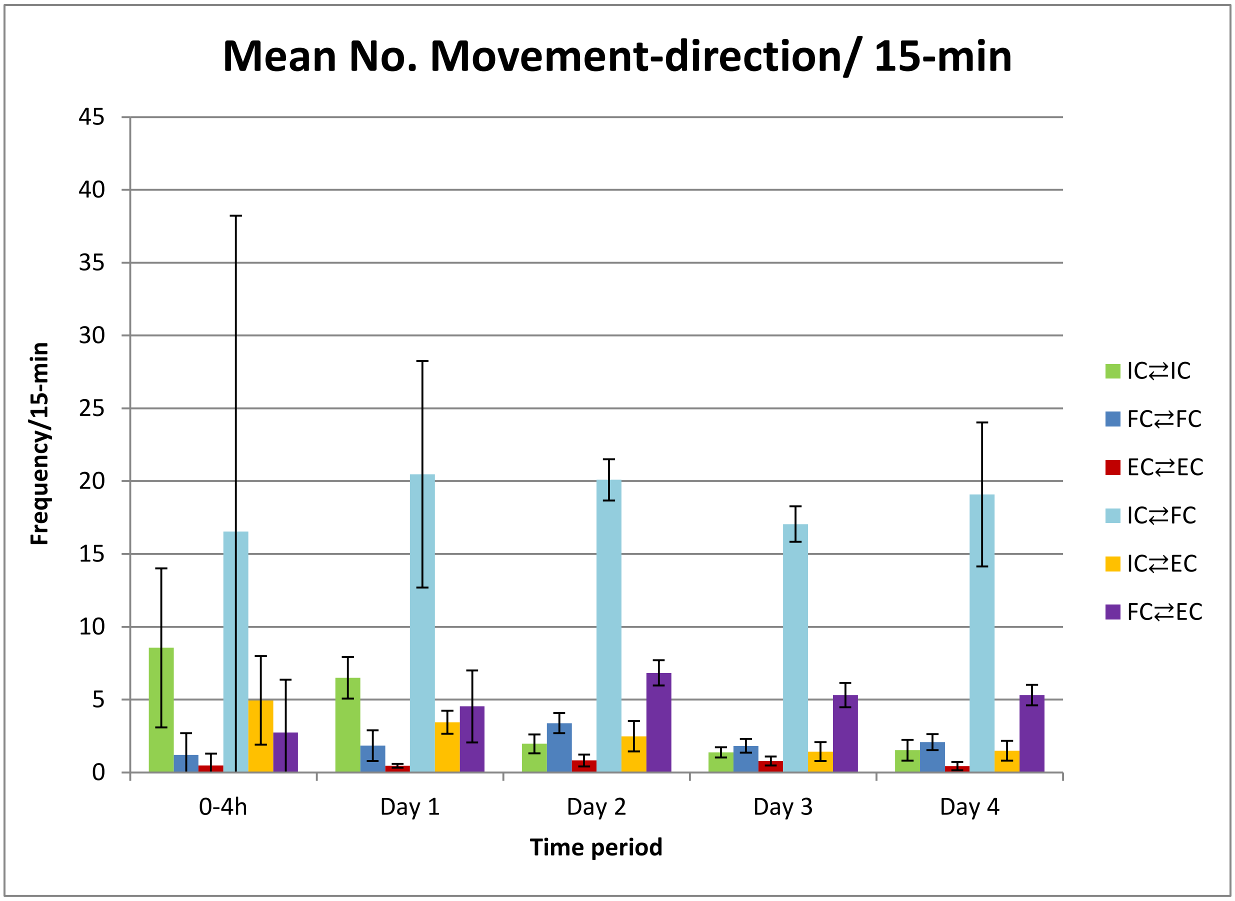


Figure 7: The mean number of directed TF per 15-min by replicate. Each TF is an instance a termite left a chamber, entered the y-tube and subsequently entered another chamber. TF is labeled the two chambers termites moved between (Chamber A⇄Chamber B).

Key: IC= Introduction-chamber, FC= Food-chamber; EC= Empty-chamber

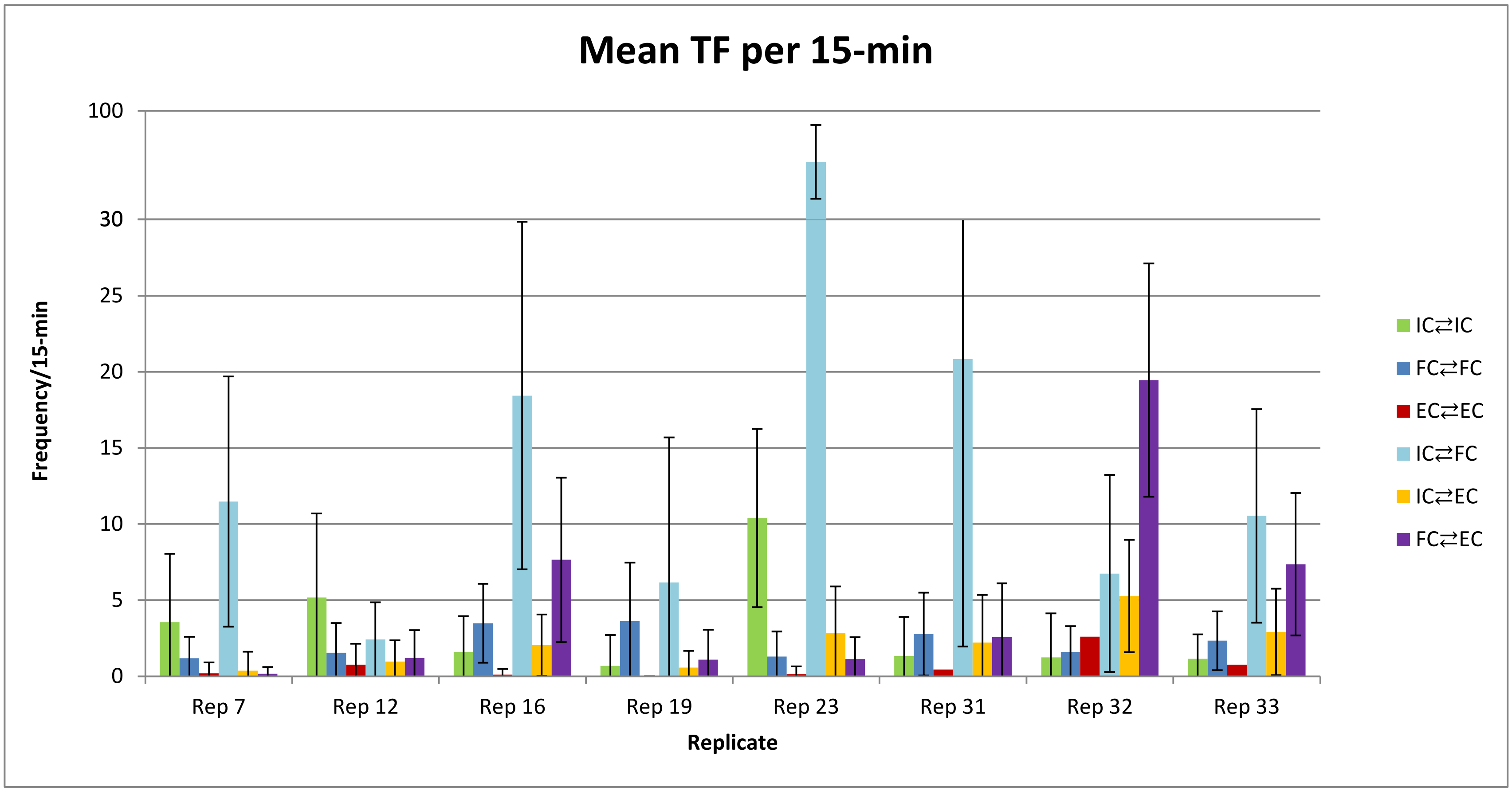
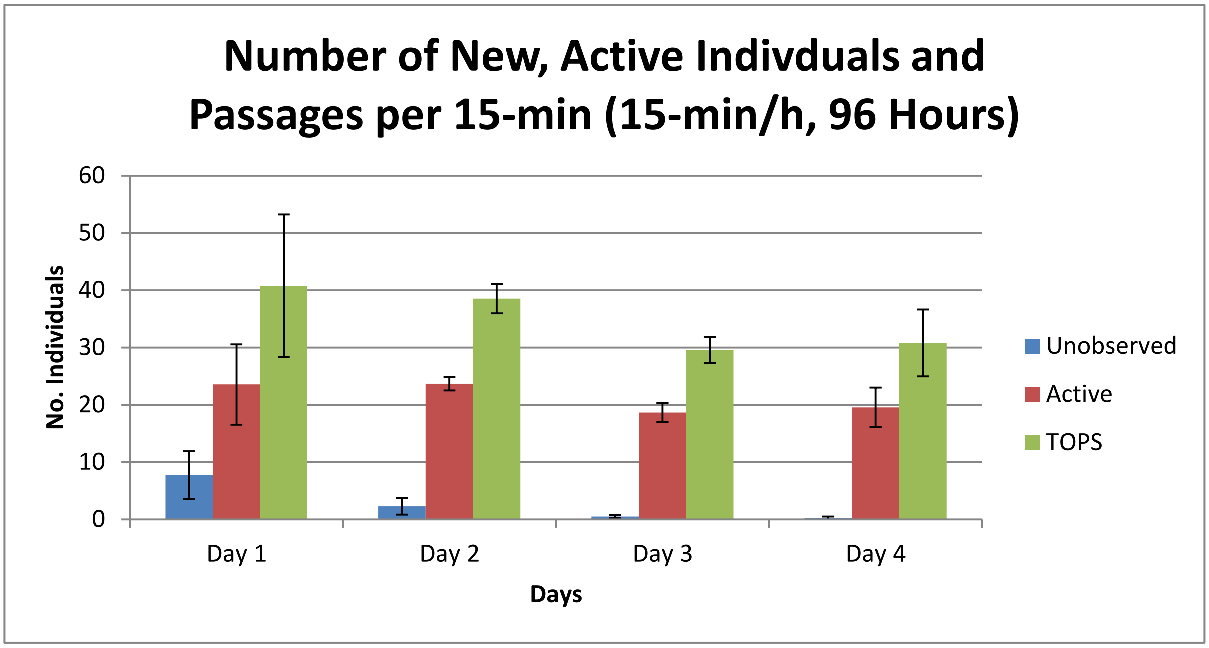


Figure 8: The mean number of appearance of previously Unobserved, Active individuals and Passages per 15-min by Day using 15/h data (96 hours). Unobserved refers to average number of new, previously unobserved individuals appearing per 15-min. Active refers to average number of unique individuals that are active per 15-min. TOPS refers Termites Observed Passing a Sensor.



3.6 Appendices

Appendix A

```
#include <SD.h>
#include <Wire.h>
#include <SPI.h>
#include <Ethernet.h>
byte mac[] = {
  0x90, 0xA2, 0xDA,
0x0D, 0x50, 0x93 };
IPAddress
ip(169,254,246,222);
IPAddress
gateway(169,254,246,221)
;
IPAddress subnet(255,
255, 0, 0);
EthernetServer server(80);
const int chipSelect = 4;
int sensorPin1 = A0;
int sensorPin2 = A2;
int sensorPin3 = A4;
int ledPin = 13;
int x,l,m,n,o;
int sensorValue1 = 0;
int sensorValue2 = 0;
int sensorValue3 = 0;
float voltage1;
float voltage2;
float voltage3;
String voltageString1 =
"default";
String voltageString2 =
"default";
String voltageString3 =
"default";
int time;
int time2;
void setup() {
 Serial.begin(9600);

if(!SD.begin(chipSelect)){
    Serial.println("Card
Failed");
  return;
  }
  else {
  Serial.println("card
initialized");
  }
  Ethernet.begin(mac, ip,
gateway, subnet);
  server.begin();
  Serial.print("server is at
");

Serial.println(Ethernet.loca
lIP());
}
void loop() {
   l=0;
   m=0;
   n=0;
   for(x=0; x< 5; x++){
   sensorValue1 =
analogRead(sensorPin1);
  sensorValue2 =
analogRead(sensorPin2);
  sensorValue3 =
analogRead(sensorPin3);
  voltage1 =
sensorValue1*(5.0/1023.0)
;
  voltage2 =
sensorValue2*(5.0/1023.0)
;
  voltage3 =
sensorValue3*(5.0/1023.0)
;
  delay(1000);
  if(voltage1 < 1.0) {
    l+=1;
    }
   if(voltage2 < 1.0) {
     m+=1;
     }
  if(voltage3 < 1.0) {
    n+=1;
    }
}
   File dataFile =
SD.open("termite.txt",
FILE_WRITE);
  if (dataFile) {
    Serial.print(voltage1);
    Serial.print("   ");
    Serial.print(voltage2);
    Serial.print("   ");
    Serial.print(voltage3);
    Serial.print("   ");
    dataFile.print(l);
    dataFile.print("   ");
    dataFile.print(m);
    dataFile.print("   ");
    dataFile.print(n);
    dataFile.print("   ");
    dataFile.print(o);
    dataFile.println(" ");
    dataFile.close();
  }
  else {
    Serial.println("error
opening termite.txt");
  }
}
```

Appendix B

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	24
1	146	2																			
2	17	14																			
3	44	5	2																		
4	28	5		1																	
5	11	6																			
6	8	2																			
7	3	1																			
8	2			1																	
9	9		1																		
10		2	1																		
11	2	1																			
12	2																				
13	2		2																		
14	3	1																			
15	1																				
17	2	1																			
18		1																			
19	1	1																			
22	2	1																			
23		1																			
24	1																				
26		1	1																		
29	3																				
30			1																		
34	1																				
35		1																			
36	2																				
37	1																				
39	1	1																			
41	1																				
45	1																				
46			1																		
49		1																			
54	1																				
56	1																				
65		1																1			
67		1																			
74	1																				
76	1																				
81		1																			
84	2																				
86	1																				
94							1		1												
95									1												
110							1														
112		1																			
114	1																				
132															1						
147			1																		
152				1																	
155				1																	
163						1															
176							1														
189		1																			
214											1										
217	1																				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	24
233						1															
240	1			1																	
254							1														
267											1										
281							1														
311														1							
326									1												
354		1																			
355	1																				
362		1																			
367						1															
393								1													
404				1																	
412																1					
438													1								
446							1														
474					1																
526																			1		
540										1											
552												1									
557		1																			
576														1	1						
623					1																
638		1																			
645																					1
654		1																			
680										1											
683								1													
700										1											
706								1													
800																				1	
893													1								
902				1																	
987	1																				
1136					1																

Correction factor:

1-6 continuous 1s recorded corrected into "1"

>6 continuous 1s recorded corrected using formula $\frac{\sqrt{x}}{2}$, where "x" is value of continuous obstruction

Appendix C

Time (h)	Rep 1						Rep 2					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.027	0.021	0.453	15.02	0.00	0.00	0.343	0.057	0.200	17.44	8.00	2.25
3-4	0.021	0.021	1.000	10.23	0.00	0.00	0.343	0.029	0.029	8.20	9.60	36.29
5-6	0.114	0.029	0.200	25.13	11.49	1.73	0.343	0.029	0.029	10.68	11.98	38.24
7-8	0.886	1.000	1.000	11.70	13.26	12.32	0.029	0.029	0.029	9.91	14.22	39.49
9-10	0.057	0.343	0.686	9.27	13.18	11.92	0.029	0.029	0.029	13.75	17.59	42.66
11-12	0.057	0.686	0.029	8.71	14.05	8.27	0.200	0.029	0.029	12.78	16.67	41.49
13-14	0.029	0.343	0.057	8.28	12.82	6.55	0.200	0.029	0.029	11.01	13.72	39.25
15-16	0.029	0.200	0.029	9.06	16.82	7.30	0.200	0.029	0.029	13.91	16.47	39.75
17-18	0.057	0.029	0.029	9.23	16.18	6.20	0.029	0.029	0.029	11.79	15.60	40.98
19-20	0.029	0.057	0.029	11.18	17.61	9.22	0.057	0.343	0.343	18.28	21.38	35.09
21-22	0.029	0.686	0.029	9.40	16.68	10.06	0.343	0.057	0.029	14.73	17.86	11.02
23-24	0.029	0.200	0.029	13.10	20.75	10.96	0.029	0.686	0.057	14.12	19.64	15.77
25-26	0.029	0.200	0.029	11.23	22.86	8.92	0.114	0.029	0.029	14.80	19.44	9.68
27-28	0.029	0.029	0.029	14.13	25.05	10.77	0.057	0.029	0.029	17.01	21.42	10.68
29-30	0.029	0.059	0.029	14.23	20.20	8.15	0.029	0.200	0.029	14.69	18.86	11.68
31-32	0.200	0.686	0.029	12.41	16.18	9.47	0.200	0.200	0.029	15.51	20.27	14.26
33-34	0.057	0.486	0.029	13.06	18.66	7.24	0.486	0.029	0.029	24.66	29.12	15.39
35-36	0.343	0.029	0.029	14.37	16.97	7.06	0.343	0.029	0.029	21.89	24.01	14.16
37-38	0.029	0.029	0.029	13.81	19.97	8.49	0.686	0.114	0.029	17.45	18.09	11.13
39-40	0.029	0.029	0.029	21.16	31.37	13.79	1.000	0.029	0.057	20.51	19.15	13.81
41-42	0.057	0.029	0.029	16.07	25.09	10.76	0.686	0.200	0.343	19.97	21.86	15.41
43-44	0.029	0.486	0.029	15.90	21.59	14.08	0.343	0.057	0.057	19.35	23.54	15.49
45-46	0.200	0.886	0.114	11.63	16.81	13.47	0.147	0.114	0.029	14.42	17.01	10.53
47-48	0.029	0.114	0.200	14.82	26.33	18.80	0.114	0.886	0.343	12.98	15.93	12.67
49-50	0.057	0.200	0.200	12.85	22.73	18.63	1.000	0.686	1.000	14.88	16.14	17.38
51-52	0.029	0.029	0.343	14.84	25.10	34.09	0.029	0.029	0.686	10.60	16.64	14.34
53-54	0.029	0.029	0.029	13.14	21.37	40.64	0.029	0.686	0.029	18.41	22.78	15.51
55-56	0.029	0.029	0.029	14.00	18.62	44.94	0.029	0.029	0.200	12.87	18.31	15.86
57-58	0.029	0.029	0.029	11.43	22.80	47.28	0.886	0.029	1.000	13.35	16.81	16.71
59-60	0.029	0.029	0.029	9.95	17.89	53.17	0.114	0.343	0.114	15.32	20.17	17.47
61-62	0.029	0.029	0.029	9.38	19.04	50.74	0.029	0.886	0.114	17.29	24.06	18.37
63-64	0.029	0.029	0.029	10.69	20.22	53.10	0.081	0.686	0.886	13.34	18.47	16.82
65-66	0.029	0.029	0.029	11.51	23.07	55.98	0.029	0.029	0.343	11.03	19.57	21.18
67-68	0.029	0.029	0.029	9.40	17.96	23.93	0.029	0.029	0.885	8.48	19.89	20.22
69-70	0.029	0.029	0.114	12.01	20.85	26.22	0.029	0.029	0.486	12.50	17.93	19.75
71-72	0.029	0.029	0.343	13.21	22.83	27.31	0.029	0.029	0.343	12.60	19.91	21.21
73-74	0.029	0.029	0.029	10.93	17.76	35.66	0.057	0.029	0.886	10.35	16.98	16.99
75-76	0.114	0.029	0.029	15.63	18.52	38.42	0.057	0.029	1.000	11.62	18.80	17.96
77-78	0.029	0.029	0.029	12.86	21.74	33.31	0.343	0.200	0.686	11.11	16.12	17.28
79-80	0.057	0.029	0.057	12.03	21.96	27.72	0.486	0.686	1.000	13.24	16.22	15.80
81-82	0.029	0.029	0.057	9.75	16.24	24.63	0.029	0.200	0.686	11.49	16.96	18.76
83-84	0.029	0.029	0.200	10.54	22.91	26.12	0.200	0.343	0.686	8.81	16.33	18.97
85-86	0.029	0.029	0.686	10.47	21.15	22.77	0.886	0.029	0.029	7.67	7.90	11.34
87-88	0.029	0.343	0.343	14.36	21.16	18.49	0.114	0.200	0.486	7.55	15.59	12.86
89-90	0.057	0.486	0.114	12.86	20.86	13.99	0.029	0.057	0.886	9.10	16.59	16.93
91-92	0.029	0.200	0.114	11.95	20.13	15.83	0.029	0.029	1.000	8.38	15.16	14.74
93-94	0.200	1.000	0.114	14.63	24.49	16.29	0.029	0.029	1.000	8.65	15.43	17.02
95-96	0.029	0.114	0.114	9.34	17.04	11.85	0.029	0.029	0.200	7.70	16.79	21.04

Time (h)	Rep 3						Rep 4					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.114	0.029	0.029	23.20	11.14	1.19	0.114	0.343	0.686	23.73	15.13	18.05
3-4	0.029	0.029	0.029	17.65	10.57	2.70	0.886	1.000	1.000	5.88	5.37	4.88
5-6	0.057	0.029	0.029	12.07	6.33	1.76	0.200	0.486	0.200	5.23	7.98	5.99
7-8	0.029	0.029	0.309	6.10	3.56	2.06	1.000	0.029	0.029	8.26	7.45	4.47
9-10	0.200	0.057	0.686	4.60	2.63	2.12	0.686	0.057	0.029	6.51	6.97	4.54
11-12	1.000	0.029	0.029	4.71	5.23	2.01	0.057	0.686	0.057	6.12	8.73	4.54
13-14	0.886	0.486	0.343	8.37	8.55	6.70	0.057	0.686	0.114	4.79	8.65	6.19
15-16	1.000	0.200	0.343	7.73	7.18	5.43	0.057	0.686	0.057	5.40	9.77	7.29
17-18	0.561	0.114	0.200	11.25	9.82	7.60	0.029	0.343	0.343	7.77	11.72	9.41
19-20	0.772	0.200	0.200	6.76	6.59	4.14	0.029	0.114	0.029	9.99	18.28	14.02
21-22	0.343	0.029	0.029	13.97	12.08	5.41	0.029	0.029	0.029	11.37	18.31	14.51
23-24	0.343	0.029	0.029	16.56	14.50	5.70	0.114	0.686	0.200	13.00	19.80	14.82
25-26	0.486	0.029	0.029	17.86	15.14	7.10	0.029	0.029	0.029	13.08	22.12	15.63
27-28	0.343	0.029	0.114	16.54	13.72	9.57	0.029	0.200	0.200	14.18	19.25	16.07
29-30	0.686	0.029	0.029	20.09	19.80	7.33	0.057	0.686	0.057	13.47	24.92	15.65
31-32	0.686	0.029	0.029	15.12	15.68	7.24	0.029	0.029	0.057	11.42	21.11	16.72
33-34	0.057	0.029	0.029	19.83	16.72	7.43	0.029	0.343	0.057	10.78	21.02	14.46
35-36	0.343	0.057	0.029	17.63	19.34	11.23	0.029	0.200	0.114	11.37	21.08	14.67
37-38	0.200	0.057	0.029	11.55	15.48	7.08	0.029	0.029	0.029	8.67	18.44	12.25
39-40	0.114	0.114	0.057	13.89	17.71	12.01	0.029	0.057	0.343	10.46	25.41	21.26
41-42	0.029	0.114	0.029	12.47	19.78	11.08	0.029	0.029	0.057	11.46	21.06	15.60
43-44	0.686	0.029	0.029	12.26	15.01	5.48	0.029	0.029	0.686	8.12	19.84	17.36
45-46	0.486	0.114	0.029	15.78	13.39	6.68	0.029	0.029	0.200	8.10	19.90	15.07
47-48	0.886	0.886	0.200	10.07	11.24	9.04	0.029	0.029	0.686	7.78	15.27	14.59
49-50	0.886	0.114	0.114	12.73	12.07	6.81	0.029	0.029	0.200	7.01	17.76	16.58
51-52	0.200	0.029	0.029	9.98	12.17	8.22	0.029	0.029	0.486	4.62	16.61	16.14
53-54	0.686	0.029	0.029	15.60	15.92	7.58	0.029	0.029	0.309	6.83	21.44	16.49
55-56	1.000	0.057	0.029	14.85	14.33	8.04	0.029	0.029	0.343	8.54	18.35	15.69
57-58	0.886	0.029	0.029	15.48	15.91	10.22	0.029	0.029	0.114	8.01	19.87	17.50
59-60	0.486	0.057	0.029	14.97	17.16	8.95	0.029	0.029	0.114	10.33	24.21	18.24
61-62	0.343	0.057	0.029	10.91	14.47	6.46	0.029	0.029	0.029	10.28	19.91	13.31
63-64	0.486	0.057	0.029	11.76	12.54	5.75	0.029	0.029	0.057	5.89	20.23	14.61
65-66	0.886	0.029	0.029	16.81	16.67	7.81	0.029	0.029	0.114	6.38	19.23	16.53
67-68	0.029	0.029	0.029	22.04	13.95	9.07	0.029	0.200	0.029	10.10	20.24	12.33
69-70	0.057	0.029	0.057	27.16	18.03	6.46	0.029	0.029	0.114	9.47	21.78	16.51
71-72	0.029	0.029	0.029	29.58	15.97	6.75	0.029	0.081	0.114	12.05	22.59	16.12
73-74	0.029	0.029	0.029	26.50	14.17	6.51	0.029	0.029	0.057	9.43	20.87	16.46
75-76	0.200	0.057	0.114	20.67	13.78	5.55	0.029	0.029	0.114	8.48	21.32	17.90
77-78	0.886	0.029	0.029	12.20	11.47	5.82	0.029	0.029	0.114	7.18	21.19	17.56
79-80	0.486	0.029	0.029	14.24	16.55	7.49	0.029	0.029	0.200	9.50	21.32	18.41
81-82	0.200	0.686	0.114	13.15	16.64	11.22	0.029	0.029	0.029	9.25	22.37	16.73
83-84	0.686	0.343	0.200	17.11	18.34	12.67	0.029	0.029	0.486	8.29	20.72	17.55
85-86	0.200	0.029	0.029	15.15	18.48	9.84	0.029	0.114	0.057	9.44	19.24	15.53
87-88	0.686	0.057	0.057	14.25	13.41	6.39	0.029	0.029	0.200	3.23	19.10	14.87
89-90	0.029	0.029	0.029	23.76	12.83	4.27	0.029	0.029	0.057	6.86	20.01	17.34
91-92	0.029	0.029	0.029	24.63	13.53	6.85	0.029	0.029	1.000	7.64	17.36	17.77
93-94	0.029	0.029	0.029	33.46	14.73	6.34	0.029	0.057	0.200	5.14	16.57	13.46
95-96	0.029	0.029	0.029	32.03	12.52	6.02	0.029	0.029	0.343	6.84	18.17	15.65

Time (h)	Rep 5						Rep 6					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.057	0.029	0.486	27.24	10.37	4.36	0.029	0.029	0.561	17.18	1.84	1.53
3-4	0.886	0.486	0.042	5.97	6.65	4.16	0.029	0.029	0.110	12.94	2.84	0.78
5-6	0.114	0.114	0.029	3.92	8.41	3.40	0.029	0.021	0.021	8.01	1.62	0.00
7-8	0.029	0.114	0.029	3.66	7.40	2.10	0.029	0.029	0.057	7.72	1.81	0.53
9-10	0.057	0.886	0.029	5.95	11.82	6.65	0.029	0.027	0.027	6.85	2.09	0.00
11-12	0.029	1.000	0.029	7.92	12.89	8.89	0.114	0.028	0.108	5.09	2.81	0.75
13-14	0.200	0.686	0.200	10.98	14.51	10.69	0.343	0.486	0.686	8.06	5.28	4.31
15-16	0.029	0.057	0.029	15.31	19.20	8.44	0.686	0.200	0.114	13.17	14.99	8.54
17-18	0.200	0.886	0.343	12.12	13.58	11.66	0.886	1.000	0.886	12.30	10.47	10.42
19-20	0.029	0.886	0.057	9.36	16.97	10.84	0.029	0.686	0.057	9.13	15.06	10.16
21-22	0.029	0.029	0.029	12.27	17.34	9.61	0.029	0.114	0.114	7.44	18.69	13.11
23-24	0.029	0.486	0.029	9.81	17.03	8.89	0.114	0.886	0.029	8.20	13.09	7.39
25-26	0.029	0.486	0.029	12.75	18.22	11.21	0.343	0.029	0.029	12.90	15.60	8.53
27-28	0.343	0.029	0.029	15.99	18.88	11.85	0.886	0.029	0.029	15.42	15.48	7.84
29-30	0.343	0.057	0.029	17.35	19.62	10.34	0.114	0.114	0.686	17.88	12.85	11.55
31-32	0.486	0.686	0.200	14.50	17.26	11.07	0.486	0.029	0.029	12.43	15.33	10.20
33-34	0.029	0.029	0.029	17.08	22.09	10.64	0.886	0.057	0.114	11.48	11.76	7.71
35-36	0.200	0.029	0.029	17.15	20.94	8.62	0.343	0.686	0.486	13.08	16.60	13.57
37-38	1.000	0.029	0.029	21.87	21.17	10.09	0.200	0.200	0.029	13.50	18.26	8.56
39-40	0.886	0.029	0.029	15.94	15.95	8.57	0.114	0.200	0.486	7.88	13.46	10.95
41-42	0.114	0.029	0.029	15.83	20.42	9.52	0.029	0.686	0.114	7.05	12.94	7.40
43-44	0.029	0.029	0.029	15.49	19.30	7.43	0.029	0.200	0.200	7.11	13.32	9.43
45-46	0.886	0.029	0.029	14.47	14.53	3.73	0.029	0.029	0.114	4.69	12.83	8.12
47-48	0.886	0.029	0.029	15.41	15.98	6.31	0.029	0.029	0.886	9.54	14.31	14.16
49-50	0.114	0.057	0.029	12.57	17.20	8.28	0.343	0.686	0.486	7.37	9.18	7.79
51-52	0.343	0.029	0.029	10.36	14.89	5.66	0.057	0.200	0.200	7.45	14.97	11.25
53-54	0.057	0.029	0.029	12.65	19.39	6.78	0.057	0.114	0.343	7.96	15.77	12.06
55-56	0.200	0.114	0.029	12.01	17.17	6.50	0.029	0.057	0.114	4.73	20.28	10.92
57-58	0.029	0.029	0.029	14.76	20.17	3.79	0.029	0.029	0.343	4.06	15.52	11.57
59-60	0.114	0.114	0.029	11.68	15.59	6.38	0.114	0.200	0.200	4.56	12.45	8.29
61-62	0.343	0.029	0.029	14.73	16.45	6.00	0.029	0.029	0.029	4.17	23.17	12.58
63-64	0.886	0.029	0.029	13.56	13.87	6.54	0.029	0.029	0.029	5.45	14.28	9.47
65-66	0.200	0.114	0.029	13.68	18.34	6.80	0.029	0.029	0.029	3.23	33.19	9.63
67-68	0.029	0.029	0.029	12.50	17.91	6.56	0.029	0.029	0.029	2.38	25.53	8.59
69-70	0.029	0.029	0.029	13.83	20.69	9.77	0.029	0.200	0.029	7.32	27.93	13.57
71-72	0.029	0.057	0.029	13.38	17.85	8.30	0.029	0.029	0.029	6.99	27.77	10.70
73-74	0.886	0.029	0.029	14.87	16.13	6.36	0.029	0.114	0.029	6.19	20.89	13.41
75-76	0.029	1.000	0.029	11.76	16.25	10.41	0.057	0.114	0.486	5.95	10.42	8.98
77-78	0.029	0.029	0.029	13.79	19.63	11.55	0.029	0.114	0.114	3.74	13.36	8.38
79-80	0.029	0.029	0.029	12.79	17.85	5.72	0.029	0.029	0.686	5.98	11.67	11.24
81-82	0.057	0.029	0.029	13.08	17.87	7.23	0.029	0.029	0.114	5.44	15.67	10.92
83-84	0.686	0.343	0.200	17.51	18.77	13.88	0.057	0.029	0.686	6.26	29.57	16.92
85-86	0.486	0.029	0.029	14.55	16.07	6.83	0.029	0.029	0.886	3.16	10.49	9.25
87-88	0.686	0.029	0.029	12.92	12.42	5.59	0.200	0.200	0.886	3.36	9.70	9.49
89-90	0.029	0.343	0.029	13.22	16.94	10.28	0.029	0.057	1.000	5.55	11.71	13.67
91-92	0.343	0.029	0.114	12.10	10.19	5.45	0.029	0.029	0.886	3.75	9.96	10.07
93-94	0.886	0.029	0.029	14.41	14.22	1.47	0.029	0.029	0.886	5.06	9.91	9.75
95-96	0.886	0.029	0.057	12.27	13.99	4.03	0.029	0.029	0.343	4.09	11.97	9.95

Time (h)	Rep 7						Rep 8					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.029	0.029	0.309	17.90	5.42	1.82	0.029	0.029	0.029	30.20	10.42	1.53
3-4	0.027	0.021	0.453	13.02	0.00	0.00	0.486	0.029	0.029	11.35	10.00	4.00
5-6	0.029	0.021	0.186	7.27	0.25	0.00	0.029	0.486	0.114	6.40	10.64	7.18
7-8	0.029	0.021	0.069	7.02	0.57	0.00	0.114	0.029	0.029	10.04	13.24	6.64
9-10	0.886	0.027	0.027	8.43	7.44	0.00	0.200	0.057	0.029	11.87	15.90	6.57
11-12	0.114	0.029	0.029	8.83	7.57	3.83	0.343	0.029	0.029	12.86	15.69	5.67
13-14	0.686	0.029	0.029	6.67	6.85	2.92	0.029	0.029	0.029	10.59	15.50	6.63
15-16	0.343	0.029	0.029	7.01	8.33	3.08	0.029	0.029	0.029	12.72	17.62	7.30
17-18	0.772	0.029	0.029	6.02	7.69	2.11	0.029	0.029	0.029	12.45	16.28	8.50
19-20	0.886	0.029	0.029	6.98	10.09	5.16	0.057	0.114	0.029	12.65	17.60	9.44
21-22	0.343	0.886	0.343	7.32	10.85	7.55	0.114	0.029	0.029	18.58	21.57	9.57
23-24	0.029	0.114	0.114	6.19	8.98	7.57	0.343	0.486	0.057	15.28	17.48	14.63
25-26	0.886	0.343	0.057	8.19	9.47	5.11	0.057	0.686	0.057	13.55	23.57	13.79
27-28	0.114	0.486	0.245	5.92	8.58	6.41	0.114	0.486	0.029	12.76	19.58	12.18
29-30	1.000	0.029	0.029	10.60	11.06	3.17	0.057	0.057	0.886	10.25	17.40	16.47
31-32	0.200	0.029	0.029	7.59	10.87	1.06	0.029	0.029	0.686	8.62	18.12	16.96
33-34	0.114	0.029	0.029	7.67	10.96	1.90	0.029	0.029	0.343	8.41	16.48	15.24
35-36	0.147	0.027	0.027	6.13	8.98	0.00	0.114	0.029	1.000	12.00	18.01	17.84
37-38	0.114	0.027	0.027	4.75	7.30	0.00	0.029	0.029	0.686	9.92	18.37	18.30
39-40	0.343	0.029	0.029	6.93	9.18	0.53	0.029	0.029	0.686	9.97	17.89	18.55
41-42	0.486	0.029	0.081	8.33	6.37	3.26	0.029	0.057	0.486	7.56	15.91	15.05
43-44	0.886	0.200	0.686	7.51	5.55	4.62	0.029	0.029	0.686	7.12	19.70	17.46
45-46	0.343	0.029	0.200	7.01	9.42	6.28	0.029	0.029	0.486	8.44	21.96	20.72
47-48	0.886	0.029	0.029	8.38	8.15	1.56	0.029	0.029	0.486	7.84	18.87	19.88
49-50	1.000	0.027	0.027	8.47	8.06	0.00	0.029	1.000	0.309	8.51	19.07	11.65
51-52	0.886	0.029	0.029	6.65	7.43	1.81	0.029	0.282	0.021	8.99	18.67	6.12
53-54	0.200	0.029	0.029	13.46	17.86	4.24	0.029	0.114	0.343	6.18	16.93	15.41
55-56	0.114	0.029	0.029	14.77	19.36	2.59	0.029	0.029	0.886	5.59	17.76	16.23
57-58	1.000	0.029	0.029	12.79	11.28	0.30	0.029	0.029	0.886	8.95	21.06	20.61
59-60	0.686	0.021	0.021	12.61	13.72	0.00	0.029	0.029	0.486	9.86	17.09	19.42
61-62	0.343	0.027	0.027	12.52	14.31	0.00	0.029	0.029	0.886	8.94	19.79	19.93
63-64	0.686	0.029	0.029	13.34	13.43	1.36	0.029	0.029	0.686	9.47	17.88	19.61
65-66	0.686	0.029	0.029	11.28	11.36	0.57	0.029	0.029	1.000	10.88	22.23	21.55
67-68	0.886	0.021	0.021	13.92	13.59	0.00	0.029	0.029	0.343	7.98	19.49	18.36
69-70	0.114	0.027	0.027	10.91	14.02	0.00	0.029	0.029	1.000	8.01	18.35	17.31
71-72	0.486	0.027	0.027	14.37	16.56	0.00	0.029	0.029	0.886	9.40	21.93	20.35
73-74	0.686	0.057	0.029	14.78	13.52	5.35	0.029	0.029	1.000	8.13	18.05	16.72
75-76	0.886	0.027	0.027	12.29	12.92	0.00	0.029	0.029	1.000	7.90	15.99	15.87
77-78	0.686	0.027	0.027	9.60	11.45	0.00	0.029	0.029	0.886	8.78	17.17	17.40
79-80	0.200	0.021	0.021	13.76	9.08	0.00	0.029	0.029	0.886	7.22	17.18	17.84
81-82	1.000	0.027	0.027	10.16	9.07	0.00	0.029	0.029	0.686	10.10	18.92	18.29
83-84	1.000	0.029	0.029	9.40	10.08	0.56	0.029	0.029	0.686	7.35	16.85	17.00
85-86	0.114	0.021	0.021	10.32	7.61	0.00	0.029	0.029	0.686	8.00	18.43	19.30
87-88	0.686	0.027	0.027	7.51	7.47	0.00	0.029	0.029	0.486	11.15	16.84	18.74
89-90	0.886	0.021	0.021	11.85	11.08	0.00	0.114	0.114	0.886	7.88	21.26	21.08
91-92	0.686	0.021	0.021	10.54	12.02	0.00	0.029	0.057	0.686	8.84	18.74	20.73
93-94	0.886	0.021	0.021	9.50	8.77	0.00	0.029	0.029	0.343	6.60	19.33	20.73
95-96	0.686	0.021	0.021	9.05	7.62	0.00	0.029	0.029	0.886	7.41	16.39	16.31

Time (h)	Rep 9						Rep 10					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.114	0.057	0.486	32.65	15.46	12.03	0.886	1.000	0.343	16.65	19.88	13.35
3-4	0.343	0.200	0.486	14.70	9.81	12.42	1.000	0.886	0.886	12.98	14.07	13.59
5-6	0.686	0.686	0.200	15.49	16.46	11.34	0.114	0.486	0.343	10.09	15.26	11.61
7-8	0.486	0.343	0.029	13.93	15.41	11.10	0.686	0.057	0.057	14.84	14.81	8.53
9-10	0.200	0.057	0.029	16.28	19.16	10.35	0.486	0.029	0.029	14.47	17.22	10.08
11-12	0.686	0.029	0.029	16.63	16.78	9.69	0.114	0.029	0.029	11.61	17.11	8.04
13-14	0.886	0.029	0.029	17.70	17.28	8.54	0.686	0.114	0.029	14.80	18.36	10.26
15-16	0.886	0.029	0.029	16.09	16.35	7.07	0.057	0.200	0.029	14.05	19.15	11.19
17-18	0.686	0.029	0.029	17.81	19.84	6.74	0.343	0.343	0.343	11.80	15.77	9.42
19-20	0.686	0.029	0.029	22.18	22.95	7.78	0.029	0.029	0.029	15.12	17.95	9.64
21-22	0.114	0.029	0.029	18.11	22.65	6.96	0.029	0.200	0.029	11.60	16.32	8.56
23-24	0.343	0.029	0.029	17.03	18.03	10.60	0.114	0.200	0.114	11.50	16.39	9.02
25-26	0.886	0.114	0.029	17.08	17.47	10.28	0.200	0.200	0.029	14.93	18.83	10.59
27-28	0.029	0.057	0.029	15.39	19.86	8.21	0.114	0.200	0.114	13.01	17.46	10.13
29-30	0.200	0.029	0.029	18.64	21.64	9.26	0.029	1.000	0.057	13.61	16.89	13.04
31-32	0.114	0.029	0.029	12.68	18.13	4.12	0.343	0.200	0.029	12.74	17.76	11.85
33-34	0.057	0.029	0.029	14.43	18.68	4.07	0.200	0.200	0.057	14.86	19.99	11.43
35-36	0.486	0.029	0.029	15.35	16.41	7.51	0.114	0.029	0.029	15.27	18.49	12.80
37-38	0.200	0.029	0.029	15.93	17.33	4.14	0.200	0.343	0.029	16.73	18.67	12.77
39-40	0.057	0.029	0.029	16.71	19.76	4.89	0.114	0.029	0.029	14.92	17.37	10.59
41-42	0.057	0.029	0.029	13.57	19.30	3.46	0.200	0.029	0.029	15.12	16.68	11.40
43-44	0.029	0.029	0.029	17.88	23.13	5.62	0.114	0.200	0.029	12.38	16.76	9.07
45-46	0.200	0.029	0.029	13.34	16.24	2.21	0.343	0.486	0.200	13.96	15.90	10.82
47-48	0.200	0.029	0.029	11.30	15.70	3.65	0.200	0.057	0.029	10.58	13.67	8.40
49-50	0.343	0.029	0.029	14.52	18.89	2.54	0.343	0.486	0.057	10.25	14.92	9.33
51-52	0.114	0.029	0.029	13.72	17.91	2.13	0.686	0.114	0.029	11.57	13.46	8.18
53-54	0.029	0.029	0.029	13.87	15.86	1.03	0.486	0.343	0.114	10.78	12.12	8.43
55-56	0.029	0.029	0.029	14.21	19.08	1.07	0.686	0.029	0.029	15.40	15.38	8.79
57-58	0.029	0.029	0.029	11.83	18.90	1.07	0.343	0.114	0.029	15.89	19.25	11.53
59-60	0.029	0.029	0.029	11.71	18.96	3.70	0.029	0.029	0.029	14.94	18.31	6.39
61-62	0.029	0.029	0.029	11.88	18.79	1.79	0.343	0.029	0.029	13.74	15.19	6.47
63-64	0.029	0.029	0.029	10.02	15.54	0.75	0.057	0.114	0.029	13.60	18.33	10.50
65-66	0.029	0.029	0.029	11.35	18.96	2.39	0.114	0.486	0.029	13.29	19.41	12.59
67-68	0.029	0.029	0.029	13.76	20.93	2.38	0.057	0.200	0.029	11.85	17.41	8.65
69-70	0.029	0.029	0.029	14.35	20.90	2.66	0.029	0.686	0.029	10.46	19.12	13.00
71-72	0.029	0.029	0.029	11.00	16.58	0.25	0.029	0.029	0.029	9.47	17.44	14.65
73-74	0.200	0.029	0.029	11.09	18.01	4.49	0.343	0.343	0.029	10.99	14.58	9.19
75-76	0.200	0.029	0.029	12.33	16.09	2.17	0.057	0.486	0.343	10.58	16.28	12.59
77-78	0.057	0.029	0.029	9.77	16.98	0.59	0.029	0.886	0.029	11.40	16.76	11.65
79-80	0.057	0.021	0.021	6.92	14.82	0.00	0.057	0.057	0.029	13.38	17.25	10.01
81-82	0.029	0.027	0.027	8.15	14.00	0.00	0.114	0.200	0.029	14.99	18.57	12.06
83-84	0.029	0.027	0.027	8.63	13.10	0.00	0.029	0.029	0.029	12.12	18.46	7.70
85-86	0.029	0.029	0.029	10.15	13.66	0.28	0.029	0.343	0.029	17.78	23.73	15.03
87-88	0.029	0.057	0.029	14.99	23.95	6.43	0.114	0.200	0.029	13.21	18.22	6.47
89-90	0.057	0.200	0.029	10.50	22.99	4.76	0.057	0.029	0.029	14.44	19.64	9.24
91-92	0.057	0.029	0.029	13.16	22.12	4.28	0.029	0.886	0.029	9.53	16.77	10.59
93-94	0.200	0.029	0.029	15.52	18.49	1.76	0.029	0.200	0.029	12.58	16.09	9.14
95-96	0.029	0.029	0.029	15.47	20.28	5.76	0.081	0.886	0.200	10.73	15.42	11.70

Time (h)	Rep 11						Rep 12					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.114	0.029	0.114	25.09	15.61	10.65	0.021	0.027	0.453	8.39	0.00	0.00
3-4	1.000	0.200	0.114	11.67	11.08	8.31	0.027	0.027	1.000	12.37	0.00	0.00
5-6	0.029	0.686	0.029	8.20	11.31	7.74	0.027	0.021	0.453	15.66	0.00	0.00
7-8	0.886	0.059	0.309	13.53	13.01	10.76	0.059	0.027	0.505	10.76	0.25	0.00
9-10	0.200	0.486	0.686	14.20	13.40	12.78	0.057	0.027	0.124	11.88	1.03	0.00
11-12	0.886	0.343	0.057	14.46	14.20	11.44	0.029	0.021	0.069	6.86	2.14	0.00
13-14	0.057	0.486	0.057	11.72	14.33	11.08	0.057	0.027	0.027	4.21	2.34	0.00
15-16	0.886	0.029	0.114	11.35	12.17	8.78	0.029	0.029	0.663	4.22	1.03	0.54
17-18	0.486	0.029	0.029	13.10	14.38	8.97	0.057	0.029	0.234	4.35	1.03	0.75
19-20	0.343	0.886	0.114	10.80	12.62	10.20	0.486	0.029	0.183	4.27	3.26	1.28
21-22	0.114	0.686	0.200	8.52	11.73	9.21	0.200	0.114	0.029	3.65	4.45	2.03
23-24	0.486	0.686	0.886	11.17	13.01	13.80	0.114	0.191	0.059	1.79	4.90	0.78
25-26	0.057	0.029	0.886	7.88	13.80	13.81	0.114	0.245	0.029	2.28	4.62	1.25
27-28	0.114	0.114	0.886	9.15	11.34	11.67	0.686	0.183	0.055	1.31	2.17	0.00
29-30	0.029	0.029	0.486	7.34	11.83	13.08	0.200	0.886	0.114	3.14	5.93	2.62
31-32	0.029	0.029	1.000	8.09	12.13	13.17	0.029	0.343	0.200	1.84	5.53	3.81
33-34	0.029	0.029	0.114	8.07	12.06	14.07	0.200	0.200	0.114	2.91	5.40	2.03
35-36	0.029	0.029	0.486	8.61	12.47	13.67	0.343	0.029	0.029	4.82	6.22	1.84
37-38	0.029	0.029	0.486	14.51	22.81	23.61	0.029	0.029	0.029	4.93	7.36	1.78
39-40	0.029	0.029	0.029	12.34	17.32	24.51	0.057	0.029	0.029	5.29	7.58	1.11
41-42	0.029	0.029	0.200	9.98	16.53	21.85	0.029	0.029	0.029	5.18	8.44	1.03
43-44	0.029	0.029	0.057	13.33	21.77	25.24	0.057	0.029	0.029	7.41	12.19	3.67
45-46	0.029	0.029	0.057	12.14	16.36	19.07	0.057	0.200	0.200	4.25	11.52	7.41
47-48	0.029	0.029	0.686	8.20	16.04	17.57	0.029	0.114	0.029	7.21	13.88	5.31
49-50	0.029	0.029	0.886	9.42	16.31	17.55	0.029	0.200	0.029	4.35	14.81	6.66
51-52	0.029	0.029	1.000	9.06	13.48	12.73	0.029	0.200	0.029	6.86	15.69	5.74
53-54	0.029	0.029	0.686	4.53	11.06	9.39	0.029	0.200	0.029	8.39	18.17	6.68
55-56	0.057	0.029	0.886	5.65	12.65	9.90	0.029	0.059	0.029	8.94	16.01	4.31
57-58	0.029	0.057	0.663	8.20	15.35	15.51	0.029	0.686	0.029	6.55	13.50	5.62
59-60	0.029	0.029	0.663	4.84	11.50	11.61	0.029	0.029	0.029	8.07	16.72	5.95
61-62	0.029	0.057	0.057	6.75	11.63	9.06	0.029	0.686	0.057	8.14	18.66	10.63
63-64	0.114	0.245	0.486	7.81	15.07	11.27	0.029	0.057	0.029	8.65	18.33	13.92
65-66	0.029	0.029	0.200	8.40	14.28	10.68	0.029	0.114	0.029	5.15	17.91	11.03
67-68	0.029	0.081	0.029	5.78	10.96	8.28	0.029	0.029	0.886	5.31	14.57	13.63
69-70	0.029	0.343	0.029	4.87	10.62	7.75	0.029	0.029	0.029	5.53	17.17	12.48
71-72	0.029	0.029	0.029	3.81	10.14	7.92	0.029	0.029	0.029	5.06	17.93	15.26
73-74	0.029	0.057	0.200	9.04	19.06	13.65	0.029	0.029	0.029	4.43	20.59	14.58
75-76	0.029	0.114	0.057	6.84	14.75	10.44	0.029	0.029	0.486	4.37	17.57	14.89
77-78	0.029	0.057	0.114	5.85	13.72	10.41	0.029	0.029	0.343	4.23	17.46	13.63
79-80	0.029	0.029	0.886	5.57	11.50	12.12	0.029	0.029	0.309	10.09	17.79	16.73
81-82	0.057	0.486	0.081	4.28	7.31	4.62	0.057	0.114	0.886	7.41	17.43	16.05
83-84	0.029	0.486	0.029	6.25	11.92	7.28	0.029	0.029	0.343	5.70	15.26	13.95
85-86	0.059	0.191	0.343	6.25	10.91	8.28	0.029	0.029	0.343	6.40	13.70	12.91
87-88	0.029	0.486	0.057	7.31	11.28	6.06	0.029	0.029	0.343	6.13	16.35	14.43
89-90	0.029	0.114	0.029	4.06	9.60	5.62	0.029	0.029	0.686	6.27	15.19	13.56
91-92	0.029	0.343	0.029	6.34	11.97	6.86	0.029	0.029	0.200	3.92	13.08	12.62
93-94	0.029	0.343	0.029	5.31	10.37	7.28	0.029	0.029	0.057	6.03	15.63	12.19
95-96	0.114	0.200	0.114	5.82	10.65	8.62	0.029	0.029	1.000	4.28	15.65	15.02

Time (h)	Rep 13						Rep 14					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.343	0.114	0.029	13.79	15.36	7.45	0.686	0.057	0.114	18.16	9.40	3.48
3-4	0.200	0.057	0.029	16.17	19.24	7.94	0.029	0.343	0.057	13.20	15.37	6.21
5-6	0.029	0.057	0.029	9.68	15.04	4.98	0.343	0.200	0.200	15.47	19.06	8.93
7-8	0.200	0.057	0.029	9.79	14.28	4.71	0.029	0.886	0.029	17.13	23.53	16.62
9-10	0.029	0.029	0.029	11.87	16.53	7.27	0.029	0.686	0.029	16.92	23.77	16.61
11-12	0.029	0.200	0.029	11.73	17.42	9.10	0.057	0.114	0.029	17.92	23.29	15.20
13-14	0.029	0.686	0.029	9.51	15.12	8.56	0.057	0.029	0.029	17.24	23.35	12.79
15-16	0.029	0.029	0.029	6.66	13.32	9.87	0.057	0.343	0.029	16.12	20.87	12.37
17-18	0.029	0.343	0.029	6.96	16.70	8.37	0.029	0.686	0.029	15.76	21.71	15.69
19-20	0.029	0.057	0.057	5.85	14.73	11.02	0.029	0.686	0.029	13.91	21.29	14.41
21-22	0.029	0.029	0.057	6.45	13.34	9.73	0.029	0.200	0.029	13.87	21.88	15.94
23-24	0.029	0.029	0.245	7.20	13.22	11.89	0.059	0.029	0.029	16.32	24.42	14.13
25-26	0.029	0.029	1.000	7.01	15.68	16.01	0.029	0.029	0.029	15.16	21.25	9.13
27-28	0.029	0.029	0.686	9.19	14.35	13.81	0.029	0.029	0.029	15.10	18.53	7.92
29-30	0.029	0.029	0.686	5.93	13.97	13.85	0.029	0.029	0.029	12.66	18.74	5.37
31-32	0.029	0.029	0.343	7.29	15.98	15.41	0.029	0.029	0.029	12.09	15.96	5.43
33-34	0.029	0.029	0.057	8.04	17.19	15.12	0.057	0.029	0.029	11.57	13.92	5.97
35-36	0.029	0.029	0.057	9.32	19.05	16.36	0.029	0.029	0.029	14.93	16.52	3.81
37-38	0.029	0.029	0.343	8.56	17.95	15.37	0.114	0.029	0.029	12.60	18.16	4.91
39-40	0.029	0.029	0.200	9.04	20.01	18.29	0.057	0.029	0.029	11.22	14.84	3.87
41-42	0.029	0.029	0.200	9.08	18.96	18.15	0.057	0.029	0.029	13.68	18.43	5.34
43-44	0.029	0.029	0.886	6.49	17.90	17.76	0.057	0.029	0.029	13.62	16.99	4.31
45-46	0.029	0.029	0.114	7.09	19.11	16.12	0.343	0.029	0.029	9.93	13.75	2.30
47-48	0.029	0.029	0.886	9.86	19.66	19.67	0.029	0.029	0.029	9.94	15.47	6.40
49-50	0.029	0.029	0.200	11.22	22.24	19.32	0.029	0.029	0.029	8.41	13.80	5.15
51-52	0.057	0.029	0.486	10.28	17.84	18.88	0.200	0.029	0.029	9.39	12.32	3.65
53-54	0.029	0.029	0.200	10.74	17.54	15.06	0.029	0.343	0.029	8.13	13.76	7.09
55-56	0.029	0.029	1.000	11.20	17.43	16.89	0.343	0.029	0.029	9.32	11.49	3.88
57-58	0.029	0.029	0.886	10.14	17.29	16.57	0.245	0.029	0.029	10.06	10.86	1.25
59-60	0.029	0.029	0.886	10.35	17.84	17.60	0.200	0.029	0.029	10.01	11.45	2.75
61-62	0.029	0.029	0.486	11.92	16.67	17.59	0.343	0.029	0.029	9.83	10.61	2.25
63-64	0.029	0.029	0.486	7.28	14.86	15.18	0.686	0.029	0.029	8.85	9.42	1.53
65-66	0.343	0.200	1.000	10.56	15.22	14.93	0.686	0.029	0.029	9.89	10.10	1.08
67-68	0.486	0.886	0.486	15.52	16.47	15.27	1.000	0.029	0.029	10.90	10.60	1.75
69-70	0.686	0.200	0.200	12.23	12.93	15.32	1.000	0.029	0.029	8.81	8.40	1.33
71-72	0.686	0.200	0.200	13.43	14.34	16.68	0.029	0.029	0.029	8.57	11.13	3.50
73-74	0.686	0.200	0.686	13.17	15.05	15.13	0.486	0.029	0.029	7.06	8.39	0.54
75-76	0.200	0.343	0.343	12.61	17.29	15.60	0.486	0.029	0.029	5.56	6.34	1.25
77-78	0.029	0.057	0.486	13.70	16.42	15.19	0.343	0.029	0.029	6.85	8.59	1.00
79-80	0.114	0.200	0.486	13.07	17.23	16.65	0.486	0.029	0.029	7.79	9.05	0.75
81-82	0.029	0.029	0.029	12.66	23.71	19.31	0.114	0.114	0.029	5.56	8.87	3.25
83-84	0.029	0.029	0.886	8.65	16.13	16.77	0.110	0.029	0.029	6.56	8.50	1.62
85-86	0.029	0.029	0.200	10.20	21.48	18.97	0.057	0.029	0.029	6.49	8.81	3.50
87-88	0.114	0.200	0.886	13.53	19.31	16.97	0.245	0.029	0.029	7.78	9.13	0.53
89-90	0.200	0.200	0.686	15.46	19.38	17.75	0.057	0.029	0.029	5.25	7.84	0.75
91-92	0.057	0.057	0.486	11.69	19.25	18.16	0.191	0.029	0.028	5.56	6.56	0.25
93-94	0.029	0.200	0.200	11.99	17.71	14.93	0.147	0.029	0.029	8.06	10.11	0.75
95-96	0.029	0.029	0.343	9.37	17.34	16.70	0.059	0.028	0.029	6.03	9.41	0.50

Time (h)	Rep 15						Rep 16					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.686	0.029	0.057	13.21	11.88	7.38	0.029	0.021	0.186	2.61	0.50	0.00
3-4	0.114	0.686	0.057	11.65	14.04	10.56	0.069	0.069	1.000	1.59	0.00	0.00
5-6	0.057	0.200	0.029	12.30	15.54	9.80	0.021	0.021	1.000	3.17	0.00	0.00
7-8	0.029	0.886	0.029	13.32	20.13	13.37	0.114	0.029	0.243	15.54	5.01	1.56
9-10	0.029	0.200	0.029	12.07	18.97	13.22	0.886	0.029	0.029	13.44	11.11	2.25
11-12	0.029	0.057	0.029	9.16	20.61	12.40	0.886	0.029	0.029	11.16	10.62	2.88
13-14	0.029	0.029	0.029	9.46	21.71	15.59	0.114	0.029	0.029	10.99	11.55	2.08
15-16	0.029	0.029	0.029	8.60	20.07	16.01	0.686	0.029	0.029	13.95	12.56	3.32
17-18	0.029	0.029	1.000	9.01	19.43	20.00	0.686	0.029	0.029	16.13	18.51	3.61
19-20	0.029	0.029	0.886	5.70	20.27	20.19	0.886	0.029	0.029	13.78	14.00	4.62
21-22	0.029	0.029	0.686	4.94	20.05	20.01	0.486	0.029	0.029	9.59	13.74	4.06
23-24	0.029	0.029	1.000	8.55	19.34	19.62	0.029	0.029	0.029	9.34	13.28	3.06
25-26	0.029	0.029	0.686	5.38	21.56	22.28	0.029	0.029	0.029	8.59	11.61	3.25
27-28	0.029	0.029	0.343	7.24	22.91	25.80	0.057	0.029	0.029	8.14	12.70	3.09
29-30	0.029	0.029	0.200	7.48	20.87	23.97	0.029	0.029	0.029	6.37	9.80	4.31
31-32	0.029	0.029	0.886	10.69	22.93	21.94	0.029	0.029	0.029	8.31	13.05	5.17
33-34	0.029	0.029	0.886	6.92	23.86	21.56	0.057	0.114	0.029	8.70	13.56	4.91
35-36	0.029	0.029	0.200	8.82	17.72	19.64	0.029	0.029	0.029	7.03	11.26	4.10
37-38	0.029	0.029	0.343	6.25	20.96	19.85	0.029	0.029	0.029	9.10	12.92	4.39
39-40	0.029	0.029	0.343	5.45	23.66	22.44	0.191	0.029	0.029	10.15	12.84	3.90
41-42	0.029	0.029	0.486	8.12	23.64	25.57	0.029	0.029	0.029	9.72	14.04	3.59
43-44	0.029	0.029	0.343	7.16	20.75	21.69	0.200	0.029	0.029	10.10	11.39	3.55
45-46	0.029	0.029	0.200	6.48	21.50	24.06	0.200	0.029	0.029	9.99	12.55	5.11
47-48	0.029	0.029	0.486	6.68	22.29	24.07	0.029	0.029	0.029	8.99	12.13	4.82
49-50	0.029	0.029	0.486	5.59	24.28	25.04	0.029	0.029	0.029	9.23	14.90	5.57
51-52	0.029	0.029	1.000	7.28	24.09	23.62	0.029	0.029	0.029	7.20	11.62	3.54
53-54	0.029	0.029	0.886	6.82	22.20	20.23	0.029	0.059	0.029	7.09	11.36	3.56
55-56	0.029	0.029	0.200	6.83	16.48	18.78	0.029	0.029	0.029	7.10	10.72	2.78
57-58	0.029	0.029	0.686	11.50	19.24	19.45	0.081	0.343	0.029	5.28	8.90	3.59
59-60	0.029	0.029	1.000	8.45	17.93	19.05	0.029	0.029	0.029	6.60	12.19	3.06
61-62	0.029	0.029	0.886	8.44	16.39	16.13	0.029	0.029	0.029	7.62	11.93	3.28
63-64	0.029	0.029	0.886	8.11	17.65	17.93	0.057	0.081	0.029	8.34	12.96	3.50
65-66	0.029	0.029	0.343	8.30	16.67	17.93	0.029	0.029	0.029	6.41	11.57	3.06
67-68	0.029	0.029	0.486	9.02	16.97	19.92	0.029	0.245	0.029	4.84	11.82	3.81
69-70	0.029	0.029	0.686	7.91	18.03	18.66	0.029	0.029	0.029	7.85	12.57	3.78
71-72	0.029	0.029	0.057	9.03	17.99	20.87	0.029	0.029	0.029	5.35	12.85	2.50
73-74	0.029	0.029	0.686	6.82	16.65	17.35	0.029	0.029	0.029	7.35	14.06	3.06
75-76	0.029	0.029	0.029	10.19	15.80	18.68	0.029	0.029	0.029	6.78	11.43	2.53
77-78	0.029	0.057	0.343	13.24	20.58	18.86	0.029	0.029	0.029	4.06	11.94	1.79
79-80	0.029	0.029	0.486	8.35	19.76	18.09	0.057	0.029	0.029	4.75	9.45	2.25
81-82	0.029	0.029	0.486	7.69	17.24	18.71	0.029	0.029	0.029	6.06	10.62	1.50
83-84	0.029	0.029	0.886	8.55	18.90	18.47	0.029	0.057	0.029	5.03	10.49	2.25
85-86	0.029	0.029	0.343	8.09	17.42	15.75	0.029	0.029	0.029	5.53	9.58	1.53
87-88	0.029	0.029	1.000	12.07	21.27	21.98	0.029	0.029	0.029	5.81	10.64	1.75
89-90	0.114	0.029	0.114	11.20	14.10	19.31	0.029	0.029	0.029	6.58	11.21	2.25
91-92	0.029	0.029	0.886	10.29	19.04	18.26	0.029	0.029	0.029	5.10	10.14	1.83
93-94	0.200	0.057	0.486	12.62	14.58	15.22	0.029	0.191	0.029	3.50	8.88	2.25
95-96	0.686	0.886	1.000	13.82	14.56	14.01	0.029	0.042	0.029	3.53	9.12	2.25

Time (h)	Rep 17						Rep 18					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.686	0.029	0.029	18.36	13.53	4.42	0.343	0.029	0.029	14.44	7.47	2.00
3-4	0.029	0.114	0.029	13.78	19.35	7.87	0.200	0.029	0.029	7.89	11.09	2.53
5-6	0.200	0.147	0.029	11.88	19.65	3.28	0.114	0.029	0.029	13.45	18.80	5.61
7-8	0.114	0.114	0.029	8.15	13.39	2.50	0.029	0.029	0.029	16.80	18.51	4.78
9-10	0.114	0.029	0.029	14.42	20.68	3.63	0.114	0.029	0.029	16.57	22.03	8.17
11-12	0.029	0.029	0.029	16.95	25.36	5.12	0.029	0.057	0.029	11.58	17.45	7.27
13-14	0.057	0.029	0.029	23.31	29.17	4.99	0.029	0.057	0.029	11.22	16.90	6.73
15-16	0.057	0.029	0.029	23.76	28.87	7.29	0.029	0.114	0.029	9.93	18.26	6.94
17-18	0.200	0.029	0.029	21.76	26.78	5.90	0.057	0.886	0.029	12.24	23.64	12.03
19-20	0.057	0.029	0.029	18.41	24.15	7.32	0.029	0.029	0.886	8.18	21.43	19.25
21-22	0.029	0.029	0.029	13.83	21.04	5.41	0.114	0.029	0.343	8.20	13.95	16.92
23-24	0.029	0.029	0.029	14.78	19.75	4.76	0.057	0.029	0.200	9.96	14.46	18.21
25-26	0.486	0.029	0.029	15.24	18.11	5.12	0.029	0.029	0.200	10.45	19.84	26.11
27-28	0.114	0.029	0.029	17.58	23.00	4.50	0.029	0.029	0.886	5.03	20.63	19.73
29-30	0.057	0.029	0.029	12.54	22.04	2.78	0.029	0.029	1.000	3.35	17.63	17.95
31-32	0.114	0.029	0.029	7.12	12.46	1.75	0.029	0.029	0.200	4.40	22.27	19.25
33-34	0.114	0.029	0.029	16.20	21.25	4.84	0.029	0.029	0.114	4.97	22.65	19.91
35-36	0.029	0.029	0.029	17.78	23.15	8.24	0.029	0.029	0.114	7.08	26.75	22.73
37-38	0.029	0.029	0.029	17.47	23.58	7.52	0.029	0.029	0.343	10.49	27.16	25.56
39-40	0.057	0.029	0.029	18.52	23.55	8.65	0.029	0.029	0.114	10.59	30.79	27.03
41-42	0.029	0.686	0.114	16.55	22.23	16.72	0.029	0.029	0.886	16.47	29.62	28.44
43-44	0.029	0.057	0.029	16.55	28.93	19.69	0.029	0.029	0.686	12.99	27.47	26.89
45-46	0.029	0.029	0.029	13.46	24.33	18.00	0.029	0.029	0.886	10.97	27.34	27.24
47-48	0.057	0.686	0.029	16.74	20.50	15.56	0.029	0.029	0.686	8.53	21.32	22.06
49-50	0.029	0.686	0.029	15.78	20.90	14.96	0.029	0.029	0.686	7.62	20.14	20.76
51-52	0.029	0.029	0.029	16.83	22.57	11.44	0.029	0.029	0.200	5.56	16.63	18.84
53-54	0.114	0.029	0.029	18.94	24.78	10.48	0.029	0.029	0.686	5.84	21.40	21.17
55-56	0.686	0.029	0.029	20.38	20.87	7.53	0.029	0.029	0.200	9.20	20.64	23.18
57-58	0.029	0.029	0.029	19.72	24.69	8.38	0.029	0.029	1.000	7.07	18.70	18.62
59-60	0.029	0.029	0.029	17.34	21.98	5.17	0.029	0.029	0.686	6.25	19.46	18.74
61-62	0.686	0.029	0.029	21.89	26.20	8.34	0.029	0.029	0.029	8.98	23.95	20.65
63-64	0.029	0.029	0.029	16.09	22.12	8.53	0.029	0.029	0.686	9.87	23.69	25.06
65-66	0.200	0.029	0.029	17.24	21.51	7.57	0.029	0.029	0.886	13.18	26.00	25.48
67-68	0.029	0.029	0.029	10.60	15.48	5.29	0.029	0.029	0.486	11.60	23.66	23.17
69-70	0.029	0.029	0.029	13.22	17.38	4.03	0.029	0.029	0.029	12.37	20.50	24.27
71-72	0.057	0.029	0.029	12.38	16.38	2.53	0.029	0.029	0.486	8.56	15.15	16.48
73-74	0.114	0.029	0.029	10.91	14.69	1.78	0.029	0.029	0.486	5.84	15.05	13.73
75-76	0.114	0.029	0.029	13.98	18.52	3.00	0.029	0.029	0.486	8.53	19.07	17.86
77-78	0.200	0.029	0.029	11.89	15.36	2.75	0.029	0.029	0.029	8.40	19.78	16.06
79-80	0.114	0.029	0.029	12.12	16.07	2.56	0.029	0.029	0.057	8.09	17.15	12.94
81-82	0.343	0.029	0.029	12.49	14.83	2.75	0.029	0.147	0.029	6.93	16.14	8.66
83-84	0.114	0.029	0.029	10.85	14.56	1.03	0.029	0.057	0.029	6.62	18.75	10.16
85-86	0.029	0.029	0.029	11.06	15.71	1.25	0.029	0.343	0.029	11.96	25.77	8.81
87-88	0.486	0.029	0.029	10.57	12.34	0.75	0.029	0.029	0.029	16.43	26.72	8.11
89-90	0.029	0.029	0.029	8.89	13.20	2.56	0.029	0.029	0.029	14.69	26.66	4.28
91-92	0.200	0.029	0.029	6.81	7.95	0.78	0.057	0.029	0.029	17.52	26.17	4.03
93-94	0.057	0.029	0.029	8.44	11.54	1.00	0.200	0.029	0.029	13.73	19.07	1.81
95-96	0.114	0.027	0.027	7.11	9.90	0.00	0.114	0.029	0.029	11.96	17.30	1.00

Time (h)	Rep 19						Rep 20					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.183	0.307	0.881	5.90	0.50	1.00	0.343	0.029	0.029	16.45	11.94	4.51
3-4	0.686	0.029	0.029	14.08	12.03	0.25	0.114	0.029	0.029	14.09	18.16	5.20
5-6	0.486	0.029	0.029	8.11	9.10	1.00	0.029	0.029	0.029	13.83	17.88	2.18
7-8	0.029	0.029	0.029	6.61	10.48	0.25	0.200	0.029	0.029	14.25	19.62	3.97
9-10	0.029	0.028	0.029	5.56	8.68	0.75	0.029	0.029	0.029	18.14	24.77	5.68
11-12	0.114	0.027	0.027	3.83	6.39	0.00	0.057	0.029	0.029	19.97	24.25	7.57
13-14	0.028	0.026	0.026	2.00	6.31	0.00	0.029	0.200	0.029	14.51	23.57	9.34
15-16	0.029	0.028	0.028	1.75	9.56	0.25	0.029	0.057	0.029	15.61	24.21	11.40
17-18	0.026	0.023	0.026	2.50	7.94	0.00	0.343	0.029	0.029	19.01	22.24	7.35
19-20	0.029	0.020	0.021	1.03	5.45	0.00	0.114	0.200	0.029	13.56	19.26	9.42
21-22	0.029	0.021	0.021	2.00	7.67	0.00	0.029	0.029	0.029	12.51	15.06	5.01
23-24	0.029	0.029	0.029	3.78	8.92	0.50	0.029	0.343	0.029	9.90	18.00	6.34
25-26	0.029	0.041	0.029	2.50	8.94	0.75	0.029	0.114	0.029	8.74	18.22	5.07
27-28	0.028	0.027	0.027	2.50	7.03	0.25	0.029	0.029	0.029	7.19	12.26	2.61
29-30	0.029	0.180	0.029	1.50	6.88	0.50	0.057	0.029	0.029	11.49	16.86	4.26
31-32	0.885	0.021	0.020	4.09	4.12	0.00	0.029	0.029	0.029	11.05	16.06	4.85
33-34	0.029	0.186	0.021	0.25	4.46	0.00	0.029	0.029	0.029	10.75	16.73	5.36
35-36	0.027	0.453	0.021	0.00	3.56	0.00	0.114	0.057	0.029	10.73	18.17	5.85
37-38	0.027	0.453	0.021	0.00	3.34	0.00	0.029	0.200	0.029	7.23	15.90	9.73
39-40	0.027	0.453	0.021	0.00	2.46	0.00	0.029	0.114	0.029	5.87	16.63	7.86
41-42	0.021	1.000	0.021	0.00	2.53	0.00	0.029	0.686	0.029	7.87	14.81	6.93
43-44	0.029	0.067	0.021	0.75	3.33	0.00	0.029	0.343	0.029	6.78	14.42	8.81
45-46	0.059	0.186	0.021	0.25	3.42	0.00	0.029	1.000	0.029	7.13	13.16	7.22
47-48	0.028	0.067	0.020	0.75	3.62	0.00	0.029	0.029	0.029	12.30	15.87	5.58
49-50	0.029	0.067	0.021	0.75	3.64	0.00	0.057	0.886	0.114	7.94	17.30	12.23
51-52	0.028	0.181	0.021	0.25	3.71	0.00	0.029	0.114	0.029	7.65	14.88	12.03
53-54	0.027	0.453	0.021	0.00	4.64	0.00	0.029	0.029	0.029	7.46	18.19	10.96
55-56	0.021	1.000	0.021	0.00	2.53	0.00	0.114	0.486	0.057	10.00	16.93	8.02
57-58	0.029	0.186	0.021	0.25	2.97	0.00	0.029	0.886	0.343	10.05	19.03	10.06
59-60	0.021	0.013	0.021	0.50	2.03	0.00	0.029	0.029	1.000	7.79	23.66	24.85
61-62	0.069	0.013	0.021	1.00	2.05	0.00	0.029	0.029	0.114	5.15	21.05	23.79
63-64	0.189	0.069	0.021	0.75	1.53	0.00	0.029	0.029	0.886	9.94	15.47	16.63
65-66	0.739	0.067	0.018	1.00	1.00	0.00	0.029	0.029	0.486	8.64	16.07	14.74
67-68	0.086	0.181	0.019	0.25	0.75	0.00	0.029	0.029	0.686	6.50	15.27	15.81
69-70	0.552	0.067	0.069	0.50	1.00	0.00	0.029	0.029	0.081	5.17	14.80	10.49
71-72	0.453	1.000	0.453	0.00	0.00	0.00	0.057	0.114	0.114	6.42	13.19	10.50
73-74	0.243	0.069	0.067	32.75	0.50	0.00	0.029	0.029	0.029	6.45	14.00	11.09
75-76	0.186	1.000	0.186	0.00	0.25	0.00	0.029	0.029	0.057	6.90	18.82	13.32
77-78	0.649	0.067	0.020	0.75	0.75	0.00	0.029	0.029	0.029	5.02	16.91	12.70
79-80	0.760	0.186	0.067	0.25	0.50	0.00	0.029	0.029	0.114	5.62	17.68	15.70
81-82	0.069	0.069	1.000	0.75	0.00	0.00	0.029	0.029	0.029	4.14	17.55	11.24
83-84	0.408	0.453	0.186	0.00	0.50	0.00	0.029	0.029	0.200	4.69	18.13	13.81
85-86	1.000	1.000	1.000	0.00	0.00	0.00	0.029	0.029	0.200	3.29	11.23	7.27
87-88	1.000	1.000	1.000	0.00	0.00	0.00	0.029	0.114	0.343	1.82	10.71	7.43
89-90	1.000	1.000	1.000	0.00	0.00	0.00	0.029	0.029	0.029	1.83	10.54	7.47
91-92	0.029	0.021	0.186	56.51	0.25	0.00	0.029	0.029	0.200	2.67	10.02	8.19
93-94	0.869	0.453	0.186	0.00	0.25	0.00	0.029	0.029	0.029	3.31	12.62	8.18
95-96	0.186	1.000	0.186	0.00	0.25	0.00	0.029	0.200	0.057	4.65	12.47	7.22

Time (h)	Rep 21						Rep 22					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.343	0.029	0.886	18.19	8.62	4.60	0.486	0.343	0.057	4.12	8.32	1.31
3-4	0.772	0.029	0.029	6.64	6.06	2.31	0.200	0.057	0.029	6.12	11.54	3.34
5-6	1.000	0.029	0.029	10.18	10.17	2.56	0.343	0.029	0.029	15.10	17.50	5.23
7-8	0.114	0.114	0.029	8.80	15.01	2.57	0.029	0.029	0.029	15.36	18.48	3.49
9-10	0.029	0.029	0.029	10.06	16.02	4.46	0.029	0.029	0.029	13.73	22.56	5.40
11-12	0.057	0.029	0.029	13.16	21.71	2.41	0.029	0.029	0.029	14.60	24.51	7.28
13-14	0.200	0.029	0.029	16.58	22.82	2.23	0.029	0.029	0.029	12.98	22.09	5.94
15-16	0.114	0.029	0.029	15.82	24.46	3.40	0.029	0.029	0.029	12.31	21.30	6.50
17-18	0.029	0.057	0.029	18.65	27.96	4.38	0.029	0.029	0.029	12.19	20.24	4.32
19-20	0.057	0.029	0.486	9.67	32.91	21.99	0.114	0.029	0.029	11.75	17.19	3.58
21-22	0.057	0.029	0.057	10.54	17.29	22.49	0.029	0.029	0.029	11.07	19.91	4.99
23-24	0.029	0.029	0.114	7.81	16.93	20.11	0.029	0.029	0.029	10.45	20.19	5.58
25-26	0.029	0.029	0.200	6.88	12.11	15.55	0.200	0.686	0.029	7.99	14.71	4.87
27-28	0.029	0.029	0.029	3.38	13.15	17.99	0.021	0.486	0.021	16.55	6.12	15.48
29-30	0.029	0.029	0.343	3.64	22.44	23.57	1.000	0.029	0.686	16.18	14.05	11.09
31-32	0.029	0.029	0.486	3.61	18.78	16.19	0.029	0.057	0.029	11.50	16.53	6.78
33-34	0.029	0.029	0.886	5.36	21.38	20.88	0.029	0.029	0.029	12.77	16.85	6.38
35-36	0.029	0.029	1.000	7.17	29.04	29.73	0.343	0.029	0.029	16.94	20.50	5.89
37-38	0.029	0.029	0.114	9.04	25.58	27.79	0.029	1.000	0.029	8.20	17.90	8.34
39-40	0.029	0.029	0.486	8.25	26.97	28.28	0.029	1.000	0.029	8.86	17.41	8.14
41-42	0.200	0.029	0.486	5.90	18.07	22.18	0.057	0.057	0.029	10.60	18.87	6.25
43-44	0.029	0.029	0.057	5.57	11.92	14.86	0.029	0.029	0.029	12.50	17.19	7.72
45-46	0.029	0.029	0.057	3.56	18.47	19.80	0.114	0.029	0.029	10.37	13.89	4.13
47-48	0.029	0.029	0.686	4.85	20.27	21.13	0.114	0.029	0.029	11.54	14.24	3.96
49-50	0.029	0.029	0.886	5.46	20.76	21.66	0.114	0.029	0.029	12.51	15.91	4.12
51-52	0.029	0.029	0.057	7.26	27.16	28.92	0.114	0.029	0.029	15.35	18.78	3.89
53-54	0.029	0.029	0.200	9.30	24.44	26.15	0.029	0.029	0.029	15.59	21.44	4.16
55-56	0.029	0.029	0.029	9.96	25.07	28.18	0.200	0.029	0.029	14.19	20.66	7.74
57-58	0.029	0.029	0.200	11.06	26.12	30.27	0.029	0.114	0.029	15.02	22.84	10.26
59-60	0.029	0.029	1.000	6.11	23.39	22.73	0.886	0.200	0.886	14.76	12.13	12.29
61-62	0.029	0.029	0.686	10.70	23.88	23.03	0.029	0.029	0.029	10.34	18.55	5.85
63-64	0.029	0.029	0.886	12.08	25.79	26.13	0.200	0.029	0.029	13.53	17.52	3.78
65-66	0.029	0.029	0.114	12.75	20.22	25.63	0.343	0.029	0.029	12.90	18.99	4.44
67-68	0.029	0.029	0.486	11.81	20.59	23.09	0.886	0.029	0.029	13.02	14.85	2.88
69-70	0.029	0.029	0.885	11.66	22.97	24.71	0.686	0.029	0.029	13.45	14.51	3.64
71-72	0.029	0.029	0.029	14.09	20.70	27.11	0.029	0.029	0.029	14.70	17.51	3.78
73-74	0.029	0.029	0.029	10.70	24.09	28.21	0.200	0.029	0.029	13.76	16.82	2.34
75-76	0.029	0.029	0.114	9.79	22.10	25.54	0.343	0.029	0.029	15.42	17.33	2.70
77-78	0.029	0.029	0.686	11.50	22.45	23.70	0.486	0.029	0.029	14.49	16.03	3.62
79-80	0.029	0.029	0.200	8.47	24.77	27.08	0.200	0.029	0.029	12.29	16.74	4.99
81-82	0.029	0.029	0.886	10.52	25.97	25.98	0.200	0.029	0.029	13.81	16.32	2.35
83-84	0.029	0.029	0.686	7.18	21.29	22.03	0.057	0.029	0.029	13.24	17.77	1.29
85-86	0.029	0.029	0.200	4.93	20.23	19.47	0.029	0.029	0.029	11.27	14.48	7.31
87-88	0.029	0.029	1.000	6.97	23.39	22.85	0.200	0.029	0.029	11.46	16.77	4.45
89-90	0.029	0.029	0.686	5.77	22.39	20.94	0.029	0.029	0.029	12.07	17.10	0.79
91-92	0.029	0.029	0.886	6.89	19.57	21.83	0.114	0.029	0.029	8.49	11.61	0.50
93-94	0.029	0.029	0.114	6.20	19.23	21.15	0.114	0.029	0.029	9.70	11.21	0.58
95-96	0.029	0.029	0.343	6.05	20.39	20.73	0.057	0.029	0.029	7.55	11.04	0.53

Time (h)	Rep 23						Rep 24					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.191	0.029	0.080	14.25	3.50	1.75	0.343	0.029	0.309	22.12	20.10	15.69
3-4	0.029	0.029	0.028	27.50	22.50	3.00	0.343	0.029	0.029	22.73	24.28	17.42
5-6	0.028	0.029	0.029	29.00	21.50	1.25	0.486	0.057	0.057	24.11	25.94	18.85
7-8	0.029	0.029	0.029	29.00	21.00	0.75	0.486	0.029	0.029	23.49	22.44	15.97
9-10	0.029	0.029	0.029	30.25	25.50	1.00	1.000	0.029	0.029	24.93	24.01	13.77
11-12	0.200	0.029	0.029	27.25	23.25	0.50	0.686	0.029	0.029	21.98	23.57	12.02
13-14	0.663	0.028	0.027	22.00	21.75	1.75	0.686	0.029	0.029	21.88	22.02	13.13
15-16	0.200	0.029	0.029	23.25	19.75	0.75	0.886	0.029	0.029	22.04	22.11	10.53
17-18	0.770	0.029	0.029	18.75	15.75	0.75	0.686	0.029	0.029	20.71	21.67	11.37
19-20	0.200	0.029	0.029	19.75	15.50	1.50	0.686	0.029	0.029	19.52	21.68	8.39
21-22	0.191	0.029	0.029	22.00	16.00	2.25	0.886	0.029	0.029	19.46	19.52	7.87
23-24	0.029	0.027	0.027	15.50	10.25	0.00	0.029	0.029	0.029	22.50	25.14	8.44
25-26	0.029	0.028	0.029	15.50	9.75	0.25	0.200	0.029	0.029	18.35	22.44	9.16
27-28	0.147	0.029	0.029	16.50	12.75	0.25	0.486	0.029	0.029	18.26	21.13	5.67
29-30	0.028	0.029	0.027	18.75	12.25	0.25	0.343	0.029	0.029	17.87	19.11	6.64
31-32	0.029	0.029	0.028	18.75	13.75	0.25	1.000	0.029	0.029	18.05	17.36	3.94
33-34	0.029	0.027	0.026	17.75	12.50	0.00	0.686	0.029	0.029	13.57	13.75	3.91
35-36	0.042	0.021	0.021	17.50	11.25	0.00	1.000	0.029	0.029	13.92	12.98	4.30
37-38	0.029	0.027	0.027	16.50	12.25	0.00	0.686	0.029	0.029	13.01	12.39	3.87
39-40	0.089	0.027	0.028	15.00	13.75	2.00	0.343	0.029	0.029	14.71	16.01	4.53
41-42	0.029	0.029	0.029	15.75	10.25	0.50	0.343	0.029	0.029	19.52	21.35	5.06
43-44	0.029	0.028	0.029	16.50	11.25	1.25	1.000	0.029	0.029	19.29	19.21	4.65
45-46	0.029	0.027	0.027	14.75	10.50	1.00	1.000	0.029	0.029	16.69	18.13	3.53
47-48	0.029	0.028	0.029	15.25	10.00	0.25	0.886	0.029	0.029	18.91	19.44	4.63
49-50	0.029	0.027	0.026	12.75	10.50	0.00	0.886	0.029	0.029	17.79	18.22	3.82
51-52	0.059	0.020	0.021	15.50	10.25	0.00	0.886	0.029	0.029	14.73	13.77	1.82
53-54	0.057	0.029	0.029	14.00	11.25	0.25	0.343	0.029	0.029	14.96	12.94	2.95
55-56	0.029	0.026	0.027	16.00	10.25	0.50	1.000	0.029	0.029	11.62	10.83	3.98
57-58	0.381	0.028	0.029	15.00	14.25	1.50	0.886	0.029	0.029	8.87	9.76	2.56
59-60	0.343	0.029	0.029	17.75	12.00	1.25	0.686	0.029	0.029	11.96	12.17	3.20
61-62	0.307	0.029	0.029	16.25	12.75	0.50	0.686	0.029	0.029	12.83	11.34	1.06
63-64	0.059	0.029	0.028	25.50	21.50	2.00	0.886	0.029	0.029	12.57	12.29	1.75
65-66	0.041	0.028	0.029	22.50	16.25	0.50	1.000	0.029	0.029	12.87	12.54	1.25
67-68	0.465	0.021	0.021	17.75	16.00	0.00	0.200	0.029	0.029	11.00	12.86	1.00
69-70	0.041	0.029	0.028	14.25	11.25	0.25	0.343	0.029	0.029	10.42	11.40	0.25
71-72	0.029	0.021	0.020	15.50	11.25	0.00	0.114	0.027	0.027	6.25	9.03	0.00
73-74	0.059	0.027	0.026	14.25	10.50	0.00	0.200	0.027	0.027	6.34	8.70	0.00
75-76	0.057	0.028	0.028	15.75	10.75	0.25	0.057	0.029	0.029	5.03	8.75	0.25
77-78	0.029	0.020	0.021	15.50	11.25	0.00	0.029	0.029	0.029	6.28	9.39	0.25
79-80	0.028	0.021	0.019	16.50	12.75	0.00	0.114	0.029	0.029	6.25	9.35	1.50
81-82	0.104	0.021	0.020	16.25	13.00	0.00	0.029	0.029	0.029	6.75	11.31	0.78
83-84	0.059	0.027	0.026	16.25	10.00	0.00	0.029	0.029	0.029	6.03	9.84	1.03
85-86	0.029	0.027	0.027	14.75	8.75	0.00	0.029	0.027	0.026	6.78	8.63	0.00
87-88	0.042	0.027	0.027	16.00	9.00	0.00	0.029	0.021	0.021	5.03	9.85	0.00
89-90	0.029	0.021	0.021	13.25	8.50	0.00	0.114	0.029	0.029	4.25	6.84	0.25
91-92	0.042	0.021	0.021	13.00	8.50	0.00	0.245	0.028	0.028	6.06	8.09	0.25
93-94	0.041	0.021	0.020	10.75	7.50	0.00	0.200	0.027	0.027	3.25	5.61	0.00
95-96	0.029	0.026	0.027	13.50	6.00	0.00	0.059	0.027	0.026	3.75	6.31	0.00

Time (h)	Rep 25						Rep 26					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.886	0.029	0.057	15.28	17.20	9.64	1.000	0.057	0.057	17.28	17.82	7.09
3-4	1.000	0.343	0.343	22.38	23.06	19.61	0.200	0.468	0.059	17.56	26.00	15.82
5-6	0.886	0.029	0.029	26.74	26.79	21.93	0.029	0.029	0.029	18.42	23.85	15.45
7-8	0.114	0.029	0.029	27.17	28.17	22.96	0.200	0.057	0.057	20.73	26.09	13.24
9-10	0.114	0.114	0.029	24.19	28.23	22.80	0.029	0.029	0.029	20.24	24.99	16.55
11-12	0.886	0.114	0.200	24.79	26.21	22.33	0.057	0.057	0.029	20.92	24.34	15.82
13-14	0.114	0.029	0.029	24.44	27.32	18.23	0.114	0.029	0.029	23.36	26.46	16.16
15-16	0.114	0.057	0.029	25.45	28.69	18.45	0.029	0.029	0.029	20.65	23.77	14.45
17-18	0.029	0.057	0.029	24.45	28.34	20.66	0.114	0.200	0.029	16.95	21.51	13.60
19-20	0.886	0.029	0.029	26.26	26.41	19.10	0.200	0.200	0.057	17.51	21.59	14.56
21-22	0.029	0.029	0.029	20.78	24.15	15.70	0.200	0.029	0.029	17.04	20.85	12.09
23-24	0.486	0.029	0.029	23.79	24.57	18.32	0.343	0.029	0.057	16.19	23.59	13.62
25-26	0.114	0.029	0.029	22.83	25.63	17.03	0.029	0.886	0.029	15.91	23.28	16.01
27-28	0.686	0.029	0.029	24.45	22.18	15.46	0.029	0.486	0.029	14.81	20.24	13.10
29-30	0.343	0.114	0.029	21.27	24.58	18.20	0.029	0.114	0.057	12.87	19.93	14.57
31-32	0.057	0.057	0.029	22.36	26.94	17.59	0.029	0.486	0.029	12.88	18.99	14.01
33-34	0.486	0.057	0.029	20.70	22.84	14.87	0.057	0.343	0.200	13.55	21.06	15.49
35-36	0.057	0.029	0.029	20.18	22.92	13.97	0.029	0.029	0.029	14.19	20.42	15.56
37-38	0.686	0.029	0.029	21.89	22.98	8.36	0.029	0.343	0.029	12.47	19.58	14.67
39-40	0.686	0.029	0.029	20.22	19.19	7.22	0.029	0.343	0.029	11.66	19.27	13.05
41-42	0.200	0.029	0.029	22.39	20.84	3.31	0.029	0.057	0.029	12.49	20.56	15.55
43-44	0.686	0.029	0.029	19.68	18.41	3.85	0.029	0.029	0.029	13.01	20.42	16.74
45-46	0.029	0.029	0.029	18.31	20.30	4.08	0.029	0.486	0.029	16.66	22.36	17.95
47-48	0.486	0.029	0.029	19.13	20.76	5.03	0.029	0.029	0.029	10.98	23.41	16.33
49-50	0.029	0.029	0.029	17.48	19.81	3.25	0.029	0.081	0.114	12.37	20.80	15.28
51-52	0.057	0.029	0.029	14.42	16.42	2.32	0.029	0.029	0.029	10.64	20.46	13.56
53-54	0.686	0.029	0.029	17.34	15.97	2.56	0.029	0.663	0.029	11.65	17.80	10.93
55-56	0.343	0.029	0.029	14.12	16.23	2.00	0.029	0.200	0.029	9.06	15.03	7.09
57-58	0.343	0.029	0.029	10.20	13.44	1.04	0.029	0.114	0.029	9.59	15.25	7.35
59-60	0.343	0.029	0.029	12.69	15.27	1.78	0.029	0.057	0.029	11.12	16.89	5.75
61-62	0.057	0.029	0.029	13.10	19.32	2.50	0.029	0.057	0.029	9.33	17.16	5.78
63-64	0.114	0.029	0.029	11.20	15.47	2.60	0.029	0.029	0.029	9.28	16.72	3.82
65-66	0.029	0.027	0.028	8.00	13.37	0.75	0.029	0.029	0.029	8.81	17.34	3.25
67-68	0.057	0.029	0.029	8.06	11.65	1.75	0.029	0.200	0.029	10.66	18.36	6.64
69-70	0.081	0.029	0.029	7.75	9.43	1.75	0.029	0.029	0.029	10.37	17.36	4.00
71-72	0.114	0.029	0.029	8.75	12.20	1.78	0.029	0.029	0.029	9.41	16.13	4.00
73-74	0.114	0.029	0.029	7.61	10.63	1.75	0.059	0.029	0.029	8.62	13.73	1.78
75-76	0.057	0.057	0.029	6.28	9.92	1.50	0.029	0.029	0.029	8.31	12.34	1.00
77-78	0.029	0.147	0.029	4.25	11.06	3.04	0.029	0.029	0.029	10.78	14.19	1.75
79-80	0.057	0.027	0.027	3.50	6.25	1.00	0.029	0.029	0.029	11.63	17.01	3.25
81-82	0.041	0.020	0.021	1.03	3.84	0.00	0.343	0.029	0.029	7.62	9.34	1.53
83-84	0.029	0.288	0.027	0.75	3.03	0.25	0.029	0.029	0.029	6.32	11.28	0.75
85-86	0.240	0.620	0.049	0.25	1.50	0.00	0.029	0.027	0.027	6.56	11.14	0.00
87-88	0.027	0.453	0.021	0.00	1.56	0.00	0.029	0.027	0.027	8.34	14.26	2.50
89-90	0.028	0.608	0.027	0.25	2.28	0.00	0.029	0.029	0.029	8.34	11.76	1.50
91-92	0.037	0.453	0.021	0.00	2.00	0.00	0.029	0.029	0.029	9.36	13.21	1.25
93-94	0.021	1.000	0.021	0.00	1.03	0.00	0.343	0.029	0.029	7.28	9.21	0.75
95-96	0.243	0.020	0.021	1.00	3.59	0.00	0.029	0.029	0.029	11.54	21.46	5.75

Time (h)	Rep 27						Rep 28					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.686	0.200	0.200	14.50	8.12	4.50	0.886	0.114	0.200	12.69	12.90	4.81
3-4	0.059	0.884	0.110	2.03	5.75	2.78	0.057	0.029	0.029	11.57	20.35	6.60
5-6	0.343	0.059	0.029	8.84	10.67	4.50	0.029	0.029	0.029	22.01	26.48	6.06
7-8	0.200	0.059	0.029	13.97	17.49	6.00	0.029	0.029	0.029	19.73	29.46	6.37
9-10	0.029	0.114	0.029	14.81	22.45	10.15	0.029	0.029	0.029	16.17	27.41	4.57
11-12	0.029	0.486	0.029	14.96	25.51	15.68	0.029	0.029	0.029	12.39	21.79	2.03
13-14	0.029	0.486	0.029	13.12	24.11	16.19	0.029	0.029	0.029	15.35	27.02	2.14
15-16	0.029	0.029	0.343	12.74	23.29	19.08	0.029	0.029	0.029	8.00	18.75	2.53
17-18	0.029	0.686	0.029	22.83	34.13	20.85	0.029	0.029	0.029	5.28	13.73	3.09
19-20	0.029	0.029	0.057	18.18	33.51	28.21	0.110	1.000	0.114	4.12	7.18	3.86
21-22	0.029	0.029	0.029	16.23	35.98	25.51	0.057	0.486	0.114	2.50	8.51	3.91
23-24	0.029	0.029	0.029	16.66	31.90	26.19	0.663	1.000	0.886	2.53	3.04	2.85
25-26	0.029	0.029	0.029	15.48	34.10	27.46	0.191	1.000	0.343	2.50	3.85	2.28
27-28	0.029	0.029	0.029	19.54	38.15	33.62	0.029	0.029	0.200	2.78	6.56	5.22
29-30	0.029	0.029	0.029	21.41	35.12	29.99	0.029	0.200	0.343	3.32	5.79	4.86
31-32	0.029	0.029	0.057	21.22	32.17	27.56	0.027	0.027	0.772	4.00	5.03	5.35
33-34	0.200	0.200	0.486	14.09	27.77	25.74	0.028	0.029	0.468	3.00	6.00	6.90
35-36	0.057	0.686	0.057	31.03	40.05	28.56	0.029	0.029	0.200	4.13	8.37	9.88
37-38	0.029	0.057	0.686	23.30	29.61	28.50	0.029	0.029	0.885	3.75	9.31	8.81
39-40	0.029	0.029	0.343	24.38	38.10	32.27	0.029	0.114	1.000	4.31	9.64	9.37
41-42	0.686	0.343	0.029	32.73	32.41	25.06	0.029	0.029	0.886	4.84	12.51	12.99
43-44	0.343	0.029	0.029	28.46	30.45	23.34	0.029	0.029	0.886	7.21	13.03	13.84
45-46	0.343	0.029	0.029	26.87	23.84	16.23	0.029	0.029	0.886	6.37	14.31	15.36
47-48	0.686	0.029	0.029	18.67	19.14	14.50	0.029	0.029	0.486	7.80	14.92	13.16
49-50	1.000	0.029	0.029	16.66	16.99	11.89	0.029	0.029	0.772	9.85	18.90	18.19
51-52	0.686	0.057	0.029	20.48	21.13	15.10	0.029	0.029	0.686	9.80	19.55	18.75
53-54	1.000	0.029	0.029	27.22	26.89	15.82	0.029	0.029	0.029	9.98	22.38	23.72
55-56	0.686	0.029	0.029	24.95	25.52	14.24	0.029	0.029	0.886	12.10	25.19	25.89
57-58	0.885	0.029	0.029	25.28	24.99	16.62	0.029	0.029	0.686	10.44	26.17	27.44
59-60	0.886	0.029	0.029	24.20	24.86	14.08	0.029	0.029	0.886	10.03	30.09	28.52
61-62	0.886	0.029	0.029	26.78	27.12	12.85	0.029	0.029	1.000	11.49	31.56	30.74
63-64	0.686	0.029	0.029	24.69	22.61	10.27	0.029	0.029	0.486	12.47	31.26	31.87
65-66	0.886	0.029	0.029	25.96	25.56	10.73	0.029	0.029	0.686	12.43	31.47	31.18
67-68	0.486	0.029	0.029	26.21	24.95	10.69	0.029	0.029	0.686	10.82	33.06	34.06
69-70	0.886	0.029	0.029	22.25	21.50	9.34	0.029	0.029	1.000	12.62	31.45	33.56
71-72	0.200	0.029	0.029	23.00	25.64	11.08	0.029	0.029	0.343	11.71	33.09	34.29
73-74	0.886	0.029	0.029	21.16	20.97	7.50	0.029	0.029	1.000	12.19	29.08	30.15
75-76	0.686	0.029	0.029	22.07	20.41	9.70	0.029	0.029	0.029	11.01	24.72	28.33
77-78	0.486	0.029	0.029	25.00	22.87	7.07	0.029	0.029	0.343	12.92	28.41	31.80
79-80	0.886	0.029	0.029	22.31	22.06	9.87	0.029	0.029	0.200	12.69	27.80	30.73
81-82	0.114	0.029	0.029	25.65	23.91	7.81	0.029	0.029	1.000	12.48	26.76	27.50
83-84	0.486	0.029	0.029	26.48	25.17	8.66	0.029	0.029	0.343	11.04	28.02	30.21
85-86	0.114	0.029	0.029	24.02	21.89	6.57	0.029	0.029	0.029	10.74	27.97	30.30
87-88	0.486	0.029	0.029	26.06	23.67	7.50	0.029	0.029	0.886	11.60	25.41	27.58
89-90	0.686	0.029	0.029	22.60	21.79	4.92	0.029	0.029	0.343	9.24	26.91	26.39
91-92	0.886	0.029	0.029	25.86	25.40	4.59	0.029	0.029	0.886	12.78	25.41	25.87
93-94	0.886	0.029	0.029	23.34	22.87	3.53	0.029	0.029	0.486	12.63	24.30	22.26
95-96	0.057	0.029	0.029	23.48	21.63	4.87	0.029	0.029	0.343	12.37	27.10	23.49

Time (h)	Rep 29						Rep 30					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.886	0.029	0.343	13.24	12.07	4.66	1.000	0.309	0.486	13.41	6.66	4.70
3-4	0.200	0.029	0.029	12.36	17.48	2.03	0.557	0.465	0.465	1.50	2.00	0.53
5-6	0.057	0.029	0.029	20.94	24.76	4.40	0.766	0.186	0.069	0.75	1.03	0.00
7-8	0.200	0.029	0.029	19.87	23.37	2.25	0.353	0.453	0.067	0.00	0.50	0.00
9-10	0.057	0.029	0.029	15.73	20.41	2.51	1.000	0.037	0.027	1.28	1.28	0.00
11-12	0.114	0.114	0.029	14.94	18.65	8.19	0.686	0.055	0.027	3.86	5.70	0.00
13-14	0.200	0.200	0.029	11.96	14.65	9.95	0.886	0.110	0.059	5.76	6.45	0.81
15-16	0.200	1.000	0.029	13.48	15.78	13.67	0.686	0.029	0.029	10.64	11.12	3.43
17-18	0.057	0.057	0.029	16.44	19.51	14.02	1.000	0.029	0.029	13.09	13.09	4.37
19-20	0.114	0.200	0.029	18.06	21.93	16.27	0.029	0.029	0.029	10.54	14.32	6.17
21-22	0.343	1.000	0.114	23.22	26.66	23.00	0.486	0.029	0.029	9.80	12.47	4.68
23-24	0.343	0.486	0.686	20.78	25.28	25.03	0.029	0.029	0.029	23.40	26.64	5.10
25-26	0.029	0.114	0.343	21.94	27.40	25.63	0.029	0.057	0.029	12.11	20.96	6.42
27-28	0.029	0.029	0.686	20.21	30.90	30.03	0.029	0.886	0.057	7.00	16.76	7.84
29-30	0.029	0.029	0.029	19.08	27.77	30.53	0.029	0.147	0.343	2.28	9.57	6.40
31-32	0.029	0.029	0.114	20.22	30.22	32.52	0.029	0.057	0.200	2.50	7.81	4.59
33-34	0.029	0.029	0.200	18.77	29.00	33.66	0.029	0.029	0.114	5.12	8.53	7.13
35-36	0.029	0.029	0.029	15.81	29.02	33.52	0.029	0.029	0.886	4.81	12.17	11.60
37-38	0.029	0.029	0.029	17.53	29.60	35.89	0.029	0.029	0.686	3.57	13.71	12.42
39-40	0.029	0.029	0.200	17.89	28.58	31.80	0.029	0.029	0.686	4.30	15.02	16.37
41-42	0.029	0.029	0.686	17.61	30.80	32.19	0.029	0.029	0.686	6.43	18.72	19.40
43-44	0.029	0.029	0.686	15.98	29.27	31.59	0.029	0.029	0.486	9.03	22.40	24.37
45-46	0.029	0.029	0.886	13.51	27.76	29.73	0.029	0.029	0.057	9.44	25.36	28.38
47-48	0.029	0.029	0.081	11.89	25.44	27.32	0.029	0.029	0.686	8.44	24.47	24.72
49-50	0.029	0.029	0.486	12.93	26.54	25.88	0.029	0.029	0.057	10.50	26.57	29.88
51-52	0.029	0.029	1.000	13.91	25.37	25.45	0.029	0.029	0.114	9.52	26.05	30.45
53-54	0.029	0.029	0.057	16.19	21.89	26.49	0.029	0.029	0.200	9.07	26.80	30.54
55-56	0.029	0.029	0.486	16.85	22.88	25.80	0.029	0.029	0.200	9.16	28.54	32.57
57-58	0.886	0.029	0.029	18.62	18.02	24.48	0.029	0.029	0.200	5.04	12.40	15.46
59-60	0.200	0.029	0.029	13.95	17.29	21.72	0.029	0.029	0.057	4.35	13.66	16.89
61-62	0.029	0.029	0.200	14.46	19.87	25.63	0.029	0.029	0.200	4.24	14.79	16.59
63-64	0.029	0.029	0.114	15.71	22.92	26.69	0.029	0.029	0.886	2.50	15.20	15.17
65-66	0.029	0.029	0.029	13.78	20.20	26.23	0.029	0.029	0.029	2.00	11.95	15.70
67-68	0.029	0.029	0.343	13.10	36.51	25.35	0.029	0.029	0.486	2.00	13.10	12.44
69-70	0.200	0.029	0.343	13.85	19.05	25.19	0.029	0.029	0.114	3.50	13.87	17.06
71-72	0.029	0.029	0.029	14.07	18.26	22.80	0.029	0.029	0.245	2.50	14.43	15.93
73-74	0.029	0.029	0.343	14.12	19.91	22.23	0.029	0.029	0.200	4.03	15.76	18.43
75-76	0.029	0.029	0.343	14.26	21.60	22.82	0.029	0.029	0.029	4.83	17.46	20.71
77-78	0.029	0.029	0.486	14.87	22.77	23.22	0.029	0.029	0.486	5.00	19.79	22.42
79-80	0.057	0.200	0.886	17.05	22.05	21.61	0.029	0.029	0.114	5.75	20.59	22.34
81-82	0.029	0.029	0.343	16.83	21.13	22.85	0.029	0.029	0.200	7.03	15.89	20.99
83-84	0.114	0.029	0.200	18.62	22.18	25.55	0.027	0.027	0.029	5.50	17.20	21.73
85-86	0.029	0.029	0.057	16.84	22.78	20.58	0.029	0.029	0.114	5.50	15.00	17.49
87-88	0.114	0.029	1.000	15.48	21.97	22.76	0.029	0.029	0.886	7.31	17.22	17.17
89-90	0.343	0.343	0.486	15.95	17.79	17.14	0.029	0.029	0.114	6.59	15.65	18.29
91-92	0.486	0.057	1.000	17.53	19.31	19.62	0.029	0.029	0.200	9.67	13.97	18.31
93-94	0.029	0.057	0.114	14.43	20.23	17.56	0.029	0.029	0.200	4.31	12.85	11.03
95-96	1.000	0.343	0.200	16.60	18.20	14.82	0.029	0.029	0.114	5.06	9.50	11.95

Time (h)	Rep 31						Rep 32					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.886	0.029	0.029	9.36	10.06	1.78	0.114	0.029	0.200	9.97	8.32	4.84
3-4	0.343	0.029	0.029	16.29	19.37	4.62	0.114	0.200	0.029	6.86	10.56	5.55
5-6	0.486	0.029	0.029	24.16	26.32	9.73	0.029	0.886	0.029	6.15	12.73	6.30
7-8	0.200	0.029	0.029	19.78	23.84	6.33	0.029	0.343	0.114	5.81	13.15	8.07
9-10	0.114	0.029	0.029	12.06	16.91	9.17	0.029	0.029	0.114	3.00	12.45	10.34
11-12	0.114	0.200	0.343	8.53	14.48	12.02	0.029	0.029	0.486	5.56	11.92	11.16
13-14	0.057	0.029	0.686	13.14	17.46	16.36	0.029	0.029	0.343	3.75	10.67	9.60
15-16	0.114	0.200	0.886	14.69	16.98	18.23	0.029	0.029	0.114	5.78	8.79	11.81
17-18	0.029	0.200	0.886	15.39	22.85	22.06	0.200	0.029	0.029	5.75	7.64	10.65
19-20	0.114	0.200	0.886	19.05	22.89	23.33	0.886	0.029	0.029	6.78	5.89	10.72
21-22	0.029	0.029	0.686	20.25	30.01	30.98	0.028	0.029	0.029	4.75	6.25	10.10
23-24	0.029	0.029	0.343	15.40	28.84	29.64	0.029	0.200	0.029	32.67	7.31	11.19
25-26	0.029	0.029	0.114	15.98	31.31	35.51	0.772	0.029	0.029	7.75	7.85	10.96
27-28	0.029	0.029	0.114	14.78	30.62	33.49	0.029	0.029	0.147	3.75	7.50	10.42
29-30	0.029	0.029	0.029	14.21	27.54	33.04	0.029	0.029	0.055	4.00	7.92	8.89
31-32	0.029	0.029	0.057	11.62	28.96	33.07	0.029	0.029	0.042	2.78	6.91	9.89
33-34	0.029	0.029	0.029	9.83	25.68	31.99	0.029	0.029	0.200	1.82	7.06	10.64
35-36	0.029	0.029	0.057	12.53	25.42	34.71	0.029	0.029	0.029	3.78	6.89	10.03
37-38	0.029	0.029	0.057	15.11	29.15	37.74	0.029	0.029	0.343	2.00	8.09	8.93
39-40	0.029	0.029	0.057	16.59	31.19	41.26	0.027	0.027	0.114	1.50	7.06	9.53
41-42	0.029	0.029	0.114	15.79	35.48	37.84	0.028	0.029	0.191	1.03	5.25	6.60
43-44	0.029	0.029	0.686	16.99	34.49	36.85	0.029	0.029	0.486	1.50	5.38	6.28
45-46	0.029	0.029	0.029	17.62	31.84	34.91	0.486	0.343	0.686	3.78	6.65	7.25
47-48	0.029	0.029	0.057	17.84	31.38	37.83	0.021	0.021	0.561	1.00	5.53	4.78
49-50	0.029	0.029	0.200	20.33	27.10	34.82	0.029	0.029	0.147	1.00	6.09	5.03
51-52	0.029	0.029	0.029	14.62	25.71	29.44	0.029	0.029	0.243	1.25	4.75	5.62
53-54	0.029	0.029	0.029	15.02	26.29	30.89	0.029	0.029	0.886	0.25	4.78	4.50
55-56	0.057	0.029	0.057	18.09	24.06	30.88	0.029	0.028	0.766	0.50	4.50	4.00
57-58	0.029	0.029	0.200	12.46	26.10	29.90	0.028	0.028	1.000	0.75	4.78	5.28
59-60	0.029	0.029	0.029	17.15	22.25	28.34	0.019	0.021	0.457	1.00	3.75	4.03
61-62	0.029	0.029	0.057	15.91	21.48	26.92	0.029	0.029	0.686	0.75	3.53	4.53
63-64	0.114	0.029	0.029	20.52	26.63	33.57	0.029	0.029	1.000	1.25	3.75	3.53
65-66	0.029	0.029	0.029	17.76	26.40	33.90	0.029	0.029	0.772	1.00	4.75	4.00
67-68	0.029	0.029	0.029	15.96	21.52	27.51	0.028	0.029	0.460	0.25	3.57	3.28
69-70	0.114	0.029	0.029	19.01	23.75	32.58	0.029	0.029	0.561	0.75	3.78	3.50
71-72	0.029	0.029	0.029	20.69	26.09	34.57	0.027	0.027	0.561	1.00	5.04	3.28
73-74	0.029	0.029	0.057	18.11	25.92	34.40	0.029	0.080	1.000	0.75	2.55	2.75
75-76	0.686	0.029	0.029	21.15	20.88	31.39	0.028	0.028	0.189	1.25	4.28	3.00
77-78	0.114	0.029	0.029	19.25	22.53	29.66	0.028	0.055	0.191	2.28	5.00	2.78
79-80	0.029	0.029	0.029	19.98	22.52	28.82	0.081	0.108	0.884	0.78	2.04	2.50
81-82	0.343	0.029	0.029	17.98	19.41	25.76	0.027	0.026	0.552	1.00	2.28	2.50
83-84	0.886	0.029	0.029	21.85	21.04	30.36	0.642	0.649	0.881	1.50	1.75	1.50
85-86	0.029	0.029	0.029	20.54	26.67	37.12	0.040	0.454	0.106	0.25	2.25	0.75
87-88	0.486	0.029	0.029	23.53	24.40	35.20	0.041	0.739	0.027	0.50	2.25	0.50
89-90	0.343	0.029	0.029	17.82	20.22	30.50	0.026	0.134	0.027	0.50	1.79	0.75
91-92	0.486	0.029	0.029	17.32	19.37	29.83	0.114	1.000	0.114	0.00	1.00	0.00
93-94	0.561	0.029	0.029	18.47	18.64	25.80	0.021	0.181	0.053	0.00	1.75	0.25
95-96	0.114	0.029	0.029	19.97	18.23	27.74	0.020	0.453	0.049	0.00	1.25	0.00

Time (h)	Rep 33						All Replicates (n=33)					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.029	0.057	0.057	6.18	0.53	2.88	0.000	0.000	0.000	10.80	6.78	3.50
3-4	0.057	0.885	0.110	4.34	0.86	3.35	0.764	0.000	0.002	7.55	7.25	4.13
5-6	1.000	0.766	0.663	2.60	2.07	2.03	0.544	0.000	0.001	7.93	8.43	4.38
7-8	0.686	0.029	0.029	6.09	5.49	3.04	0.270	0.000	0.000	7.85	8.83	4.55
9-10	0.686	0.057	0.057	7.54	7.98	2.31	0.057	0.001	0.000	7.95	9.75	5.10
11-12	0.343	0.029	0.029	8.00	8.89	2.85	0.022	0.004	0.000	7.63	9.85	5.28
13-14	0.343	0.029	0.029	4.90	6.40	2.53	0.015	0.011	0.000	7.63	10.05	5.58
15-16	0.057	0.343	0.029	6.31	9.85	3.66	0.007	0.013	0.000	7.78	10.20	5.90
17-18	0.029	0.029	0.029	6.49	10.49	4.53	0.010	0.024	0.000	8.00	10.58	6.25
19-20	0.029	0.029	0.029	7.09	12.40	4.37	0.004	0.259	0.002	7.75	10.65	7.10
21-22	0.029	0.114	0.029	7.73	13.64	6.23	0.003	0.264	0.000	7.40	10.43	6.70
23-24	0.114	0.191	0.029	8.40	11.52	4.00	0.012	0.154	0.000	8.10	10.65	6.90
25-26	0.057	0.029	0.029	7.28	10.48	4.28	0.001	0.475	0.002	7.45	10.78	7.18
27-28	0.029	0.200	0.029	7.15	13.10	6.06	0.007	0.367	0.003	7.40	10.48	7.35
29-30	0.029	0.029	0.029	8.14	12.24	4.50	0.002	0.608	0.002	7.23	10.45	7.25
31-32	0.057	0.486	0.029	5.59	8.61	3.56	0.001	0.764	0.004	6.78	10.13	7.03
33-34	0.029	0.886	0.029	6.34	10.24	5.03	0.000	0.744	0.003	6.88	10.48	7.18
35-36	0.057	1.000	0.057	4.03	10.38	4.28	0.001	0.744	0.005	7.50	10.98	7.80
37-38	0.029	0.462	0.029	5.00	9.38	3.83	0.000	0.836	0.005	7.03	10.85	7.73
39-40	0.029	0.772	0.029	5.16	14.52	5.64	0.000	0.920	0.009	7.25	11.28	8.13
41-42	0.029	0.886	0.057	6.27	13.51	6.60	0.000	0.995	0.009	7.28	11.08	8.00
43-44	0.029	0.886	0.029	6.03	11.09	6.06	0.000	0.889	0.017	7.28	11.08	8.10
45-46	0.057	0.200	0.343	4.34	8.27	6.25	0.000	0.836	0.017	6.88	10.55	7.75
47-48	0.200	1.000	0.114	5.06	7.31	4.87	0.000	0.744	0.017	6.55	10.40	7.73
49-50	0.486	1.000	0.486	2.53	4.38	2.28	0.000	0.589	0.004	6.50	10.50	7.63
51-52	0.029	1.000	0.029	3.31	6.11	3.78	0.000	0.878	0.014	6.38	10.33	7.55
53-54	0.029	0.686	0.029	3.11	7.66	3.78	0.000	0.973	0.005	6.88	10.85	7.85
55-56	0.114	0.686	0.057	3.81	6.42	3.28	0.000	0.734	0.016	6.95	10.48	7.83
57-58	0.029	0.886	0.029	3.59	7.87	3.00	0.000	0.774	0.014	6.70	10.30	7.83
59-60	0.029	0.882	0.029	2.50	8.13	3.25	0.000	0.764	0.047	6.53	10.00	7.85
61-62	0.114	1.000	0.029	3.00	8.37	2.79	0.000	0.952	0.007	6.75	10.75	7.68
63-64	0.029	1.000	0.029	3.03	6.33	2.00	0.000	0.995	0.013	6.78	10.43	7.90
65-66	0.029	1.000	0.029	2.28	6.68	2.00	0.000	0.973	0.008	6.80	10.78	8.00
67-68	0.029	0.343	0.029	3.58	7.86	3.00	0.000	0.889	0.005	6.30	10.58	6.88
69-70	0.029	0.029	0.029	5.12	11.44	2.78	0.000	0.920	0.018	6.65	10.10	7.25
71-72	0.029	0.885	0.029	3.84	8.85	3.56	0.000	0.952	0.016	6.48	10.18	7.28
73-74	0.108	0.661	0.029	3.31	8.26	3.03	0.000	0.774	0.022	6.85	9.55	7.25
75-76	0.029	1.000	0.029	2.50	6.40	2.29	0.000	0.816	0.043	6.25	9.25	7.18
77-78	0.029	0.686	0.029	2.81	5.88	2.28	0.000	0.868	0.030	6.18	9.70	7.03
79-80	0.029	0.686	0.029	2.53	8.17	1.78	0.000	0.878	0.018	6.25	9.73	6.98
81-82	0.029	0.885	0.029	2.81	7.05	2.50	0.000	0.899	0.049	5.90	9.33	6.65
83-84	0.029	0.663	0.029	1.81	5.43	2.00	0.000	0.573	0.026	5.85	9.73	6.90
85-86	0.029	0.114	0.029	1.86	7.94	3.53	0.002	0.989	0.013	5.83	8.98	6.28
87-88	0.029	0.885	0.029	3.12	7.18	2.53	0.005	0.667	0.008	6.25	9.20	6.25
89-90	0.645	1.000	0.645	1.00	1.89	0.75	0.006	0.367	0.007	6.30	8.85	5.78
91-92	1.000	1.000	1.000	0.00	0.00	0.00	0.015	0.351	0.017	6.90	8.58	5.80
93-94	1.000	1.000	1.000	0.00	0.00	0.00	0.009	0.334	0.008	5.95	8.18	5.18
95-96	1.000	1.000	1.000	0.00	0.00	0.00	0.007	0.485	0.007	5.95	8.13	5.28

Time (h)	Replicates Aggregated in FC (n=17)						Replicates Aggregated in EC (n=7)					
	IS-FS	IS-ES	FS-ES	Intro	Food	Empty	IS-FS	IS-ES	FS-ES	Intro	Food	Empty
1-2	0.002	0.000	0.015	12.33	7.78	4.68	0.02	0.00	0.00	9.45	6.85	2.70
3-4	0.616	0.008	0.051	8.43	7.83	4.70	0.26	0.04	0.03	6.15	7.88	2.70
5-6	0.696	0.026	0.047	7.73	8.25	4.70	0.54	0.03	0.03	9.10	10.75	3.40
7-8	0.590	0.035	0.035	7.75	8.48	4.70	0.16	0.05	0.02	8.13	11.13	3.38
9-10	0.423	0.026	0.014	8.43	9.75	5.23	0.04	0.05	0.02	7.20	10.60	3.88
11-12	0.323	0.056	0.014	8.38	9.95	5.50	0.02	0.07	0.01	6.53	10.28	4.00
13-14	0.196	0.067	0.011	8.48	10.45	5.70	0.02	0.32	0.01	6.83	10.60	4.78
15-16	0.210	0.047	0.007	8.38	10.33	5.70	0.00	0.54	0.02	7.03	10.80	5.70
17-18	0.254	0.080	0.011	8.63	10.60	5.85	0.02	0.71	0.04	7.80	12.20	6.93
19-20	0.149	0.110	0.014	8.33	10.73	6.33	0.02	0.26	0.71	6.63	11.85	9.93
21-22	0.056	0.073	0.002	7.78	10.63	5.88	0.16	0.38	0.90	7.00	10.98	10.55
23-24	0.073	0.110	0.002	8.15	10.88	6.20	0.16	0.38	0.71	7.68	11.83	10.58
25-26	0.021	0.149	0.003	8.03	11.08	6.35	0.07	0.13	1.00	6.60	12.05	11.53
27-28	0.094	0.051	0.004	8.03	10.45	6.05	0.03	0.05	1.00	5.43	12.38	12.33
29-30	0.080	0.094	0.002	8.25	10.98	6.10	0.02	0.03	0.90	4.80	11.20	11.68
31-32	0.061	0.110	0.005	7.60	9.95	5.63	0.03	0.05	1.00	4.90	11.50	11.78
33-34	0.035	0.067	0.002	7.58	10.20	5.53	0.01	0.01	0.90	4.73	12.05	12.68
35-36	0.067	0.067	0.003	8.33	10.80	5.93	0.01	0.01	0.62	5.28	12.90	13.98
37-38	0.056	0.094	0.006	7.88	10.48	5.85	0.01	0.01	0.90	5.60	13.28	14.48
39-40	0.056	0.086	0.010	7.88	10.58	5.95	0.01	0.01	0.80	5.95	14.28	15.23
41-42	0.032	0.138	0.007	8.03	10.60	5.93	0.01	0.00	0.62	6.45	14.20	15.45
43-44	0.043	0.160	0.014	8.03	10.83	6.28	0.01	0.01	0.71	6.30	13.53	14.70
45-46	0.051	0.160	0.006	7.60	9.85	5.48	0.00	0.00	0.62	5.98	14.25	15.40
47-48	0.015	0.047	0.001	7.05	9.45	5.08	0.00	0.00	0.62	5.88	13.78	14.93
49-50	0.003	0.210	0.000	6.75	9.73	5.28	0.00	0.00	0.62	6.20	14.03	15.13
51-52	0.014	0.149	0.000	6.58	9.23	4.73	0.00	0.00	0.21	6.20	13.90	15.28
53-54	0.017	0.032	0.000	7.33	10.05	4.73	0.00	0.00	0.46	6.45	14.20	15.55
55-56	0.039	0.004	0.000	7.43	9.50	4.23	0.00	0.00	0.13	7.28	13.90	15.78
57-58	0.029	0.017	0.000	7.30	9.63	4.43	0.00	0.00	0.38	6.63	12.65	14.28
59-60	0.015	0.026	0.002	7.08	9.78	4.70	0.00	0.00	0.54	5.83	12.20	13.23
61-62	0.014	0.017	0.000	7.23	10.00	4.30	0.00	0.00	0.62	6.30	13.20	13.85
63-64	0.007	0.051	0.000	6.83	9.30	4.25	0.00	0.00	0.54	6.98	14.15	15.33
65-66	0.006	0.080	0.000	6.95	9.55	4.28	0.01	0.00	0.38	6.88	13.33	15.13
67-68	0.007	0.032	0.000	6.68	9.20	3.93	0.00	0.00	0.71	6.50	14.63	14.30
69-70	0.026	0.032	0.000	6.78	9.00	3.83	0.00	0.00	0.26	7.15	13.25	15.10
71-72	0.014	0.094	0.000	6.60	9.08	4.03	0.01	0.00	0.32	6.95	12.65	14.78
73-74	0.119	0.023	0.001	7.58	8.60	4.10	0.00	0.00	0.54	6.48	12.40	14.30
75-76	0.026	0.224	0.003	5.90	8.40	4.15	0.01	0.00	0.21	7.00	12.18	14.18
77-78	0.007	0.239	0.002	5.68	8.60	4.08	0.00	0.00	0.62	7.43	13.60	14.13
79-80	0.019	0.110	0.002	5.98	8.68	4.08	0.00	0.00	0.80	7.08	13.33	13.90
81-82	0.043	0.119	0.007	5.63	8.05	3.80	0.02	0.01	0.46	6.88	12.33	13.18
83-84	0.039	0.346	0.007	5.70	8.33	4.08	0.02	0.01	0.62	6.75	12.60	13.48
85-86	0.073	0.142	0.002	5.63	7.80	3.48	0.00	0.04	0.80	6.98	13.25	12.80
87-88	0.086	0.152	0.001	5.70	7.73	3.33	0.00	0.04	0.90	8.03	13.88	13.48
89-90	0.305	0.029	0.001	6.43	7.63	3.25	0.01	0.07	1.00	7.08	12.48	11.90
91-92	0.361	0.035	0.003	7.63	7.40	3.25	0.01	0.05	1.00	7.83	12.28	11.88
93-94	0.149	0.035	0.001	5.93	7.05	2.78	0.02	0.21	0.90	7.18	11.20	10.18
95-96	0.171	0.065	0.001	6.13	7.45	3.18	0.10	0.26	1.00	7.48	10.60	9.90

Replicate 1

The traffic at 1-4h was only between the IC and y-tube. The traffic at the FS and ES started at 5h and over the next three hours (7-10h) all three sensors were statistically similar. The traffic at FS was statistically higher than other two sensors between 11-52h with the exception of 46h. During the same time frame IS and ES were equivalent 91.6% of the time between 11-34h after which traffic between all three sensors were essentially equivalent between 35-52h. The traffic at ES was highest through 53h to end of bioassay. Between 53-78h the three sensors statistically separated with ES highest, FS and ES lowest with exception of 69-72h and 75-76h. For the remainder of bioassay FS and ES were equivalent and IS lowest with exception of 89-90h and 93-94h.

For the first four hours, no termite travelled out of the y-tube to another chamber. Termites passed through the FS and ES at 4h for the first time. During the 5^{th} and 6^{th} hour, termites preferentially travelled to Food. The termites passed equally through all three sensors for the next four hours, after which FS displayed the highest level of activity for the next 41h with IS and ES equivalent. The following 24 hours showed ES with the highest level of activity followed by FS and ES. For the remainder of bioassay, FS and ES were equivalent and IS lowest. This group started slow and showed preference first to FS then ES.

Replicate 2

The traffic at 1-2h was statistically equivalent but notably highest at IS numerically. ES was the highest for the next 16 hours during which IS and FS were equivalent with exception of 7-10h and 17-18h. The activity in all three sensors was statistically equivalent at 19-20h but ES was notably highest numerically. The activity at FS and IS for the next 26 hours was consistently equivalent and ES lowest, with exception of 29-30h and 41-44h. During 47-50h, the traffic was equivalent in all three sensors, after which FS and IS were equivalent and ES lowest with exception of 53-54h, 59-60h, 63-64h, 77-80h, 83-84, 85-86h and 87-88h.

The termites in the first two hours travelled mainly at IS and the next at 18 hours at ES, during which traffic at FS and IS was equivalent. The traffic during 21-46h was equivalent between IS and FS and lowest at ES. All three sensors were equivalent in the next 4 hours, after which FS and ES was highest and equivalent and IS lowest.

Replicate 3

From 1-8h, the traffic at IS was consistently highest and gradually became equivalent to FS, while ES was lowest. The traffic at all three sensors were equivalent from 9-20h and for the next 46 hours equivalent at IS and FS and lowest at ES with exception 41-42h. The traffic at IS was highest thereafter, FS second and ES lowest from 67-74h and 89-96h. During 75-88h, the traffic pattern shifted between being equivalent in all three sensors and lowest at ES.

The traffic was at first the highest at IS before becoming equivalent at all three sensors for the next 12 hours starting at 9h. The traffic at IS and FS were the highest and equivalent and lowest at ES for the next 46 hours. The termites then pass the IS most frequently followed by FS then ES during 67-74h, and equivalently in all three sensors for the next 14 hours. For the remainder of bioassay, the termites displayed the same traffic pattern as 67-74h.

Replicate 4

The traffic from 1-2h was statistically equivalent in all three sensors for 1-16 hours, although IS was notably highest numerically. In the next 14 hours, the statistical results indicate frequent shift in traffic pattern, and generally suggest highest traffic at FS and IS and ES were equivalent. For the remainder of bioassay FS was consistently the highest and equivalent to IS with exception of 37-38h, 61-62h, 67-68h, and 81-82h. The traffic at IS during those hours was consistently the lowest.

The traffic was highest at IS for the first two hours and equivalent at all three sensors for the next 14 hours. FS was highest 17-30h, during which IS and ES were equivalent. For the remainder of the bioassay, FS and IS were equivalent and ES lowest.

Replicate 5

The traffic in the first 2 hours was statistically equivalent between IS and FS even though IS was notably highest numerically. Traffic in the next 10 hours was consistently highest at FS, which was equivalent to IS with exception of 7-8 and 11-12h, and lowest at ES. The traffic was then equivalent in all three sensors for the next two hours before becoming highest at FS again the following two hours, during which IS and ES were equivalent. The traffic was once again equivalent at 17-18h and highest at FS and lowest at IS/ES the following 8 hours. For the next 40 hours, IS and FS were both ranked 1 in traffic level and ES lowest with exception of 31-34, 43-44 and 57-58h. The traffic at 67-74h was highest at FS, followed by IS then ES. FS remained ranked 1 in the next 4 hours and ES and IS was equivalent. For the remainder of bioassay, FS was consistently the highest and equivalent to IS with exception of 79-80 and 89-90h.

The termites in the started highest at IS for the first two hours and at FS from 4-96h. IS and FS gradually became equivalent in the first 12 hours before all three became equivalent by 13h. The traffic at IS was equivalent to ES from 19-26h and FS from 28-66h. The traffic pattern was then highest at FS, then ES and FS in the next 12 hours before becoming equivalent and highest between IS and FS and lowest at ES for the remainder of bioassay.

Replicate 6

The traffic was highest at IS and equivalent between FS and ES during the first 10 hours. From 11-12 hours, IS and FS were equivalent and ES the lowest. All three sensors were equivalent in the following six hours before FS becomes highest for the remainder of bioassay. From 20-24h, IS and ES equivalent and IS and FS equivalent at 25-38h. During those hours, ES was lowest with exception of 29-30 and 33-36h. The traffic was equivalent at all three sensors from 39-40h and was equivalent at FS and ES and lowest at IS for the next 8 hours. Half of the next 20 hours ranked FS, ES and IS 1, 2 and 3 respectively and suggested great variability in traffic patterns during those hours. Numerically, the ranking above appeared to continue for all 20 hours. For the remainder of bioassay, FS and ES was equivalent and IS lowest, with exception of 75-77 and 87-88h.

The termites passed the IS most frequently in the first 10 hours and three or less trips per 5-min to FS or IS. The traffic at FS was highest by 12h and remained so for the rest of bioassay. During 19-24h, traffic at IS was equivalent to ES and to FS the next 15 hours. The traffic at ES was ranked 1 along with FS or ranked 2 for most of the remainder of bioassay time.

Replicate 7

In the first 8 hours, termites mainly travelled to IS and infrequently to FS and ES. The traffic at IS and ES are equivalent in the following 12 hours, with empty consistently the lowest. From 21-28h, the traffic at all three sensors were equivalent, with exception of 23-24h. IS and FS were consistently equivalent and ES the lowest for the reminder of bioassay, with exception of 43-44h.

The termites mainly passed the IS only during the first 8 hours and did not pass FS and ES frequently. The termites travel equally to IS and FS consistently and least frequently to ES for the remainder of bioassay the following 12 hours, with exception of brief interruption from 21-28h, during which traffic in all three sensors was equivalent.

Replicate 8

In the first 2 hours, the termites travel most to IS, followed by FS then ES. The traffic between IS and FS becomes equivalent and ES lowest for the next 10 hours, with exception of 5-6h. From 13-22h, traffic at ES was lowest and FS higher than IS 13-20h and equivalent to IS 21-22h. The traffic in all three sensors was equivalent in the next 8 hours with except 27-28h, during which ES was lowest. For the remainder of bioassay, FS and ES were highest and equivalent and IS lowest with exception of 51-52h and 89-90h.

The termites travel mostly to IS in the first two hours and more to FS than ES. The IS and FS were equivalent from 4-12 hours and highest at FS, second at IS and lowest at ES the following 8 hours. The traffic was equivalent IS and FS (rank= 1) from 21-22h and in all three sensors from 23-30h. The termites for the remainder travelled equally to FS and ES and least to IS.

Replicate 9

The traffic in all three sensors was equivalent in the first 6 hours, but IS was numerically the highest 1-2h. For the next 48 hours, the traffic between IS and FS was equivalent and ES lowest, with exception of 27-28h, 43-44h, and 53-54h. The traffic was ranked 1, 2 and 3 for FS, IS and ES respectively from 55-73, before the same pattern of 7-54h was established for the following 8 hours. From 81-86h, the termites pass the FS most frequently, IS second, and ES least, and for the remainder of bioassay to FS most frequently and equally to IS and FS.

The termites in the first two hours travel most to ES and equally to all three sensors the following four hours. From 7-54h, traffic at IS and FS the highest and equivalent, with ES lowest. The traffic in the next 32 hours was highest at FS, second at IS and lowest at ES, with interruption from 73-80h during which IS and FS were equivalent. For the rest of bioassay, FS remained the highest and IS/ES were equivalent.

Replicate 10

The traffic was equivalent in all three sensors during the first 8 hours, and during the following 8 hours equivalent between IS and ES and lowest at ES. The termites travelled equally to all three sensors from 17-18h after which FS, IS and ES were ranked 1, 2 and 3 respectively. The traffic at FS and IS in the following 40 hours was consistently highest and equivalent and ES lowest, with exception of 45-46h, 49-50h, 59-60h and 69-72h. The traffic was equivalent to all three sensors from 75-76h and 95-96h and FS was highest and IS/ES equivalent from 77-94h, with exception of 89-90h.

The traffic at FS was the highest throughout the bioassay. The traffic was equivalent in all three sensors for the first 8 hours and between IS and FS the next 8 hours. The traffic in all three sensors was equivalent again for the next 2 hours, between IS/ES from 19-32h and in all three sensors 33-34h. IS and FS was equivalent and highest in the following 40 hours, during which ES remains the lowest. All three sensor become equivalent next two hours and equivalent between IS and ES from 77-94h. For the last 2 hours of bioassay, traffic in all three sensors was equivalent.

Replicate 11

The termites travelled most to IS in the first 2 hours and equally to FS and ES. In the next 26 hours, traffic was equivalent in all three sensors with exception of 5-6h, 15-16h and 25-26h. The traffic from 29-88h, FS and ES were equivalent and highest and ES lowest, with exception of 39-40h, 63-64h, 67-72h and 83-86h. The traffic was highest at FS and equivalent between IS and ES the following 6 hours and equivalent in all three sensors the last 2 hours of bioassay.

IS was highest, followed by FS and ES in the first two hours and all three sensors were equivalent for the next 26 hours. ES and FS were equivalent and highest from 29-88h and ES remained the lowest. FS remained highest the next 6 hours, during which IS and ES were equivalent. The traffic at all three sensors was equivalent at the end of the bioassay.

Replicate 12

IS was the only sensor with traffic in the first 6 hours. The traffic at FS started at 7h and ES at 16h. The traffic was equivalent between IS and FS from 13-22h with exception of 15-16h and in all three sensors from 23-40h with exception of 25-26h and 31-32h. The traffic in the following 28 hours was highest at FS and equivalent between IS and ES with exception of 41-42h, 45-46h and 59-60h. FS remained highest for the next 6 hours, followed by ES then IS. For the remainder of bioassay, the traffic was highest and equivalent at FS and ES and lowest at IS, with exception of 81-81h.

The termite movement during the first 12 hours was only between the IC and FC. For the next 8 hours, IC was consistently the highest and equivalent to FC and ES lowest. IS and FS remained equivalent for the next 22 hours, during which ES shifted between being lower and equivalent to IS and FS. From 41-74h, traffic was highest at FS and equivalent between IS and ES for 41-68h and higher at ES than IS for 69-74h. For the remainder of bioassay, FS and ES were highest and equivalent and IS lowest.

Replicate 13

The traffic at FS was consistently the highest over the duration of bioassay. During the first 4 hours, FS was equivalent to IS and ES lowest. IS was equivalent to ES from 5-18h with exception of 9-10h and 15-16h. From 19-64h, FS was equivalent to ES and IS lowest. All three sensors were equivalent the next 12 hours. From 77-86h, FS and ES were equivalent and IS was lowest with exception of 79-82h before all three were equivalent in the next 6 hours. For the remainder of bioassay, FS and ES were equivalent and IS lowest.

The termites in the replicates consistently passed FS the most. IS was equivalent to FS in the first 4 hours and both IS and ES were lower than FS the next 14 hours. FS and ES were equivalent from 19-64h before all three were equivalent the subsequent 12 hours. For the remainder of bioassay, FS was equivalent to ES and IS lowest with brief interruption from 87-92h, during which all three sensors were equivalent.

Replicate 14

The traffic during the first 2 hours was equivalent in all three sensors, although IS was numerically higher. During the next 20 hours, FS was highest and IS and ES equivalent, with exception of 5-6h, 13-14h and 33-34h. FS remained highest from 25-36h, IS second and ES lowest, with exception of 33-34h. For the remainder of bioassay, FS and IS were highest and equivalent and ES lowest, with exception of 47-50h, 53-54h and 71-72h.

The termites consistently passed the FS most frequently over the duration of bioassay. The traffic was equivalent at all three sensors during the first 2 hours and between IS and ES for the subsequent 22 hours. The following 12 hours were characterized as highest activity at FS followed by IS then ES. For the remainder of bioassay, FS and IS were equivalent and ES lowest.

Replicate 15

The termites during the first two hours travelled equally to IS and FS and least to ES. In the next two hours, all three sensors were equivalent. FS was highest from 5-10h during which IS and ES were equivalent. From 13-16h, FS was the highest, ES second and IS lowest. For the following 76h, traffic was equivalent between FS and ES and lowest at IS, with exception of 75-76h. The traffic at all three sensors was equivalent during the last 4 hours of bioassay.

The termites at the beginning of bioassay (1-2h) travelled equally between IS and FS then to all three sensors the following 2 hours. From the 5th hour to the remainder of bioassay, FS was consistently the highest. From 5-12h, IS and ES were equivalent but ES was higher the following 40 hours. FS and ES were equivalent from 17-92h and all three sensors equivalent for the last 4 hours of bioassay.

Replicate 16

The termite movement during the first 6 hours was only between the IC and y-tube. Between 7-8h, Termites travelled equally to IS and FS and least to ES, although IS was numerically higher. During the following 14 hours, IS and FS were equivalent and ES lowest. The termites thereafter consistently passed FS most frequent for the remainder of bioassay, during which IS was ranked second and ES third, with exception of 27-28h, 33-34h, 39-40h, 43-46h, 53-54h, 57-58h, 63-64h, 67-68h, 79-80h, 83-84h and 93-94h.

The termites initially only travel between IS and y-tube and did not pass FS or ES until 7-8h. The traffic at FS was the highest from 9th hour to the remainder of bioassay. The traffic at IS was equivalent to FS (rank=1) from 9-22h and second 23-96. The traffic was lowest at ES 67.6% of the time from 23-96h.

Replicate 17

Termite traffic during the first 2 hours was equivalent at IS and FS and lowest at ES. FS was highest from 3-12h and IS and ES were equivalent, with exception of 9-10h. IS and FS were equivalent and ES lowest for the following 22 hours, with exception of 21-24h. From 35-38h, FS was highest and IS second, and ES lowest. FS remained highest during the following 22 hours and IS and FS equivalent, with exception of 51-52h. From 57-70h, FS was the highest, IS second and ES lowest, with exception of 61-62h and 65-66h. For the remainder of bioassay, FS and IS were highest and equivalent and ES lowest, with exception of 85-86h and 89-90h.

The termites travelled equivalently between IS and FS during the first two hours than highest to FS for the remainder of bioassay. IS was equivalent to ES from 3-12h than to FS 13-34h. All three sensors were equivalent the following 4 hours and between IS and ES only for the next 18. IS was higher than ES from 57-70h and to FS for the remainder of bioassay.

Replicate 18

The traffic was equivalent between IS and FS and lowest to ES during the first 10 hours of bioassay, with exception of 7-8h. FS was highest the following 8 hours and IS and ES equivalent. For the next 58 hours, FS and ES were equivalent and IS lowest, with exception of 61-62h and 69-70h. FS was highest, ES second and IS lowest from 77-86h, and FS highest, IS second and ES lowest from 87-90h. During the last 6 hours, IS and FS were equivalent and ES lowest.

The termites in the first 10 hours travelled most frequently between IS and FS, and highest to FS from 11h to end of bioassay. ES was equivalent to IS from 11-18h and to FS the following 58 hours. ES was equivalent to IS from 77-86h and lower than IS for the remainder of bioassay. FS and IS were equivalent the last 10 hours of bioassay.

Replicate 19

The traffic at all three sensors were statistically equivalent but notably higher at IS for 1-2h. The traffic was equivalent at IS and FS the following 4 hours and lowest tat ES. For the next 22 hours, FS was highest, IS second and ES lowest, with exception of 11-12h. FS remained highest from 29-68h during which IS and ES were equivalent with exception of 31-32h and 61-62h. For the remainder of bioassay, all three sensors were equivalent, with exception of 77-78h and 91-92h.

The termites travel equally to the three sensors for the first two hours then mostly to IS and FS the next 2. FS was highest from 8th hour to the end bioassay. IS was second highest and ES third from 7-28h and the two equivalent the following 40 hours. Traffic was equivalent at all three sensors from 69h to end of bioassay 69h, not due to equal amount of traffic but lack of traffic at all three.

Replicate 20

The traffic was equivalent at IS and FS and lowest at ES during the first 4 hours of bioassay. The termites travel the most to FS and equally to IS and ES the following 24 hours with exception of 7-8h, 11-12h, 17-18h and 27-28h. The traffic was equivalent at IS and FS and lowest at ES from 29-30h then highest at FS, second IS and lowest ES the next 4 hours. FS was highest from 35-52h, during which IS and ES were equivalent with exception of 47-50h. In the next 2 hours traffic was highest at FS, second ES and lowest IS and equivalent at all three sensors the subsequent 2 hours. From 57-96h, FS and ES were equivalent and IS lowest with exception of 71-74h, 77-78h, 81-82h, 89-90h and 93-94h.

The termites travelled mostly to IS and FS during the first 4 hours then to FS for the remainder of bioassay. IS and ES were equivalent the following 48 hours with exception of interruption at 29-34h, during which IS was second highest and ES third. ES was second highest and IS third from 53-54h and all three sensors equivalent the subsequent two hours. For the remainder of bioassay, FS and ES were equivalent and IS lowest.

Replicate 21

Traffic at IS was highest, FS second and ES lowest for the first 2 hours. IS and FS were equivalent the following 14 hours and ES lowest, with exception of 9-10h. FS highest and IS and ES equivalent the subsequent 2 hours. For the remainder of bioassay, FS and ES were equivalent and IS lowest, with exception of 27-28h, 55-56h and 71-74h.

The traffic was highest at IS at first (1-2h) and equivalent between IS and FS for the next 14 hours. Traffic at FS was briefly the highest (17-18h) and IS and ES equivalent. The termites thereafter travelled equally to FS and ES and least to IS for the remainder of bioassay.

Replicate 22

The traffic during the first 2 hours was highest at FS and equivalent between IS and ES. FS and IS were equivalent and ES lowest during the next 2 hours. From 7-24h, FS was highest, IS second and ES lowest, with exception of 19-20h. Termites travelled equally to IS and FS and ES least the following 6 hours with exception of 27-28h. FS was highest the next 10 hours and IS and ES equivalent, with exception of 33-36h. For the remainder of bioassay, IS and FS were equivalent and ES lowest, with exception of 43-44h, 54-55h, 57-58h, 61-62h, 71-72h, 85-86h and 89-90h.

The termites travelled the most to FS from the start to end of bioassay. During the first 4 hours, traffic was equivalent at IS and ES, and IS and FS the following 2 hours. IS was second highest and ES third the following 18 hours. The traffic at IS was equivalent to ES again from 31-40h and to FS for the remainder of bioassay. Traffic at ES was consistently ranked third or tied for second with IS during the bioassay.

Replicate 23

The traffic during the first 2 hours was highest at IS and equivalent between FS and ES. IS was highest from 3-12h, FS second and ES lowest. The traffic was equivalent at IS and FS the following 12 hours and ES lowest. During the next 28 hours, IS was highest, FS second and ES lowest, with exception of 27-28h and 39-40h. IS and FS were again equivalent from 51-64h and ES lowest, with exception of 55-56h. For the remainder of bioassay, termites travelled most to IS, second to FS and least to ES, with exception of 67-68h, 73-76h and 81-84h.

The termites consistently travelled most frequently to IS from start to end of bioassay and FS and ES were either equivalent or FS higher than ES. FS and ES were equivalent during the first two hours. FS was second highest and ES lowest majority of bioassay (3-10h, 23-50h and 85-96h). FS was equivalent to IS from 11-22h and 51-64h.

Replicate 24

The traffic was equivalent between IS and FS and lowest to ES during the first 80 hours of bioassay, with exception of 5-6h. FS was highest next 8 hours, IS second and ES lowest. IS and FS were equivalent and ES lowest for the last 8 hours of bioassay.

The traffic between IS and FS were equivalent and ES lowest for the majority of bioassay (1-4h, 7-80h and 89-90h). The only exceptions for during 5-6h when all three sensors were equivalent and 81-88h when FS, IS and ES were ranked 1-3 respectively.

Replicate 25

The traffic was equivalent between IS and FS and lowest to ES during the first 80 hours of bioassay with exception of 3-4h, 11-12h, 17-18h, 21-22h, 45-46h, 49-50h, 65-66h and 77-78h. For the remainder of bioassay, FS was highest and IS and ES equivalent, with exception of 81-82h and 95-96h.

The traffic at IS and FS was equivalent and ES lowest for the first 80 hours of bioassay. During the last 16 hours of bioassay, FS was the only sensor the termites continuously passed and IS and ES were statistically equivalent as a result of both sensors recording close to 0 termite passages.

Replicate 26

The traffic was statistically equivalent at all three sensors for the first 4 hours, although IS and FS were notably higher than ES numerically during 1-2h. For 5-6h and 9-10h, traffic was highest at IS, second at FS and lowest at ES, equivalent in all three sensors 7-8h. IS and FS were equivalent and ES lowest the following 14 hours, with exception of 15-16h. From 25-62h, FS was highest and IS and ES equivalent, with exception of 33-36h, 43-44h, 47-48h and 51-52h. Fort the remainder of bioassay, FS was the highest, IS second and ES lowest, with exception of 67-68h, 73-74h, 81-82h and 93-94h.

The termites in the first 2 hours travel equally to IS and FS then to all three chambers the next 2 hours. FS was highest, IS second and ES lowest from 5-6h and all three sensors are again equivalent 7-8h. FS is consistently the highest from 9h to end of bioassay. IS was equivalent to FS from 9-24h and ES 25-62h. FS, IS and ES were ranked 1-3 respectively for the remainder of bioassay.

Replicate 27

The traffic was statistically equivalent at all three sensors during the first 4 hours, although IS was notably higher numerically 1-2h. In the next 14 hours, FS was highest and IS and ES equivalent, with exception of 15-16h. FS and ES are equivalent and IS lowest during the next 2 hours. From 21-32h, FS was highest, ES second and IS lowest. All three sensors are equivalent 33-36h. For the next 4 hours, FS and ES are equivalent and IS lowest. For the remainder of bioassay, IS and FS were equivalent and ES lowest.

The termites travel equally to all three chambers at the start of bioassay (1-4h) and mostly to FS the following 14 hours. The traffic is highest at FS from 19-32h, during which ES was equivalent or higher than IS. The traffic becomes equivalent at all three sensors again at 33-36h and at FS and ES the subsequent 6 hours. From 41h to end of bioassay, IS and FS are consistently equivalent and ES lowest.

Replicate 28

The traffic is equivalent at all three sensors statistically during the first 2 hours but IS and FS are notably higher than ES numerically. FS and IS are equivalent 3-4h and ES lowest. In the next 14 hours, FS is highest, IS second and ES lowest. All three sensors are equivalent from 19-26h. For the remainder of bioassay, ES and FS are equivalent and IS lowest, with exception of 53-54h, 75-76h and 85-86h.

Termite traffic was highest to IS and FS during the first 4 hours and ranked 1-3 at FS, IS and ES respectively during the next 16 hours. The traffic becomes equivalent at all three chambers from 19-26h due to overall decrease in traffic in comparison to first 18 hour data. Termites travelled equally to FS and ES and least to IS for the remainder of bioassay.

Replicate 29

During the first 20 hours of bioassay, IS and FS were equivalent and ES lowest. The termites travelled equally to all three chambers the following 4 hours. From 21-88h, FS and ES were equivalent and IS lowest, with exception of 29-30h, 35-38h, 57-60h, 65-66h, 71-72h and

79-80h. Traffic was equivalent at all three sensors for the remainder of bioassay, with exception of 93-94h.

Termites travelled the most to IS and FS during the first 20 hours then equally to all three the next 4. The traffic was equivalent at FS and ES and lowest at IS for the next 64 hours, and equivalent at all three sensors for the last 8 hours of bioassay.

Replicate 30

The traffic was statistically equivalent at all three sensors during the first 8 hours of bioassay, although IS was notably the highest numerically. IS and FS were equivalent and ES lowest during the next 14 hours, with exception of 13-14h and 19-20h. FS was highest from 23-26h and IS was higher than ES from 23-24 and equivalent to ES 25-26h. For the remainder of bioassay, FS and ES were equivalent and IS lowest, with exception of 65-66h, 75-76h and 83-84h.

More termites that left IC have passed FS than ES during the first 2 hours of bioassay. The traffic was equivalent at all three sensors from 3-8h as a result of lack of traffic at all three sensors. Traffic was equivalent at IS and FS during the next 14 hours and was ranked 1-3 at FS, IS and ES respectively from 23-24h. For the remainder of bioassay, most of termite traffic was at FS and ES, and only few passed IS.

Replicate 31

The traffic was equivalent at IS and FS and lowest at ES during the first 10 hours of bioassay. The traffic was equivalent at all three sensors during the next 2 hours. From 13-50h, FS and ES were equivalent and IS lowest with exception of 15-16h, 19-20h, 29-30h, 33-34h and 45-46h. ES was highest, FS second and IS lowest from 51-54h. FS and ES were equivalent and IS lowest during the next 8 hours, with exception of 59-60h. For the remainder of bioassay, ES was highest and FS and IS equivalent, with exception of 65-68h, 71-72h, 79-80h and 85-86h.

Termites travelled most frequently to IS and FS during the first 10 hours and equally to all three the following 2. The pattern shifted to FS and ES being equivalent and IS lowest the next 38 hours. The highest traffic was at ES from 51h to end of bioassay. FS was higher than ES from 51-54h and equivalent to FS 55-62h. FS and IS were equivalent from 63h to end of bioassay.

Replicate 32

The traffic was equivalent at IS and FS and lowest at ES from 1-4h. FS was highest during the next 4 hours, during which IS and ES were equivalent. FS and ES were equivalent and IS lowest from 9-16h. The termites then travel most frequently to ES and equally to IS and FS during the next 10 hours, with exception of 21-24h. For the remainder of bioassay, traffic was equivalent at FS and ES and lowest at IS, with exception of 31-32h, 35-36h, 45-46h, 79-80h, 83-84h and 91-92h.

Highest termite activity was at IS and FS during the first 4 hours and FS the next 2. The highest traffic shifted to FS and ES from 7-16h. The pattern from 17-26 was highest at ES and equivalent at IS and FS, but displayed continuous change between 21-24h. The termites travelled most frequently to FS and ES and least to IS for the last 70 hours of bioassay.

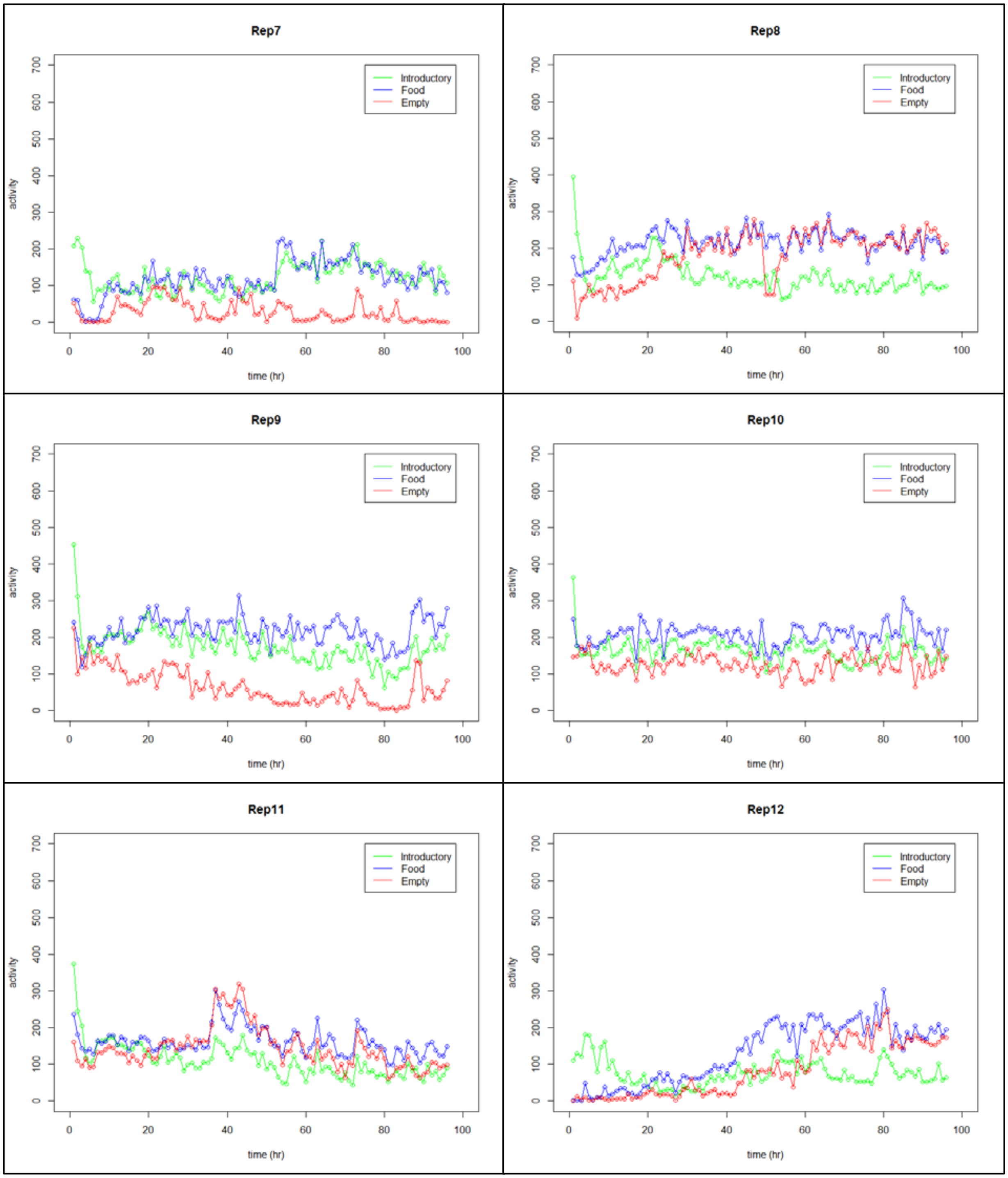
Replicate 33

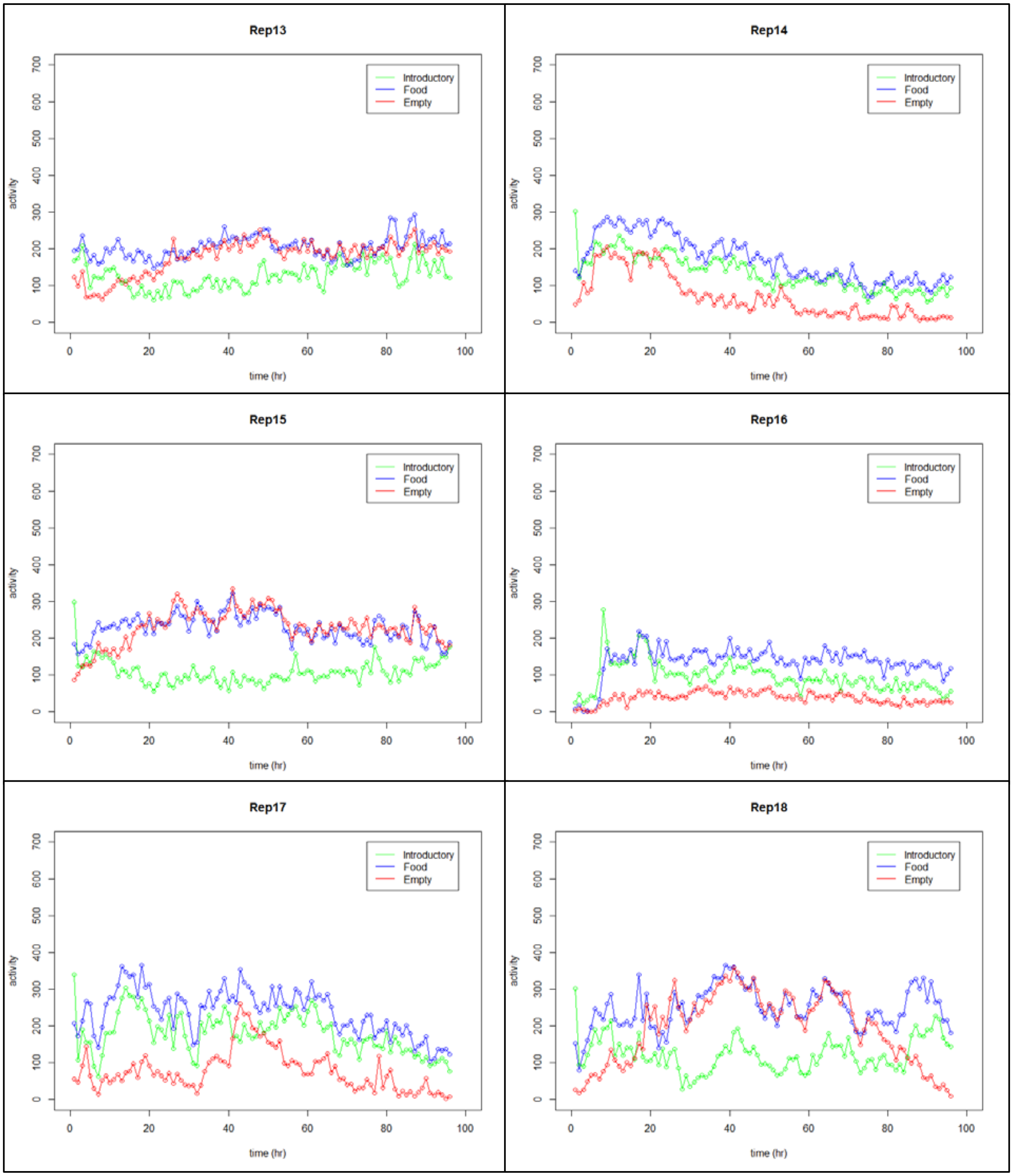
The traffic was highest at IS and equivalent at FS and ES during the first 2 hours of bioassay. All three sensors were equivalent the next 4 hours. From 7-16h, IS and FS were equivalent and ES lowest, with exception of 9-10h. FS was highest, IS second and ES lowest the subsequent 4 hours. The termites passed FS the most from 21-44h and IS and ES equally, with exception of 25-26h and 35-36h. All three sensors were equivalent from 45-50h. The traffic was highest at FS and equivalent at IS and ES for the next 38 hours, with exception of 55-56h. During the last 8 hours of bioassay, all three sensors were equivalent.

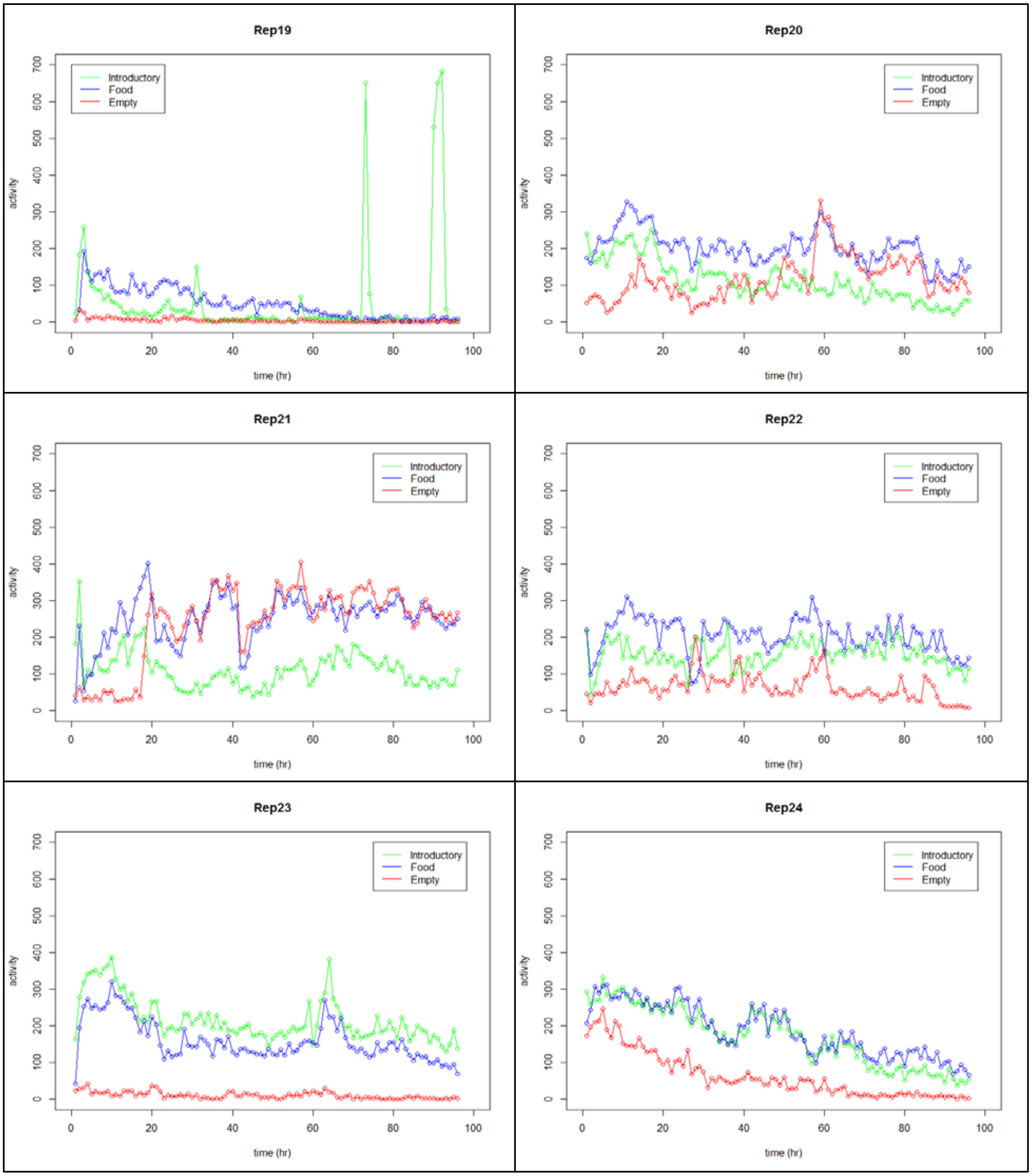
The termites in the first 2 hours travelled mostly between IC and y-tube, and only a small proportion of individuals leaving IC visited FC and EC. All three sensors were equivalent the next 4 hours, after which IS and FS were equivalent and ES lowest (7-16h). The termites travelled most to FS, IS second and ES least the next 4 hours. From 21-88h, the traffic pattern was again highest at FS and equivalent at IS and ES, with exception of from 45-50h., during which all three sensors were equivalent. All three sensors were statistically equivalent during the last 8 hours of bioassay as a result of absence of traffic at all three sensors.

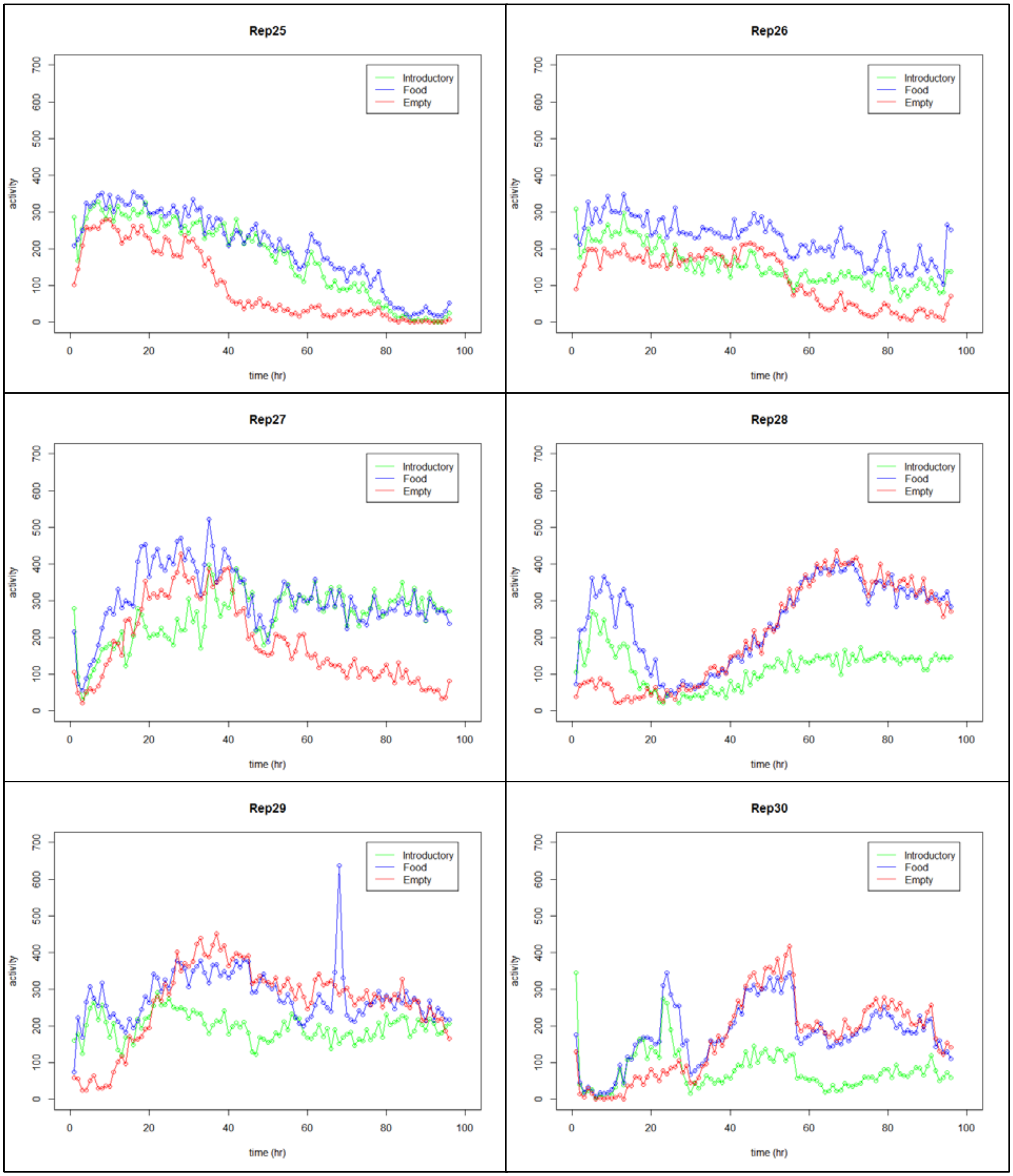
Appendix D

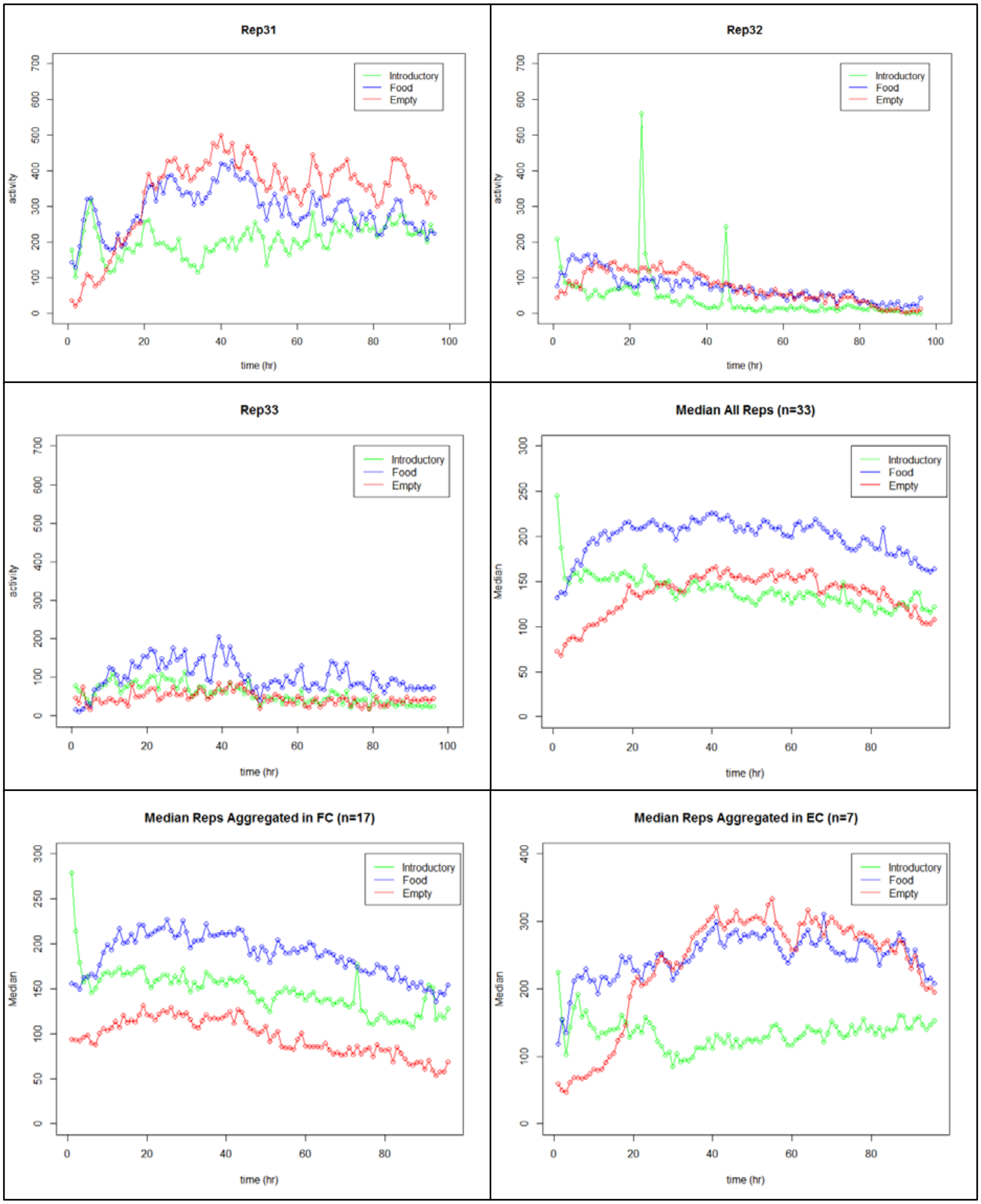

Rep1
Rep2
Rep3
Rep4
Rep5
Rep6
Introductory
Food
Empty
activity
time (hr)
0
100
200
300
400
500
600
700
20
40
60
80


Rep7
Rep8
Rep9
Rep10
Rep11
Rep12
Introductory
Food
Empty
activity
time (hr)
0
20
40
60
80
100
0
100
200
300
400
500
600
700

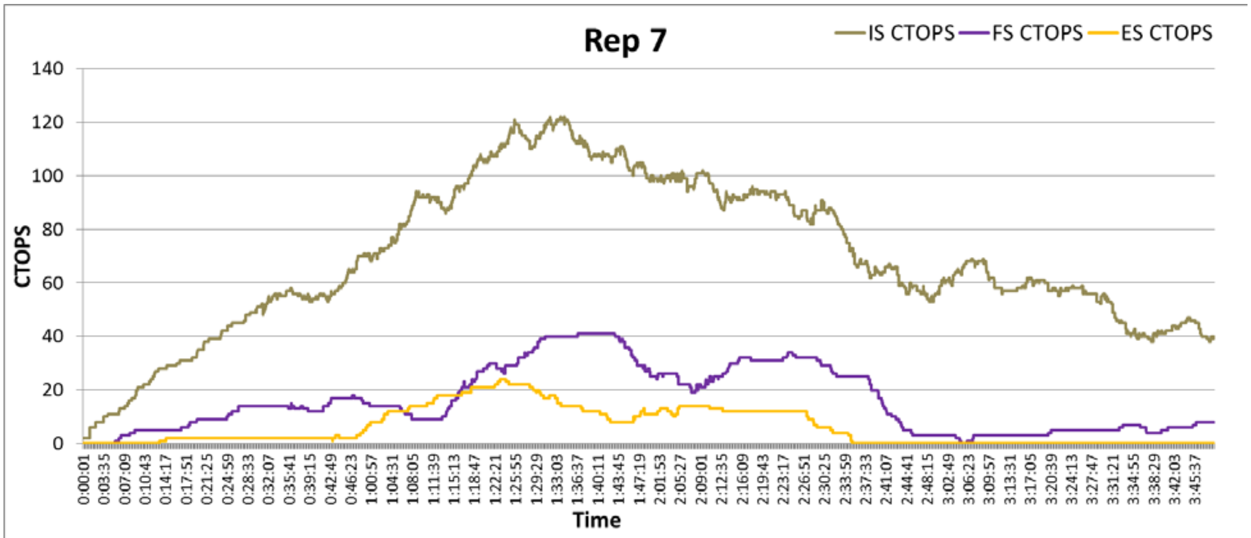

Rep13
Rep14
Rep15
Rep16
Rep17
Rep18
Introductory
Food
Empty
activity
time (hr)
0
100
200
300
400
500
600
700
0
20
40
60
80
100

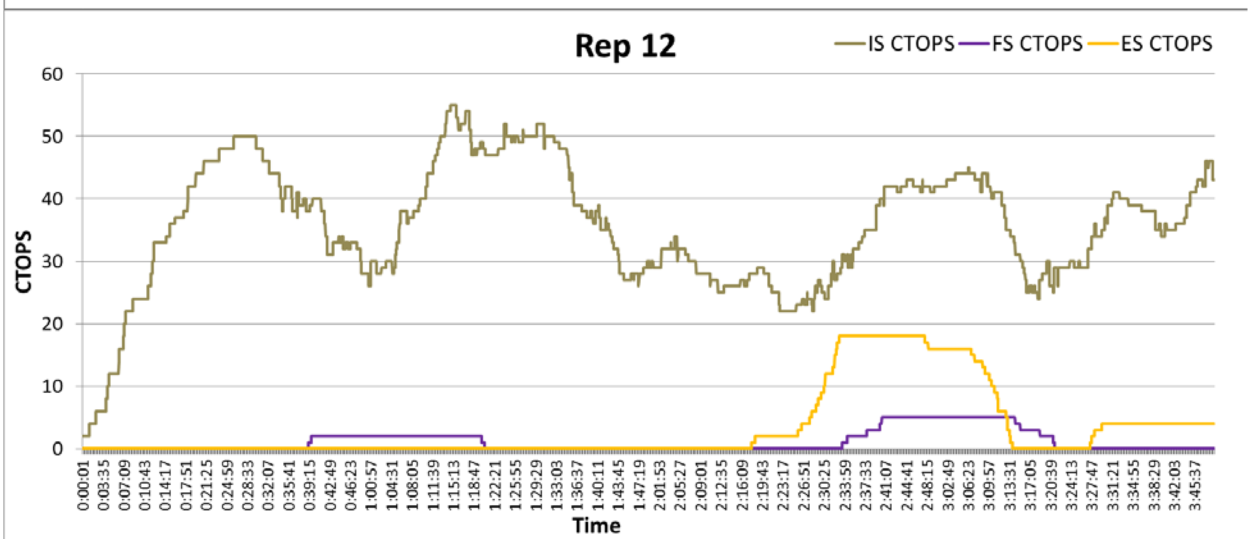

Rep19
Rep20
Rep21
Rep22
Rep23
Rep24
Introductory
Food
Empty
activity
time (hr)
0
100
200
300
400
500
600
700
0
20
40
60
80
100

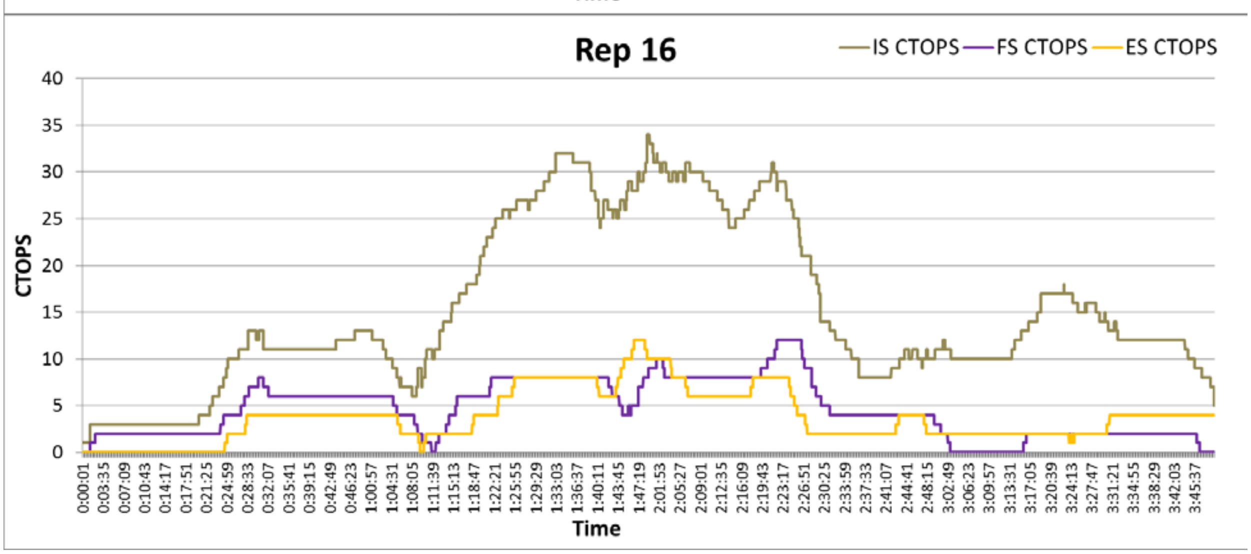

Rep25
Introductory
Food
Empty
activity
time (hr)
Rep26
Introductory
Food
Empty
activity
time (hr)
Rep27
Introductory
Food
Empty
activity
time (hr)
Rep28
Introductory
Food
Empty
activity
time (hr)
Rep29
Introductory
Food
Empty
activity
time (hr)
Rep30
Introductory
Food
Empty
activity
time (hr)

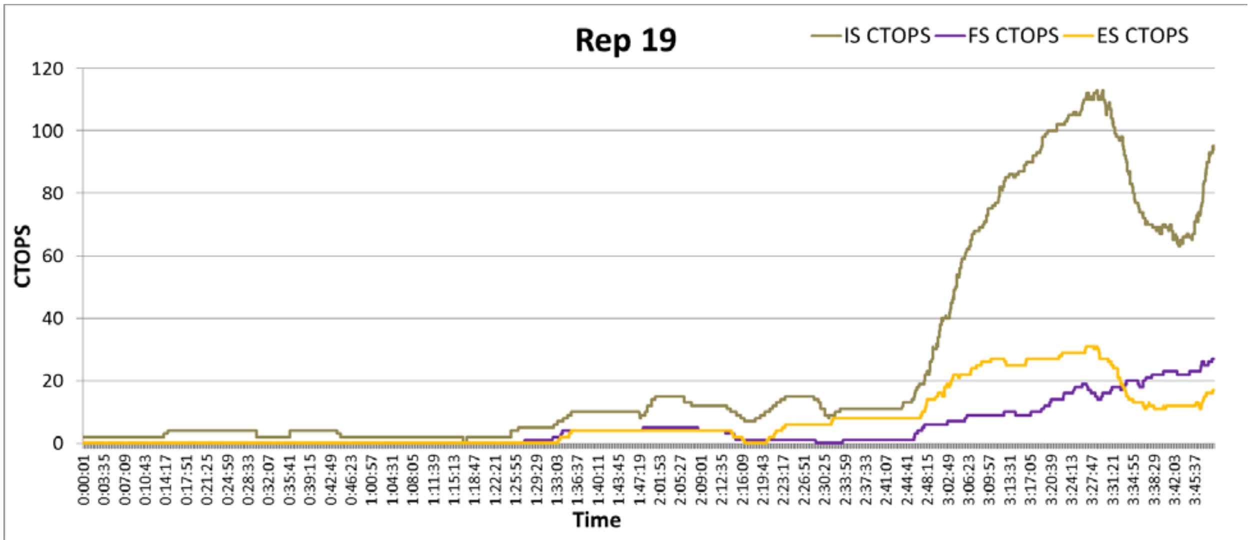

Rep31
Introductory
Food
Empty
activity
time (hr)
Rep32
Introductory
Food
Empty
activity
time (hr)
Rep33
Introductory
Food
Empty
activity
time (hr)
Median All Reps (n=33)
Introductory
Food
Empty
Median
time (hr)
Median Reps Aggregated in FC (n=17)
Introductory
Food
Empty
Median
time (hr)
Median Reps Aggregated in EC (n=7)
Introductory
Food
Empty
Median
time (hr)

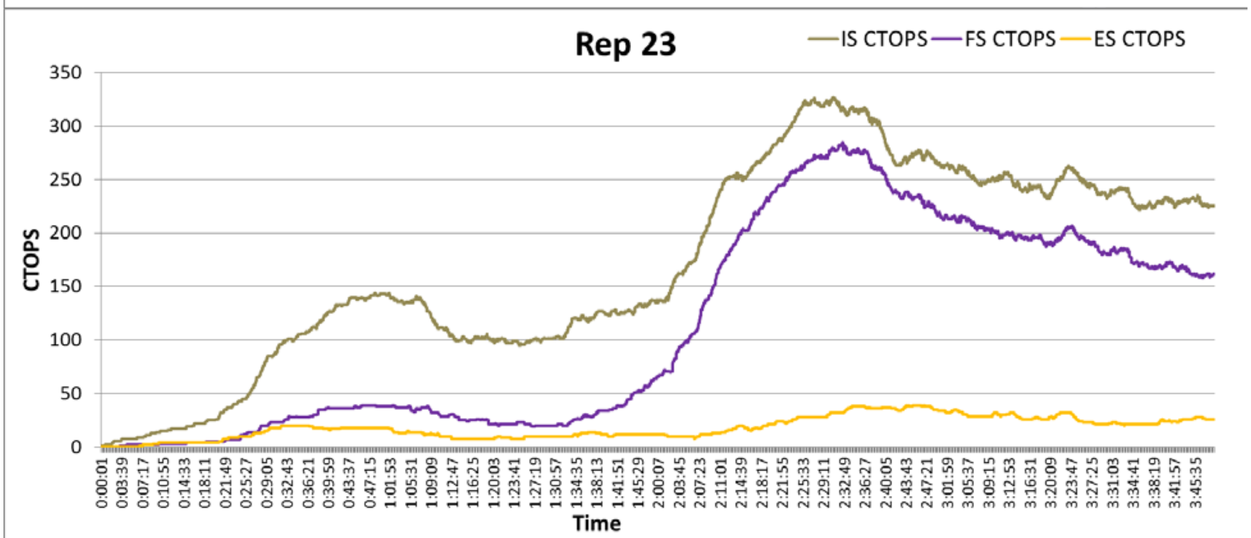
Appendix E

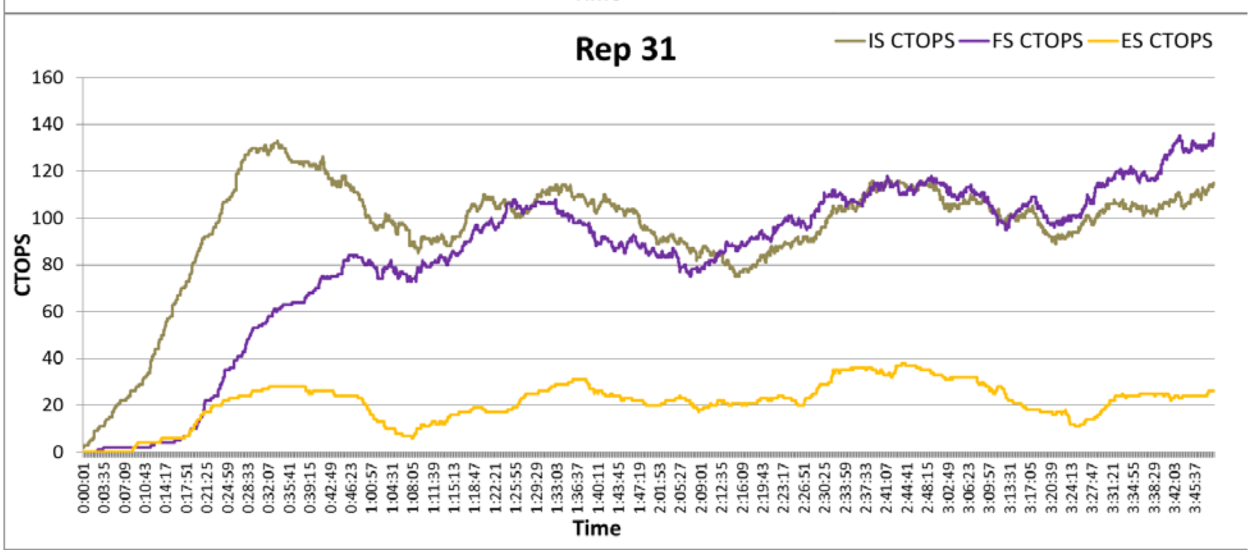

Rep 7
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
140
120
100
80
60
40
20
0
Time
0:00:01 0:03:35 0:07:09 0:10:43 0:14:17 0:17:51 0:21:25 0:24:59 0:28:33 0:32:07 0:35:41 0:39:15 0:42:49 0:46:23 1:00:57 1:04:31 1:08:05 1:11:39 1:15:13 1:18:47 1:22:21 1:25:55 1:29:29 1:33:03 1:36:37 1:40:11 1:43:45 1:47:19 2:01:53 2:05:27 2:09:01 2:12:35 2:16:09 2:19:43 2:23:17 2:26:51 2:30:25 2:33:59 2:37:33 2:41:07 2:44:41 2:48:15 3:02:49 3:06:23 3:09:57 3:13:31 3:17:05 3:20:39 3:24:13 3:27:47 3:31:21 3:34:55 3:38:29 3:42:03 3:45:37

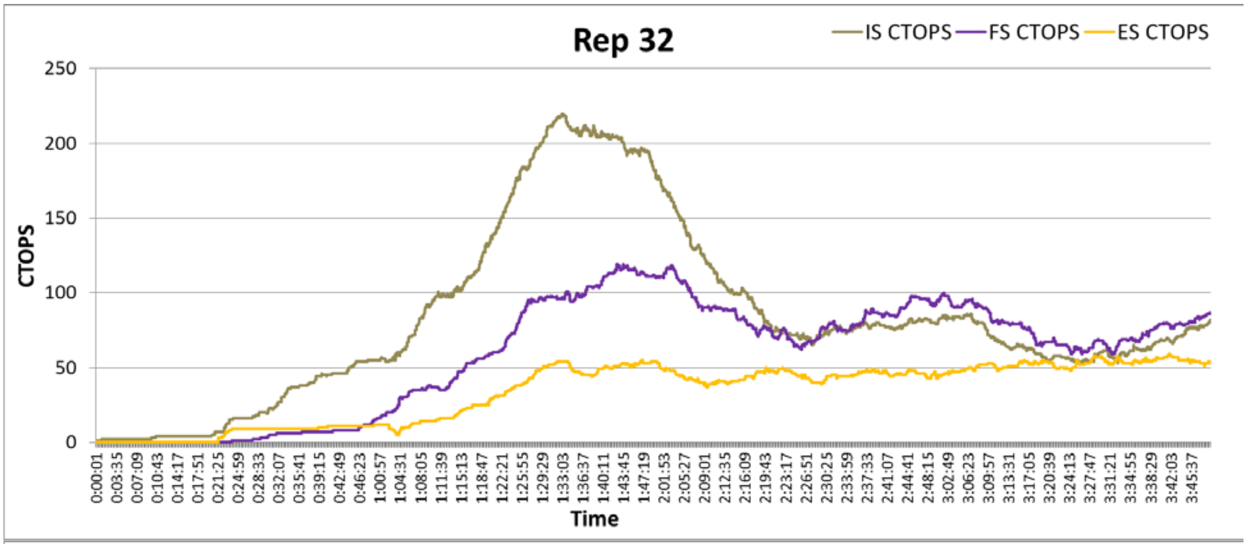

Rep 12
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
60
50
40
30
20
10
0
Time
0:00:01 0:03:35 0:07:09 0:10:43 0:14:17 0:17:51 0:21:25 0:24:59 0:28:33 0:32:07 0:35:41 0:39:15 0:42:49 0:46:23 1:00:57 1:04:31 1:08:05 1:11:39 1:15:13 1:18:47 1:22:21 1:25:55 1:29:29 1:33:03 1:36:37 1:40:11 1:43:45 1:47:19 2:01:53 2:05:27 2:09:01 2:12:35 2:16:09 2:19:43 2:23:17 2:26:51 2:30:25 2:33:59 2:37:33 2:41:07 2:44:41 2:48:15 3:02:49 3:06:23 3:09:57 3:13:31 3:17:05 3:20:39 3:24:13 3:27:47 3:31:21 3:34:55 3:38:29 3:42:03 3:45:37

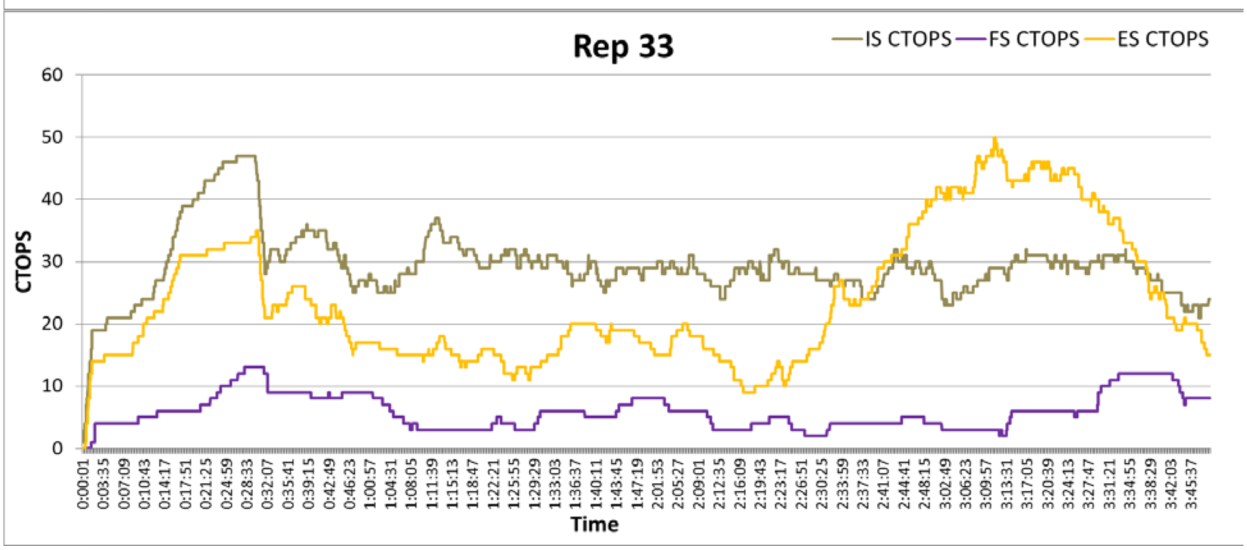

Rep 16
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
40
35
30
25
20
15
10
5
0
Time
0:00:01 0:03:35 0:07:09 0:10:43 0:14:17 0:17:51 0:21:25 0:24:59 0:28:33 0:32:07 0:35:41 0:39:15 0:42:49 0:46:23 1:00:57 1:04:31 1:08:05 1:11:39 1:15:13 1:18:47 1:22:21 1:25:55 1:29:29 1:33:03 1:36:37 1:40:11 1:43:45 1:47:19 2:01:53 2:05:27 2:09:01 2:12:35 2:16:09 2:19:43 2:23:17 2:26:51 2:30:25 2:33:59 2:37:33 2:41:07 2:44:41 2:48:15 3:02:49 3:06:23 3:09:57 3:13:31 3:17:05 3:20:39 3:24:13 3:27:47 3:31:21 3:34:55 3:38:29 3:42:03 3:45:37


Rep 19
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
120
100
80
60
40
20
0
Time


Rep 23
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
350
300
250
200
150
100
50
0
Time


Rep 31
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
160
140
120
100
80
60
40
20
0
Time


Rep 32
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
250
200
150
100
50
0
Time
0:00:01 0:03:35 0:07:09 0:10:43 0:14:17 0:17:51 0:21:25 0:24:59 0:28:33 0:32:07 0:35:41 0:39:15 0:42:49 0:46:23 1:00:57 1:04:31 1:08:05 1:11:39 1:15:13 1:18:47 1:22:21 1:25:55 1:29:29 1:33:03 1:36:37 1:40:11 1:43:45 1:47:19 2:01:53 2:05:27 2:09:01 2:12:35 2:16:09 2:19:43 2:23:17 2:26:51 2:30:25 2:33:59 2:37:33 2:41:07 2:44:41 2:48:15 3:02:49 3:06:23 3:09:57 3:13:31 3:17:05 3:20:39 3:24:13 3:27:47 3:31:21 3:34:55 3:38:29 3:42:03 3:45:37


Rep 33
IS CTOPS
FS CTOPS
ES CTOPS
CTOPS
60
50
40
30
20
10
0
Time
0:00:01 0:03:35 0:07:09 0:10:43 0:14:17 0:17:51 0:21:25 0:24:59 0:28:33 0:32:07 0:35:41 0:39:15 0:42:49 0:46:23 1:00:57 1:04:31 1:08:05 1:11:39 1:15:13 1:18:47 1:22:21 1:25:55 1:29:29 1:33:03 1:36:37 1:40:11 1:43:45 1:47:19 2:01:53 2:05:27 2:09:01 2:12:35 2:16:09 2:19:43 2:23:17 2:26:51 2:30:25 2:33:59 2:37:33 2:41:07 2:44:41 2:48:15 3:02:49 3:06:23 3:09:57 3:13:31 3:17:05 3:20:39 3:24:13 3:27:47 3:31:21 3:34:55 3:38:29 3:42:03 3:45:37