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Exploring and Describing Multiscale Activities:

Scaling Up Behaviour Analysis

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Refining and Describing Multiscale Approaches: Scaling Up Behaviour Analysis

Abstract

Behaviour analysis aims to understand functional relations between environmental contingencies and behaviour. Since Skinner's development of the operant as a unit of analysis for individual behavioural selection, behaviour analysis has largely had a molecular focus on environmental antecedents and immediate consequences that shape and maintain the operant. Multiscale behaviourism and teleological behaviourism have molar approaches to understanding behaviour. They rather define units of behaviour as multiscale processes of activities whereby a multiscale activity occurring fluidly over time may take the form of a hierarchy within which functionally related smaller scale patterns of activities may be nested. Understanding the nature of patterns of behaviour occurring within a multiscale activity and their aggregate effects may enable behaviour analysis to place behaviour in a more coherent narrative within the contingencies that they naturally occur. The articles presented here explore the theoretical basis of multiscale activities and investigate whether they may contain definable scales and measurable patterns of behaviour. Article 1 is a theoretical article which discusses the current theories that describe multiscale activities as tools to analyse behaviour, it examines their internal consistency and external validity before refining their theoretical constructs. Article 2 is a descriptive empirical study grounded in multiscale theory. It is an initial attempt to define and measure patterns of behaviour occurring within a predefined multiscale activity in an experimental setting. Taken together, this thesis presents an expansion on the multiscale activity theory which may contribute to scaling up behaviour analysis.

Keywords: Multiscale activities, Multiscale behaviourism, Teleological behaviourism, Patterns of behaviour, Scale, Unit of analysis, Nested activities, Molar behaviourism

Multiscale Activities: Scaling Up Behaviour Analysis

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Abstract

There have been calls for behaviour analysis to scale up its perspective in recent years. As of today, applied behaviour analysis is mainly used in environments that are far more controllable than most real-world settings. Multiscale behaviourism and teleological behaviourism view behaviour as temporally extended multiscale activities. Such a multiscale approach to behaviour may have the potential to give empirical behavioural research a greater ecological validity. However, the concept of multiscale activities has some conceptual issues that may present a barrier to dissemination and reliable measurement. The nature of multiscale activities is not yet supported by empirical data. This article explores the concept of multiscale activities, their place in behaviour analysis today, and the potential of using multiscale activities as units of analysis. It looks to other areas of science to provide some definitions of scale that may be conciliant with the multiscale theory of behaviour and provide a foundation for reliable measurability of multiscale activities.

Keywords: Multiscale activities, Multiscale behaviourism, Teleological behaviourism, Molar behaviourism, Scale

Sammendrag

De senere årene har det blitt oppfordret til at atferdsanalyse skal innta et bredere perspektiv. I dag brukes anvendt atferdsanalyse hovedsakelig i miljøer som er langt mer kontrollerbare enn miljøer satt i den virkelige verden. Flerskala behaviorisme og teleologisk behaviorisme ser på atferd som tidsmessig utvidede flerskala aktiviteter. En slik flerskala tilnærming til atferd kan ha potensial til å gi empirisk atferdsforskning en større økologisk validitet. Flerskala aktiviteter har imidlertid noen konseptuelle problemer som kan utgjøre en sperre for spredning og pålitelig måling. Naturen til flerskala aktiviteter støttes ikke av empiriske data ennå. Denne artikkelen utforsker begrepet flerskala aktiviteter, dets plass i atferdsanalyse i dag, og potensialet for å bruke flerskala aktiviteter som enheter for analyse. Artikkelen ser til andre grener av vitenskapen for å gi noen definisjoner av skala som kan forlikes med flerskala teori om atferd og gi grunnlag for pålitelig målbarhet av flerskala aktiviteter.

Nøkkelord: Flerskala aktiviteter, Flerskala behaviorisme, Teleologisk behaviorisme, Molær behaviorisme, Skala

A Focus Multiscale Activities: Could It Broaden the Future of Behaviour Analysis?

A researcher does not write an article by typing one word, one sentence or paragraph. A dancer does not dance a dance by dancing one dance step. An alcoholic does not become sober by drinking one drink at a party. The larger scale effect of an article, a dance or sobriety is a result of smaller scale patterns of behaviour nested in larger scale, temporally extended activities and consequences extended over time (Baum, 2013). Multiscale Behaviour Analysis (MSBA) (Baum, 2018) and Teleological Behaviourism (TLB) (Rachlin, 1992) discuss the nature of such temporally extended patterns of behaviour, and how they compose activities (in MSBA) or end causes (in TLB) which function as integrated wholes. They state that based on their functionality as integrated wholes, activities and their nested parts may be analysed as functional units, termed multiscale activities. MSBA is an evolution of molar paradigm of behaviour analysis (Baum, 2018) which has an emphasis on the fact that both behaviour and functional environmental events occur over time and are not necessarily continuous in nature (Baum, 2004). As such, different components comprising an activity may be aggregated and analysed with regards to their multiscale function and their respective temporal allocation. Behaviour should thus rather be referred to as activities to reflect its temporally extended nature (Baum, 2004).

With regards to multiscale activities, MSBA views activities as being composed of nested patterns of behaviour which may vary in scale and organisation and may be controlled by either long-term or short-term relations (Baum, 2004). Aggregates of topologically different behaviour serving the same multiscale function and time devoted to them as a larger scale activity or patterns of behaviour within them may so be analysed. Along a theoretically similar line, TLB is defined as a system of behavioural explanation and control which uses final cause as an explanatory device (Rachlin, 2013). It looks to the end cause of a behaviour (such as a dance) to explain patterns of behaviour nested within it (such as dance steps). Both MSBA and TLB have

been discussed as synonymous terms (Rachlin, 2018) and have similar theoretical perspectives on multiscale activities as a unit of behavioural analysis. They will thus be discussed together under the term Multiscale Behaviour Analysis (MSBA) in this article.

MSBA theoretically scales up behavioural theory and thus may have the potential to give empirical behavioural research a greater ecological validity and on an applied level be the "save the world through behaviourism" that the editors of *Behaviour Analysis and Social Action* are looking for (Killeen, 2018). This article will theoretically explore MSBA and it's place in today's behaviour analysis with a focus on multiscale activities as units of analysis. It will consider the theory's strengths, limitations and draw some parallels natural selection. Based on some limitations, an attempt to build on these theories will be made through some conciliant operational definitions of relevant terms and graphical explanations of nested activities as described in MSBA. It is hoped that this may facilitate the further dissemination of these theories in behaviour analysis and their measurability at an experimental level. Such measurability may in turn increase the theory's internal validity and potential to broaden the future of behaviour analysis. MSBA may have great possibilities for ecological validity, however such ecological validity cannot be established with a theory not yet supported by empirical research and thus lacking in internal validity.

Behaviour Analysis Today

Skinner (1976) described radical behaviourism as the science and technology human culture needs to save itself. He displayed prediction and control over visible behaviours which gave researchers and practitioners confidence in his methods and the technology of behaviour analysis. However, since then the goals of the experimental analysis of behaviour have gone unexamined (Killeen, 2018). Recently, behaviour analysis has been criticised for having a narrow focus on the earlier findings of radical behaviourism, with a field overly dominated by

replicating similar findings which involve observing behaviour over short periods of time and using temporally contiguous consequences (Poling, 2010). Such small procedural variations build a very reliable knowledge base, but do not move the science forward (Chance, 2007). Although replications are extremely important to any science, it has been suggested that behaviour analysis has over focussed on replicating, resulting in this field having limited power and a growing focus on the problems of people removed from the mainstream of everyday life (Normand & Kohn, 2013). For example Poling (2010) discusses that fact that applied behaviour analysis currently has a growing focus on autism spectrum disorders whilst other potential areas for the effective implementations of applied behavioural strategies are not receiving enough attention. Chance argues further that behaviour analysts are not doing anything to 'win over' policy makers to take effective action using behaviour analysis to address some of the biggest problems human societies are facing. If behaviour analysis is to have a larger impact and contribute to behaviour change on a larger scale and with a more diverse human population, perspectives on behaviour may need to be scaled up. Behaviour analysis as a field may be having trouble 'winning over policy makers' because, compared with interventions used to teach individuals with autism and developmental disorders, there currently exist few evidence based practical solutions for behaviour change on a larger scale. Applied behaviour analysts may be experts in training individual behaviours using temporally contiguous reinforcers and tracking response rates where this is necessary, but when working with a general population, training of discrete responses is not always necessary (Baum, 2001). Given that variation increases the chances of survival in a changing environment, different branches of behaviour analysis that may be advantageous in different environments, especially in such a rapidly changing global environment, should be explored. If as MSBA suggests, it is possible to analyse activities as units of analysis, it may be possible for behaviour analysis to scale up it's field and develop

practical solutions on a larger scale with a wider population. It may be literally and metaphorically time for us to think outside the (Skinner) box.

Multiscale and Molecular Behaviourism

Behaviour is defined as anything an organism does, and cannot easily be restricted further (Catania, 2013). However, what counts as behaviour may depend on the theoretical model with which a researcher is analysing behaviour. Whilst molecular behaviour analysis may analyse behaviour as concrete particulars, often termed discrete responses (a response with a specific topology or function that may be completed within a very short space of time) such as steps or pressing piano keys, MSBA scales up the unit of analysis around and looks at the extended pattern as the concrete particular and the discrete responses as the abstraction (Baum, 2003). For example, MSBA may analyse units of behaviour as activities such as walking or playing a song on the piano. Both molecular behaviour analysis and MSBA agree that the basic goal of behaviour analysis as a science is to uncover functional relations between the environment and behaviour. Based on the fact that behaviour is lawful, causal explanations are possible. From the perspective of behavioural determinism, a systematic scientific approach will reveal the rules that govern behaviour (Cooper, Heron, & Heward, 2004).

Typically, in a controlled experimental setting, changes in an environmental independent variable are manipulated and changes in an observable behavioural dependant variable are recorded and analysed (Cooper et al., 2004). The term environment has been defined as "*anything in the universe capable of affecting the organism*" (Skinner, 1953, p. 257) and any condition or event which can have an effect on an individual organism should be taken into consideration (Skinner, 1953). Using molecular analysis, a temporally contiguous three term contingency (environmental antecedent, a behaviour and it's immediate consequences) have been effectively used as a basis for the discovery of the laws of behaviour. This technology has

enabled the discovery of cause and effect relations between the environment and behaviour, whereby functional environmental events are by definition temporally contiguous with the discrete response of interest (i.e. Skinner, 1953; Cooper, Heron & Heward, 2004; Catania 2013). A discrete response can be defined structurally or functionally (Catania, 1973) as a unit of behaviour (Catania, 2013). Environmental events are functionally defined by their reinforcing (increasing the future probability) or punishing (decreasing the future probability) effect. Measures of such discrete responses rely on response rate to bridge time.

Baum (2013) argues that the complexity of the controlling environmental relations of behaviour and it's effects and consequences over time is lost when the single effect of a contiguous consequence on a discrete response is analysed in a laboratory setting, as is often the case in behaviour analysis when molecular analyses are used. MSBA views functional behavioural units on a larger scale, as temporally extended patterns. As such, an activity may function as an integrated whole (Baum, 2018). A larger scale activity may be composed of many smaller scale activities nested within them (Hineline, 2001). For example, for a researcher the larger scale activity of working may be composed of smaller scale patterns of activities such as driving to work, writing emails, writing grant applications, conducting research. Together all of these activities compose the multiscale activity of working and take up the time an individual devotes to that activity (Baum, 2004). Figure 1 depicts an example of the nested nature of multiscale activities. Nested within the multiscale activity of writing an article, is the activity of writing an introduction, nested within the activity of writing an introduction are patterns of activities such as writing words, nested within all of these activities is the activity of pressing a key. These patterns of activities are nested within the activity of working and occur due to their functional relation to that activity and the activities that they are nested within. If the multiscale

activity of working were to be outcompeted by another activity, patterns of writing articles, writing emails and research would also likely be affected.

MSBA provides a different and effective foundation for analysing behaviour over a larger time scale by analysing choice as time allocation between multiscale activities. As every individual's time is limited by it's lifespan, activities constitute choice between alternatives (Baum, 2004). For example, an individual's recreational time may be the aggregate sum of their time spent on watching TV, going to the cinema and using social media. The time spent on each of these activities would constitute their pattern of recreational behaviour (Baum, 2002) which may be a useful unit of analysis. Furthermore, time spent on social media may be observed to be 50% on Facebook, 20% on Instagram, 20% on Twitter and 10% on Tinder. This may be a useful unit of analysis. On a different scale of analysis, 50% of the time spent on the activity of using Facebook may be divided between smaller scale activities such as liking pictures, posting pictures, reading news, adding friends, blocking friends, updating a status, or writing comments in particular groups. It is important to note that activities on a larger scale (i.e. time spent on Facebook) may be reinforced or extinguished as a whole. At the same time the activity of posting pictures on Facebook may be reinforced or extinguished in themselves, while the individual may spend the same or less amount of time on the larger-scale activity of time spent on Facebook. A new activity may occur and as a result time spent on other activities may decrease. An analysis of social media use at such a scale may have high social validity when considering either individual time allocation or interventions to address larger scale social problems human society is facing today.

The nature of patterns of behaviour under different multiscale activities may be harder to observe in a controlled experimental setting than that of molecular behaviour analysis. However, they may have more ecological validity than the rate of discrete responses and their contiguous

consequences. Taking the multiscale activity of making a phone call as an example, Baum (2001) discussed that smaller patterns of behaviour such as pressing buttons on the phone in a call centre may not need to be reinforced on their own. They occur as a function of a larger scale activity. Based on this example, if a call centre manger wished to analyse behaviour, she may be more interested in calls made as units of analysis. Calls made may be viewed as a larger scale activity within which other patterns of behaviour such as pressing buttons, following a script and typing into a computer are nested. In contrast, a molecular analysis of behaviour may analyse the concrete particulars of pressing buttons on the phone and keys on a keyboard individually. For example, a chaining procedure may be used to train sequences of discrete responses and link them together to complete the terminal outcome of making a phone call. MSBA suggests that this is not always necessary, a chaining procedure may be useful for training individuals to perform a new sequence and form of responses (Cooper et al., 2004). However, Baum (2001) argues that many adults do not need special training to, for example, press a series of buttons on a phone. Furthermore, such behaviours may be treated as multiscale units once mastered and thus be analysed as such. A reliance on piecing together small units of behaviour does not place behaviour in the complex nature it naturally occurs in, neither does it contribute to a larger scale analysis. MSBA argues that all behaviour analysis is multiscale to a certain extent. Although in a snapshot of time the topology of a discrete response may be definable, even with a molecular analysis the function of a behaviour is only observed after the behaviour has occurred (Baum, 2013). For example, the function of a consequence on behaviour may only be determined by observing the increase or decrease in frequency of future behaviour. Rachlin (2013) argues further that often responses that are considered discrete, for example a pigeons pecking a key, occur as a result of a visible pattern of activities (orienting towards the key, moving beak, moving head, bending neck) that are reinforced as a whole. He questions that if such patterns of

responses may be reinforced as a whole (which often occurs after a shaping procedure), then why can't larger patterns of multiscale activity also be analysed as a whole? This question remains open as there is as there is currently little empirical evidence supporting the analysis of multiscale activities and their aggregates as a whole. According to MSBA, the longer we observe behaviour for the more sure we can be of it's function, and it's function may not necessarily be a temporally contiguous reinforcer or punisher.

A Paradigm Shift in Behaviour Analysis?

Baum (2002) describes a paradigm shift as occurring in behaviour analysis, from the molecular perspective, to the MSBA perspective. Research supports this statement to the extent that there currently appears to be disagreement in the field of behaviour analysis with regards to the temporal contiguity a consequence needs to occur in order to establish a functional relationship on behaviours that precede it. Results from surveys sent to the editors of five different behavioural journals (JABA, JEAB, JOBM, TAVB, TBA) in 1991 (Schlinger, Blakely, Fillhard, & Poling) and again in 2010 (Bradley & Poling) both revealed a lack of consensus amongst the behavioural analytical community regarding whether consequences extended in time could function as reinforcers. In both of these studies, researchers were asked to imagine the following scenario regarding a behaviour and a delayed consequence: "*There appears to be a functional relation between grant writing and receipt of grant money: A researcher receives grant money 6 months after submitting a grant application and the time and effort spent in grant writing subsequently increase.*" (Bradley & Poling, p. 44). The journal editors were then first asked to respond to the following question with either 'true', 'false' or 'other': "*Receipt of the money in the scenario is a reinforcer regardless of the long delay between the behavior (grant writing) and the consequence*" (Bradley & Poling p. 44). Results from Bradley and Poling's study were similar to Schlinger et al.'s study it replicated and showed a mean of 58% (SD 8.1) of

respondents from the five journals responding with 'true' and 39% (SD 5.5) responding false.

The disparate verbal behaviour this question produced amongst individuals which in turn select

the work of behaviour analysts to be published within the scientific community may be quite

surprising given the conceptual importance of the process of reinforcement to the field of

behaviour analysis. In question two of the same survey a small majority (61%, SD 9.7) of the

58% of participants that had responded 'true' to the previous question also responded 'true' when

asked whether the reinforcing effects of the grant money were dependant on the verbal behaviour

of the researcher. Finally, respondents were asked to comment on how delayed a consequence

can be to function as a reinforcer. Many of the responses listed in the article stated the

importance of the learning history of the individual, rules, and schedules of reinforcement (see

Bradley & Poling for an exhaustive list of responses) as variables that may affect how delayed a

consequence may occur to function as a reinforcer.

In a natural setting behaviour is often under the control of many different schedules of

reinforcement, this adds to the complexity of behaviour and it's controlling contingencies

(Catania, 2013). Through studying behaviour over time behaviour analysis has learnt a lot about

stereotypical patterns of behaviour occurring under different schedules of reinforcement (Cooper

et al., 2004). It is possible that through observing patterns of behaviour nested within multiscale

activities, behaviour analysis may learn more about the complex controlling contingencies of

behaviour on a larger scale.

Behaviourism gained the prefix radical when Skinner (1945) built onto previous

methodological behaviourism the inclusion of private events (Schneider & Morris, 1987). Private

events refer to unobservable events occurring inside the skin of an organism, for example

thoughts and feelings. Skinner (1945) stated that thoughts and feelings occur and may be

controlling variables in the behaviour of an organism but that due to the fact that thoughts and

feelings are unobservable to more than the person they occur within, they are unverifiable and unmeasurable with regards to scientific research purposes. Furthermore, such thoughts and feelings are not a reliable unit of measurement.

MSBA also states a need to avoid hypothetical constructs to explain behaviour. The difference between their theory lies within their necessity. A molecular analysis may hypothesises the relevance of private events such as rules (defined as verbal antecedents that specify contingencies; (Catania, 2013)) as controlling contingencies for behaviour (only that if they occur privately they cannot be reliably measured). Rule governed behaviour is behaviour that has come under a verbal statement of a three term contingency. Through rules human behaviour may then come under indirect control of temporally remote consequences. MSBA states that such private event behaviour may be observed and thus measured if behaviour is observed over longer periods of time, reducing the need for any hypothetical private rule governing in the analysis of behaviour. Furthermore, mental constructs used to explain behaviour may in fact be observable through temporally and socially extended patters of overt behaviour (Rachlin, 2017). As such, private events can be studied as labels given to discriminative patterns of multiscale activities. Whilst MSBA do not deny the existence of private events, they state that they are not necessary in the analysis of behaviour. Baum (2005) exemplifies this with the private event often referred to as love. The concept of love may be viewed as an aggregate of activities occurring at different times (Baum, 2005). Love occurs at no particular time but may be observed over time when one individual is observed to engage in activities often correlated with the concept of love. An individual may give another individual flowers, kiss them, giving them complements, etc. In any one of these single moments of observation, we may not be able to see if an individual loves another individual but observed over time we may see time devoted to certain activities and the frequency with which they occur.

The Practical Issues and Solutions

As previously discussed, behaviour analysis attempts to uncover functional relations controlling behaviour. The unit of behaviour analysed and the functional relations considered may depend on the theoretical framework we are viewing behaviour from. Is it possible to analyse functional relations between behaviour and the environment using MSBA? If not, it will remain theory, with little practical use. With such an underlying difference in philosophy with regards to what constitutes an explanation for behaviour it may be that MSBA is incompatible with molecular behaviourism (Iversen, 1991). MSBA theoretically explains how extended patterns of behaviour on extended time scales may occur and the nature of smaller scale activities nested within multiscale activities. It has also been heralded as a potential future direction for behaviour analysis. However, there are some conceptual ambiguities that may prevent empirical study. For example, there appears to be neither an operational definition of the nature of scales within MSBA. There neither any defined cut off points based on either time or scale of activity. This leaves questions around the amount of time that must be used or level of scale that may be defined in order to empirically analyse multiscale behaviour. The nature of potentially hierarchical organisation of multiscale activities needs to be defined (Shimp, 2013). Furthermore, there are a relatively small amount of behavioural researchers disseminating MSBA using topologically different terminology for similar theories on patterns the multiscale nature of behaviour. Different terms likely have different functions based on the learning histories of each behavioural researcher whom is unfamiliar with the multiscale approach. A more conciliant terminology used within these theories may increase understanding aid future dissemination of the theories into behaviour analysis.

Consilience

Consilience refers to the jumping together of fact based knowledge across disciplines through the linking of known facts and fact based theory (E. Wilson, O., 1998). Wilson stated that the explanations for different phenomena that are most likely to survive, are those that can be connected and proved consistent with one another. Theories may be proved consistent when whilst using different units of measurement, the same answer is achieved. Furthermore, we know that scientific language is verbal behaviour and is shaped through a researcher's history of reinforcement. Being connected requires a language with which scientific ideas may be communicated through, and within, disciplines. From a behavioural perspective, terminology should be precise and consistent in order to be potentially valuable (Bradley & Poling, 2010) which may be evidenced if multiple members of same discipline consistently tact particular stimuli in the same way. However, within the MSBA theories described, there are many different terms explaining a similar underlying theory of behaviour being a parts of multiscale activities which occurring over different scales with a larger scale activity being composed of nested, smaller scale activities within them. Some of the terms used to describe these theories are not only different from each other, they are also incongruent with existing behavioural terminology, although behaviourism is the field they claim to be part of. For example, what Baum (2018) describes as a large scale activity, Rachlin (2018) may describe as an end cause. Beside the fact that they already present a more scaled-up approach to behavioural explanations than radical behaviourism otherwise does, such a disparate and incongruent verbal behaviour may result in them appearing antagonistic to researchers with a learning history founded elsewhere in behaviourism, possibly resulting in avoidance behaviour of a reader. This may in turn create a barrier to selection within the field. Rather, we may view a multiscale analysis as complimentary to a molecular analysis, where they both may have uses in different environments, where different units of measurement are appropriate. This may expand the power of behaviour analysis

to address different problems of social importance on different scales. Whilst we may accept that

MSBA have a different theoretical grounding on the basis of scale and time which calls for a

need to expand our analyses, consilience suggests that it would be beneficial to these theories to

i) share a common language between themselves and ii) share a common language framework

with pre-established fields such the behavioural sciences, or biological evolution.

Unit of Analysis

Mensuration is also key to Wilson's (1998) consilience framework. He stated that

something can be measured using universally accepted scales, then generalisations about it are

rendered unambiguous. Whilst molecular behaviourism has a focus on reliable units of analysis

which facilities reliable measurability and replicability, this may more challenging within

MSBA. There is currently lacking an operational definition of what constitutes levels or scale of

activity in MSBA. Without agreement on what constitutes a unit of analysis, even if we were

able to observe behaviour over time, reliable measurement would be impossible, leaving these

frameworks neither provable or disprovable. This is what Wilson (1998) terms as a hallmark of

pseudoscience, rather than science. In order to progress as a science and allow measurability and

thus empirical description, prediction and control, MSBA must also define what constitutes a

unit of measurement; in conciliant terms. To do so we may look across disciplines for pre-

existing acceptable units of multiscale measurement and terminology used to define them.

Defining Scale

Possibly the biggest limitation to MSBA is one of measurability. Multiscale theory

potentially involves putting behaviours into scales of ever increasing scale of activities.

Currently, such scales have not been operationalised, let alone universally accepted. It may be

necessary to observe the behaviour of an individual for significant periods of time before the full

final cause of a behaviour and it's environmental complexities may be understood (Rachlin,

1994). As Baum (2018) described, all activities are ultimately nested in the activity of survival. This presents methodological limitations central to MSBA. This was outlined by Foxall (2008, p.132) "*Rachlin's search for plausible extensions fails because the extension identified is untestable (at least during the period of the interpretation). Where are we to draw the line?*" Indeed, Rachlin (1992, p.1380) states himself that although with wider and wider samples of a behaviour are taken, a multiscale context will never become 100% knowable; "*in principle, its context is infinite*". Furthermore, if as Baum (2005) suggests, that all multiscale activities are ultimately nested in the activity of survival, then the unit of analysis becomes too large and impractical. As such, if we are to learn more about patterns of behaviours that occur as a function of a larger scale activity, such scales must be of practical use and operationalised in such a way that they can be agreed upon and observable by more than one observer. A key problem with such analyses is where to set the boundary of analysis (Iversen, 1991). Without further attempts to operationalise terms, and then describe, predict and control these scales in a controlled basic environment, multiscale theory will likely remain theoretical hypothetical constructs and rather of practical use to a laboratory or applied behaviour analysis.

Parallels to Natural Selection

Since it's beginnings, radical behaviourism has been paralleled to Darwin's Theory of Natural Selection. This was outlined by Skinner (1981) in his paper *Selection By Consequences* where he describes the selection of human behaviour as a joint product of i) the contingencies of survival responsible for the natural selection of the species, ii) the contingencies of reinforcement responsible for the repertoires acquired by the members of the species, and iii) cultural selection maintained by an evolving cultural environment. Based on this selectionist perspective, the consequences of a particular behaviour effect the likelihood of it's reoccurrence given similar environmental antecedent variables. With regards to the contingencies of reinforcement

responsible for behavioural repertoires acquired by the members of the species, multiscale activities as a unit of analysis stands in contrast to the currently more traditional discrete response as a unit of analysis (Baum, 2004). Following radical behaviourism's parallels to natural selection there are also currently debates regarding which unit of analysis is most important regarding natural selection. Evolutionary biologists, D. S. Wilson and Wilson (2008) discuss biological selection from the perspective of multilevel selection theory with a focus on why group selection should be focussed on. This theory takes biological selection from the level of group selection down the level of gene selection using the metaphor of Russian dolls. Each Russian doll represents a unit nested in another; genes are nested in individuals, individuals are nested in groups. This is depicted in figure 2. In turn natural selection works at different levels of the hierarchy and different levels of the hierarchy may be used as units of analysis with increasing degrees of complexity. Groups may survive whilst others will not, individuals may survive whilst others will not, genes may survive whilst others will not. At the same time, survival favours adaptations on different levels. In biological selection, if a unit at a larger scale, for example a group, is extinguished, so are the individuals nested within them, and the genes nested within them. In multiscale activity theory, if a multiscale activity is extinguished then so are the nested patterns of behaviour within them; at least in that functional context.

Some Definitions

Gibson, Ostrom, and Ahn (2000) stated that one of the most important barriers between the physical and the social sciences was the concept of scale. Seeking to facilitate dialogue between the natural and social sciences, with a focus on human dimensions of global environmental change, Gibson et al. attempted conciliant definitions of the term scale that they noted was frequently used interchangeably across disciplines. Some of Gibson et al.'s (2000, p.218) *"definitions of key terms related to the concept of scales"* have been adapted and

presented in table 1. They are intended to relate to or 'jump together' knowledge on the terms related to scale with a focus on behaviour from a MSBA perspective as discussed in this article. It is hoped that these definitions may take these theories a step closer towards consilience and facilitate measurability.

Based on the terms given in table 1, we may see a critical difference between molecular behaviourism and MSBA. In radical behaviourism it is often important to measure behaviour using a scale which is as absolute scale as possible; for example the rate of discrete responses may be measured using a cumulative graph. However MSBA is interested in measuring behaviour on relative scales, examining the functional relationship of one activity to another over longer periods of time. As such, behaviours are measured on different scales; they have different temporal or analytical dimensions. Potential units of measurements based on MSBA, may thus depend on the activity the researcher wants to analyse. For example, whereby Rachlin (1998) defines a dancing a dance as the end cause; a dance may be analysed as the large scale activity and descriptively based on observations, patterns of behaviour that are functionally related to the dance may be ordered within a relative scale. When analysing phenomena based on scale, patterns that exist at one resolution may be lost at another (Gibson et al., 2000). As such, a molecular analysis and a multiscale analysis may be complimentary and both useful tools to a researcher depending on research question or applied problem to be analysed whereby behaviour at different resolutions may be useful in different settings and with different research questions.

Furthermore, whilst an analysis of scale and level may identify patterns, they do not explicitly explain them (Gibson et al., 2000). If MSBA is to begin to understand observable and measurable explanation of patterns of behaviour, it may through upward causation imply that nested patterns of behaviour, such as steps within a dance, would cease to exist if the multiscale activity of a dance ceased to exist as the patterns of dance steps occur as a function of dancing

the dance. Patterns of behaviour may be analysed within a multiscale activity as long as they are related by their shared consequence. Such an analysis has been described as useful in the analysis of behaviour change during the course of functional analytic psychotherapy (Córdoba-Salgado, 2017), whereby functional relations between topologically different patterns of behaviour over time result in the behaviour change of a client over time. The functional relation of such patterns of behaviour are only visible with such a multiscale analysis.

As yet, there are as yet many unknown variables involved with multiscale activities that may be explored and expand our knowledge base. To begin with multiscale activities may be descriptively investigated in experimental research, considering the potential measurability of multiscale activities and the smaller scale activities nested within them. This may in turn help us further define the complex nature of the behaviour within complex social systems we wish to study on a larger scale. To begin with three principles may be explored: i) Hierarchy in scale: The extent to which functionally related activities occur at different levels and the nature of hierarchical structure to be measured ii) Scale effects: What patterns of behaviour are observable and what changes in patterns of behaviour and behavioural processes can be observed when the level of scale used in analysis changes? iii) Scaling: Is it possible to isolate a multiscale activity from confounding variables in order to observe patterns of behaviour at different scales? Are there any useful theories or models within other areas of science that have used methods to translate units of analysis across scales that may be applicable?

Summary

As of today, applied behaviour analysis is mainly used in environments that are far more controllable than most other real world settings (Normand & Kohn, 2013). It is effective in environments where response units often need to be kept small and reinforcements delivered immediately (Baum, 2001). However, showing that reinforcement played a role in an exceptional

behaviour is no longer enough (Killeen, 2018). An analysis of MSBA may result in scaling up to

address behavioural problems on a larger scale, potentially enabling applied behaviour analysis

to target the concerns of people in the mainstream of everyday life on a larger scale. Drawing

from other areas of science may be necessary to enable behaviour analysis to scale up it's

perspective. However, MSBA has conceptual issues regarding reliable measurability, the

definition of scale and acceptable units of measurement. The nature of multiscale activities and

activities nested within them potentially have great ecological validity but are not yet supported

by controlled empirical study. By using the operational definitions in table 1 we may define a

multiscale activity and the nature of it's scale on acceptable units of analysis and begin by

observing and describing behaviour in a controlled environment to explore whether patterns of

behaviour within a multiscale activity are observable and measurable.

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Table 1

A list of definitions related to scale adapted for the purpose of multiscale behaviour analysis

Term	Definition
Scale	The temporal or analytical dimension used to measure and study activities.
Levels	Position along a scale: Activities that are located at the same position on a scale.
Hierarchy	A conceptually or functionally linked system of grouping of activities as processes along an analytical scale.
Inclusive Hierarchy	Activities that are ranked as lower in the hierarchy are referred to as smaller scale activities. They are nested in the hierarchy of larger scale activities.
Constitutive Hierarchy	Activities are combined into new activities that are them combined into new activities, with their own functions and emergent properties.
Absolute Scale	A measurement of dimension used to measure activities (i.e. distance, time, function) on an objectively calibrated measurement device.
Relative Scale	The transformation of a relative scale to one that describes the functional relationship of one activity to another.
Multiscale Activity	An activity with multiple levels ordered within an inclusive hierarchy with smaller scale activities nested on a relative scale which describes the functional relationship of one activity to another.

Note: Adapted from *definitions of key terms related to the concept of scales* in Gibson, C. C., Ostrom, E., & Ahn, T. K. (2000). The concept of scale and the human dimensions of global change: a survey. *Ecological Economics, 32*(2), 217-239.
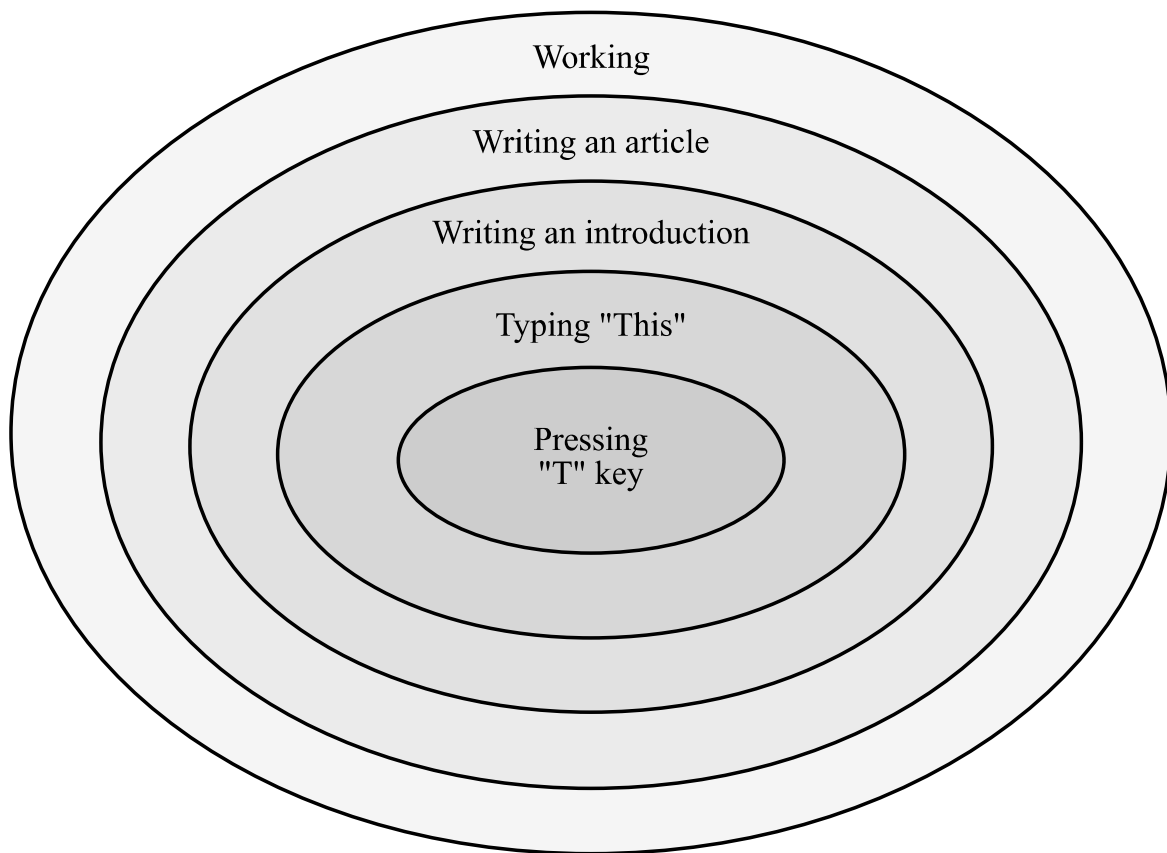
Figure 1. An illustrative example of the nested nature of multiscale activities as potential units of analysis. All the activities above are nested within the multiscale activity of working. The scale of the level of activity are reduced based on their functional relation to the higher scaled activity they are nested within.
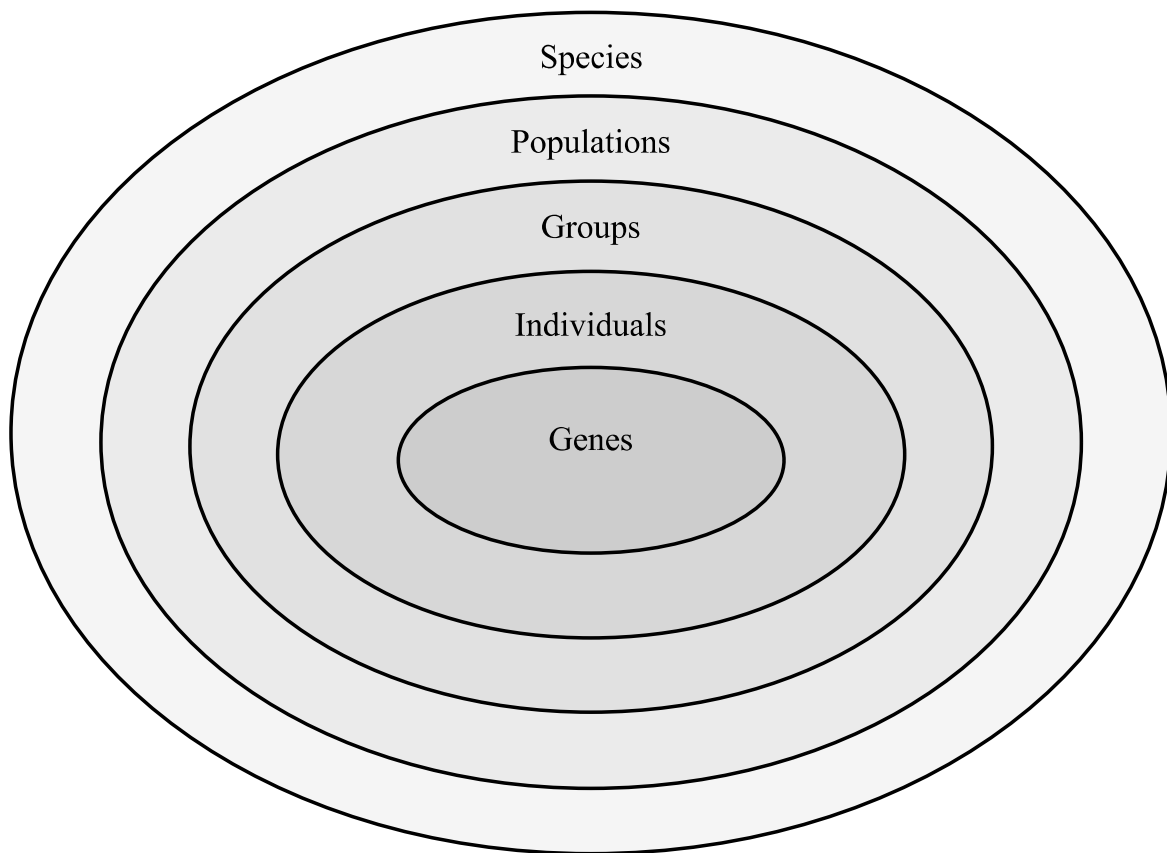
Figure 2. An illustrative example of the nested nature of biological units of analysis. All of the units above are ultimately nested within a population. The scale of unit is reduced based on it's relation to the unit it is nested within.

Multiscale Activities: A Descriptive Study

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Research Article

Abstract

This study is designed in the theoretical framework of multiscale behaviourism and teleological behaviourism which describe behaviour as multiscale activities with smaller scale patterns of behaviour nested within them. This theory is not yet supported by empirical research and as such the nature of patterns of behaviour within a multiscale activity is not yet known. This study interprets a multiscale activities as an activity with multiple levels of scale ordered within an inclusive hierarchy within which smaller scale activities nested on a relative scale. Aiming to start an empirical conversation on the nature of patterns of behaviour within a multiscale activity, this study is descriptive in nature. The design of the study is a partial replication of Bangerter and Clark (2004). Pairs of participants cooperated to complete puzzle tasks in an experimental setting and verbal responses occurring at different pre-defined scales of a multiscale activity were analysed for rate of occurrence and trend. Patterns of verbal behaviour within a multiscale activity were observed and discussed. This research suggests that patterns of behaviour within a multiscale activity may be both measurable and observable. Limitations to this research and future potential research areas are discussed.

Keywords: Patterns of behaviour; Multiscale activity, Multiscale behaviourism, Teleological behaviourism, Molar behaviourism, Scale

Sammendrag

Denne studien er utformet innenfor et teoretisk rammeverk for flerskala behaviorisme og teleologisk behaviorisme som beskriver atferd som flerskala aktiviteter der mønstre av atferd av mindre skala er nøstet innenfor. Denne teorien er ennå ikke støttet av empirisk forskning, og som sådan er det ikke kjent at mønstre for atferdsmønster i en flerkalsaktivitet er. Denne studien fortolker en flerskalaaktivitet som en aktivitet med flere nivåer ordnet innenfor et inkluderende hierarki, der mindre skala aktiviteter er nøstet etter en relativ skala. Med et mål om å starte en empirisk fundert samtale om virkemåten til atferdsmønstre innenfor en flerskala aktivitet, er denne studien deskriptiv. Utformingen av studien er en delvis replisering av Bangerter og Clark (2004). Par av deltakerne samarbeidet for å fullføre pusleoppgaver i en eksperimentell setting og verbale svar som oppstod ved forskjellige forhåndsdefinerte skalaer av en flerskala aktivitet ble analysert for frekvens og trend. Mønstre av verbal atferd innenfor en flerskala aktivitet ble observert og diskutert. Denne undersøkelsen antyder at mønstre for atferd innenfor en flerskala aktivitet kan være både målbare og observerbare. Begrensninger til denne forskningen og potensielle forskningsområder diskuteres.

Nøkkelord: Atferdsmønstre; Flerskala aktivitet, Flerskala behaviorisme, Teleologisk behaviorisme, Molær behaviorisme, Skala

Multiscale Activities: A Descriptive Study

There is currently a widening gap between laboratory and the real world in the experimental analysis of behaviour (EAB) which can only be bridged by a renewed conversation on technologies to examine behaviour, and place them in a coherent narrative, that has largely ignored (Killeen, 2018). Multiscale behaviourism (MSB) (Baum, 2018) and teleological behaviourism (TLB) (Rachlin, 2018) present a theoretical basis for a scaled up analysis of behaviour and place them in a coherent narrative. They define units of behaviour as multiscale processes of activities whereby a multiscale activity takes the form of a hierarchy within which functionally related smaller scale units of activities may be nested within. As such, it may be possible to empirically describe activities as units of multiscale behaviours which may be analysed as functional wholes occurring over time. However, this is currently theoretical in basis and has not received attention in EAB. This study attempts to build on existing multiscale theory in behaviour analysis and start an empirical conversation through a descriptive study assessing the observability of smaller scale nested patterns of behaviour nested within a multiscale activity in an empirical setting.

A multiscale activity may be large or small (Baum, 2013) and selection of the multiscale activity may depend on the unit of analysis. For example, Rachlin (1992) describes the multiscale activity of playing golf which may be analysed as a large scale activity with smaller scale activities such as hitting balls, keeping score and talking to opponents nested within. Cordoba-Salgado (2017) describes the multiscale activity of attending functional analytical psychotherapy and smaller scale activities such as conversations with a therapist and writing down poems nested within with the multiscale activity of attending therapy. They suggest that a multiscale approach would enable a behavioural analysis of the functional relation between each

of these smaller scale activities nested within the hierarchy of the multiscale activity of attending psychotherapy and in turn it's aggregate effect of behaviour change. Baum (2002) describes an even more scaled up version of a multiscale activity of working, whereby smaller scale activities such as writing emails, driving to work, completing grant funding proposals, talking to colleagues all comprise the time an individual is observed to be working and may be analysed as smaller scale activities nested within the larger scale activity of working. Such smaller scale activities are also composed of yet smaller scale patterns of activities nested within; driving to work may involve driving one road, before joining the motorway, then exiting the motorway at a certain junction before turning right. On a smaller scale of activity, turning right may be composed of patterns of activity; indicating right, pressing the brake then clutch, looking at the pedestrian crossing, turning the wheel and accelerating. Should the larger scale activity of working cease to exist, these smaller scale patterns of behaviour that are functionally related to the multiscale activity working would also cease to exist in the same functional context. As such, the functional relations of larger and smaller scale activities to one another present an important factor in the analysis of behaviour.

Key to the understanding of multiscale activities is that they fit within the molar paradigm of behaviour analysis (i.e. Baum, 2004). Molar behaviourism has a focus on the fact that behaviour takes time and should be analysed over longer periods of time than the traditional molecular analysis radical behaviourism often uses (Rachlin, 2018). A traditional molecular analysis has a focus on small units of behaviour, often termed discrete responses, being joined together into larger units which may rely on hypothetical constructs (Baum, 2003). The nature of behaviour as temporally extended patterns is denoted by the use of the term activities, rather than responses (Baum, 2004) within the molar perspective which in contrast views behaviour as

continuous, extended activities. It appears inherent in the scaling up of the analysis of behaviour that the amount of time a researcher must use to analyse some activities also increases. However, Rachlin (1999) argues that all analysis of behaviour is inherently multiscale as all units of behaviour analysed occur as result of a pattern of behaviour; even the often studied discrete response of a rat pressing on a lever occurs not only as a result of learnt environmental antecedents and consequences but as a patterns of limb and muscles movements of which the lever press is a multiscale activity or aggregate effect. As such, the time required to observe a multiscale activity may depend on the ultimate multiscale unit of analysis a researcher aims to explore.

Rachlin (1992) describes a distinction between two causes of behaviour; efficient causes and final causes. He states that efficient causes should answer the question; 'How does the behaviour occur?' (the reinforcing contingencies that shape and maintain behaviour), whereas an analysis of the final causes (the larger scale activities and behaviour is functionally related to) should answer the question 'Why does this behaviour occur?'. According to Rachlin, an analysis of final causes should reveal ends that comprise of abstract patterns of behaviours that comprise those patterns. Activities or behaviours may precede it's final cause but to fall into the pattern of activities embraced by the final cause they must fall into them; as the notes of a song must be played before a song can be said to have been played (Rachlin, 1999). Rachlin's final causes may then be viewed as multiscale activities we may often state that we are completing on a daily basis; The activity itself serves as the final cause and the patterns of behaviour embraced by that activity are smaller scale activities nested within that activity. For example, an activity of dancing a dance may be a final cause in which is nested the smaller scaled activities such as dancing certain patterns of steps. As such, final causes may be best understood as what might

follow the word 'because' in a sentence. For example, if I were to ask someone why they were pressing a button on their keyboard they would probably reply with 'because I'm writing an article' (end cause) rather than 'because then the same letter that I press appears on my screen' (efficient cause), whereby both causes are likely required for the key pressing behaviour to continue occur. Whilst behaviour analysis may tell us a lot about efficient causes of behaviour, less is known about such end causes. It is the end causes, or multiscale activities that may place behaviour in a more coherent narrative.

Despite critique that the experimental analysis of behaviour has received in recent years for it's lack of focus on placing behaviour in a larger coherent narrative (Killeen, 2018; Poling, 2010; Chance, 2007) the multiscale theories of behaviour presented by TLB and MSB have received not yet received any empirical attention in EAB. It is quite possible that such a lack of attention may be due to the empirical difficulties of prediction and control when analysing behaviour at a greater level of complexity. Iverson (1991) described the potential roots of this problem concluding that deterministic research tradition may have dictated that analysis stops when data becomes noisy and unpredictable. Furthermore, although the MSB and TLB are often discussed together (i.e. Killeen, 2018; Baum 2003) and have been used as synonymous terms (Rachlin, 2018) there is a lack of conciliant terminology used by the founders of these theories (Baum, 2013; Hineline, 2001; Rachlin, 1992). Which may present a barrier to describing a comprehensive multiscale theory and thus dissemination of the theory within behaviour analysis as a field. More importantly, a conciliant, coherent definition of the nature of scales may facilitate reliable and valid measurability in an empirical setting whereby a unit of measurement may be agreed upon by more than one person.

Both end causes and multiscale activities will be referred to as multiscale activities (MSA) throughout the rest of this paper. The following definition of a MSA will be used for the purposes of this research: An activity with multiple levels ordered within an inclusive hierarchy with smaller scale activities nested on a relative scale, which describes the functional relationship of one activity to another. This definition is deemed to be compatible with other definitions of scale within other fields (Gibson, Ostrom, & Ahn, 2000) and an interpretation of the multiscale theories presented by Baum (2018) and Rachlin (2018).

The multilevel nature of activities has received attention in other fields of psychology. In a paper published in *Cognitive Science*, Bangerter and Clark (2003) studied what they described as joint activities emerging in hierarchically nested projects and subprojects. They analysed recorded dialogue between pairs of participants cooperating to complete different pre-defined tasks together. The authors described the joint activities as emerging in hierarchical projects and subprojects defined by their functional relation to each other. They hypothesised that certain words, termed project markers, would be used to coordinate vertical transitions between activities on the same scale and that different project markers would be used to coordinate movements hierarchically upwards or downwards through the hierarchy. Two of the corpora analysed in this study were dialogue recordings from experiments in which pairs of participants were asked to solve tangram picture puzzles together. The tangram picture puzzles involved the participants putting sets of tangram pictures in a particular order in an experimental setting. One participant (The Matcher) could not see the solution showing the correct order for the tangram pictures, which was visible to the other participant (The Director). The Matcher had identical tangram pictures that were on The Directors solutions, however they were placed in a random order and not visible to The Director. The participants were asked not to visually show each other

their pictures throughout the experiment but to talk as they normally would to solve a total of 12 sets of tangram picture puzzles as correctly as possible. The same tangram pictures were used in the first six trials, a second set was introduced for the second half of trials. One corpus was recorded with a total of 18 pairs of Swiss participants speaking Swiss German, the other corpus was recorded with 18 pairs of American participants speaking U.S. English.

Bangerter and Clark (2003) predefined three hierarchical levels within the tangram picture task based on what they termed goals and sub goals, they are listed below followed by a summary of the main findings at each of them:

A-Projects (Trials) (a complete set of 8 (Swiss German) or 12 (American) tangram pictures that were to be put in order). At this level words spoken at the start and end were analysed. American participants said the words 'okay' and 'all right' as the first word in 74% of the A-Projects and as the last word in 45% of them. Swiss participants said 'okay' at 10% of the start of the trials and at 43% of the end of them with little variation over the course of the experiment.

B-Projects (Identification of an individual tangram picture). Where words spoken at the end of each description were analysed. Within A-projects using new tangram pictures and American participants, these projects were ended with 'okay' 65% of the time, within A-Projects where participants used tangram pictures from previous tasks, B-Projects were ended with 'okay' 31% of the time. There was a decreasing trend of the use of 'okay' at end of B-Projects over the course of each 6 trials with the same set of tangram pictures.

C-Projects (Discussing features of an individual tangram picture). Where words used to end question and answer sequences about the features were analysed. The authors found that the

participants became familiar with the tangram pictures, they developed a strategy of naming them and that did not often discuss their specific features.

One of the main findings of this study was that participants often used the word 'Okay' for navigating into and out of predefined extended sub-projects but not for continuing on the same scale of project.

The nature of patterns of verbal behaviour presented in Bangerter and Clark's (2003) study suggest that patterns of behaviour within a pre-defined hierarchical multiscale activity may be observable and measurable. They also suggest that verbal behaviour produced different levels ordered within an inclusive hierarchy may occur as a as a function of the level of activity and it's functional relation to the other activities within the hierarchy. Verbal responses were measurable in this task due to their effect on the process of cooperation between the pairs to complete the multiscale activity.

Verbal responses as units of analysis have been studied in behaviour analysis as far back as 1955 when Verplanck conducted a study on the effect of reinforcement on the content of conversation between two people. The aim of this study was to test whether either i) statements of agreement or ii) paraphrasing would function as reinforcement to predefined verbal responses. In real world conversations lasting 30mins, researchers used either agreement or paraphrases contingent on statements of opinion being verbalised by an unknowing participant and whilst conducting the experiment, discreetly recorded the rate of statements of opinion which was seen to increase contingent on agreement. This study had many limitations; not only would not pass ethical guidelines today, it also had poor experimental control and as such it's results should not be viewed as reliable. However, it appears to be the first study based on the theory in which

verbal responses may be treated as any other operant behaviour, with it's reinforcing effects on the behaviour of a listener.

Skinner (1957) later refined the definition of verbal responses. He described verbal behaviour as being no different to any other operant response, apart from the fact that is it maintained and reinforced by the responses of a listener whom has been specifically trained in a similar verbal community. With regards to the use of a verbal response as a dependant variable Skinner stated that the conditions and events with which they occur under serve as the dependant variables. Verbal responses may form groups of operants when they have been reinforced in similar situations or are maintained by the same environmental variables. A group of verbal operants likely to be emitted in similar situations is referred to as a response class. By this distinction, what Bangerter and Clark (2003) refer to as different types of project markers used for certain transitions between activities may be referred to as different response classes, in that they serve similar functions in similar circumstances.

More recently, Simon and Baum (2017) discussed verbal responses from a molar perspective stating that as with any other operant behaviour, verbal behaviour entails choice and that human's talking occurs as a stream whereby functional units may vary in duration and as a function of the behaviour of a listener contingent on a specific response, but also contingent on other activities occurring at the time. As such, viewing verbal responses, not only in the context of immediate changes in the environment, but also in the context of the functional relation such changes in the environment may have on a multiscale activity occurring at that time may allow us to uncover lawful relations in verbal activities on a larger scale.

Treating verbal behaviour like any other operant behaviour, patterns may emerge in multiscale activities. Using a partial replication of Bangerter and Clark's (2003) tangram picture

task study, the aim of this descriptive experiment is to investigate whether verbal responses may be used to explore the MSB theories of multiscale activities whereby smaller scale stereotypical patterns of behaviour may be nested in larger scale activities in this context. This study will vary from Banger and Clark's (2003) study, whereby nine unique tangram pictures will be used for each trial. An additional nested level of activity will be added for the completion of each set of three tangram pictures.

From a theoretical perspective, each of the smaller scale nested activities that are functionally related to the completion of a tangram puzzle may be under the control of short term reinforcers; completion of one of the levels may be reinforced by the behaviour of the other participant. However, they may also vary along the functional relation of the nested activity to the multiscale activity. The multiscale activity used as unit of analysis here will be the completion of a tangram picture task. The multiscale activity of the completed tangram puzzle occurs only as an aggregate result of many behaviours performed over larger period of time. This may be theoretically and potentially empirically important because if we are to place human behaviour in a wider context and more coherent narrative, we may explore whether there are observable regularities of behaviour nested within multiscale activities. Each completed Tangram puzzle sheet may be viewed as the multiscale activity. The smaller scale activities nested within the hierarchy of the larger scale activity are both included and placed on the scale based on their functional relation to the larger scale activity and the final product of the completed tangram picture task.

One of the key defining features of any branch of behaviourism is that theoretical concepts ought to be properly tied to behavioural data (O'Donohue & Kitchener, 1998). Science seeks to uncover nature's truths, with investigations yielding knowledge at one of three levels of

understanding: description, prediction and control (Cooper, Heron and Heward, 2014). In order

for us to begin to understand the phenomenon of patterns nested behaviours beyond the

theoretical, systematic description with which observable behavioural events can be quantified,

classified and examined for possible relations with known facts should be our starting point. This

is an important activity for any scientific discipline (Cooper, Heron & Heward, 2014). Given the

starting point of this empirical study grounded in multiscale activities, it will be descriptive in

nature. Attempting to describe regularities and patterns of activities in a larger scale activity may

tell us more about their nature. Verbal responses will serve as dependant variables and levels of

the multiscale activity will serve as independent variable where verbal responses will be

analysed.

Research Question

Will patterns of verbal responses (dependant variable) be observable in a controlled

setting in which pairs of participants are asked to complete multiscale activities with smaller

scale tasks functionally related to the multiscale activity? There are eight independent variables

which are pre-defined levels of scale in the hierarchy of the multiscale activity as listed below.

Verbal responses occurring as beginning and ends of each level will be analysed. See figure 1 for

an example of a complete tangram picture task with each level of scale depicted. The occurrence

of each independent variable visually observable and are defined as.

Tangram Puzzle Sheet (Multiscale Activity)

Set of 3 Tangram Pictures (Nested Activity Level 1)

Individual Tangram Pictures (Nested Activity Level 2)

Components of a Tangram Picture (Nested Activity Level 3)

Method

Participants

Results from 12 Oslo high school students (six pairs), aged between 14-15 years old (seven females and five males) are included in this study. Participants were attending hour long behaviour analysis workshops as part of a two-day annual science fair at Oslo Metropolitan University and did not receive any payment in return for their participation. All high schools in Oslo were invited to the science fair and class teachers registered their class to attend different scientific workshops and seminars throughout the two days. The behaviour analysis workshops included an optional participation in this experiment. The workshop and experiment were open for everyone that registered to participate. An initial sample of 60 high school pupils and two high school teachers (31 pairs, 23 males and 39 females, aged between 14 – 27 years old) chose to participate in this experiment. All participants reported having no previous knowledge of behaviour analysis. Half of the participants reported having Norwegian as their first language. Three of these pairs of used their right to withdraw from the experiment prior to completion.

Inclusion and exclusion criteria.

The sample included in this study was based on multiple inclusion and exclusion criteria with the aim of reducing the impact of as many possible potential confounding variables in this initial descriptive study. Due to the nature of the sampling methods, the inclusion and exclusion criteria restrictions had to be imposed on the initial sample post experimental sessions.

Inclusion criteria.

The inclusion criteria required that both participants in the pair a) spoke fluent Norwegian. This was defined as; i) speaking only Norwegian throughout the experimental session and ii) reporting having Norwegian as a first language.

Exclusion criteria.

The exclusion criteria excluded pairs that a) violated the rules of the experiment, this was defined as; i) turning around in their seats during the experiment and / or ii) visually showing each other a solution. As well as, b) pairs that did not understand the instructions they received; defined as i) stopping the experiment to ask the experimenters questions and ii) not progressing further than competing trial D during the course of the experiment.

Setting and Apparatus

Experimental sessions were conducted in group study rooms at Oslo and Akershus Metropolitan University. Each room consisted of a large table (size?), a small table (size?), and three chairs. The large table was placed horizontally in the centre of the room against one of the walls. One chair was placed at the centre of this table, facing towards the same wall. Back to back with this chair, another chair was placed, facing the other wall. The small table was placed next to this chair. A birds-eye view representation of the experimental room set-up is presented in Figure 1.

Prior to the experiment, a total of 72 tangram pictures were created using INKSCAPE 0.92, downloaded onto Windows using a HP 14-bp060sa 14" Laptop. These Tangram pictures were used to make eight Tangram solution sheets (lettered A-H) and corresponding sets of nine Tangram picture cards (lettered A-H). Each Tangram solution sheet contained the same Tangram pictures as the corresponding lettered set of Tangram picture cards. Each of the 72 Tangram pictures created were randomly assigned to a set. The Tangram solution sheets were white A4 sheets of card, and the nine Tangram pictures were printed in colour in 'L' shaped groups of three in portrait orientation down the page (see Appendix A for a to scale example Tangram picture solution sheet). The positioning of the Tangram pictures across the page remained the same for

all solution sheets, although the Tangram pictures themselves were unique to each set. The

Tangram solution sheets were placed on the small table in the room, facing down, stacked in

order from A-H with their corresponding letter printed on the back. On the large table, in

ascending order from the top left corner were the eight sets of Tangram picture cards. Each set

contained nine picture cards, each of the nine picture cards consisted of one Tangram picture,

printed in the same size as on the Tangram solution sheets. The nine cards were shuffled into a

pile in a random order. Each set was placed in a deck facing down on a on a blank A4 card,

which was labelled with their set letter (A – H) printer centre on the top line of the page. Placed

below these were 9 pieces of blank A4 white paper.

     A Toshiba Camileo H20 video camera on a tripod was located in the middle right had

side of the table, statically directed towards the picture cards sets and blank pieces of paper on

the table. A chair for the experimenter was placed in the corner of the room.

Procedure

     Prior to the experimental sessions.

     Seven university students studying behaviour analysis were trained as research assistants

to conduct the experimental sessions. Up to seven experimental sessions were run parallel to

each other during the course of behaviour analysis workshops. Over the course of the two days, a

total of five classes of high school pupils, one class at a time, each accompanied by one or two

teachers entered a classroom in The Department for Behavioural Science and were welcomed to

the behaviour analysis workshop. As a class, they were first given a brief 10 minute introduction

to behaviour analysis as a field and then asked if they would like to participate in some research

at the department, looking at how people work together. They were told that they would receive

further instructions in the experimental rooms should they chose to participate and that they

could change their mind and leave the experiment to return to the classroom where their teacher would be waiting at any time. The pupils that volunteered to participate were from the same school class, thus known to one another, however they were randomly assigned into pairs. On two occurrences, there was an odd number of pupils that volunteered to participate, on both occasions one of the two teachers attending with the class also volunteered to participate. Each pair was randomly assigned a research assistant that took them to one of the seven experimental rooms. Each experimental room had the same set-up.

Experimental sessions.

Once inside the experimental room the two participants were each randomly assigned one of the two chairs placed back to back. The participant seated in the chair facing the large table was informed that they would work as the Matcher and participant seated in the other chair facing the other wall was told that they would work as the Director. They were informed that a recording would be made of both of their voices and the Matcher's hands on the table once they started the experiment at their consent. They then received consent forms and were asked if they had any questions about them before signing them. They were also verbally informed again that if they did not wish to participate in the experiment or wanted to leave the experiment at any time, they should return to the classroom where their teacher was waiting without needing to explain why they did not wish to participate. They were told that if they chose to do withdraw, or requested so at the end of the experiment, the recordings of their session would be erased.

Once the consent forms were signed the participants received an instruction sheet. The instructions told the participants that their goal was to complete as many sets of Tangram picture sets as accurately as they could within a maximum time of 30 minutes, when the experimenter would stop them. They were informed that they each eight sets of nine Tangram pictures labelled

A-H and that each of the Directors sets A-H contained the same pictures as the Matcher's corresponding sets and that completion of a Tangram picture set involved the Matcher placing their Tangram picture cards out on the blank pieces of card in the same order and position as they were on the Director's Tangram picture solutions for that set. They were told that when they thought they had the correct solution that the Matcher should cover it with one of the blank piece of white paper, move it to the side of the table and that they should then begin the next, working through the sets alphabetically, starting the next only after they finished the previous. The Matcher had the blank pieces of card and Tangram picture cards but could not see the Director's Tangram solutions. The Director had the Tangram picture solutions but could not see the Matcher's picture cards or cardboard sheets where they placed the picture cards. The participant's were seated back to back and were finally informed that they should neither turn around in their seats during the course of the experiment or visually show each other anything on their tables but that they should talk as they normally would to complete the task together. They were then asked if they had any questions, in which case the experimenter clarified the instructions. After this, they were told that if they were unsure of what do next during the course of the experiment that they should refer to their printed instruction sheet that they could keep with them through the course of the experiment.

The researcher then started the camera to record, sat on a chair in the corner of the room and started a 30 minute timer. Unless the pair had completed all sets before the 30 minutes were up, once 30 minutes had passed, the experimenter waited until the participant's had completed the current group of three Tangram pictures they were currently working on and then asked the participants to stop their task and then stopped the camera. The pairs were then asked to

complete a demographics form with questions on their age, gender, first language, local dialect and whether they participated in their session as the Matcher or Director.

Post experimental sessions.

Pairs were given the opportunity to review their solutions before returning to the main classroom together with the experimenter. Participants were given a de-briefing as a class in the classroom, describing the background and aims of the experiment. They were given time to ask any questions both about the experiment and behaviour analysis as a field.

Data Collection

Recordings of each experimental session were saved on an external hard drive and named according to the room number and pair number in the order they participated. The answers to the demographics forms were coded in Excel alongside the same room number and pair number. Each pair was then assessed based on the inclusion criteria. Recordings of the sessions of the pairs that fulfilled the inclusion criteria were assessed based on the exclusion criteria. The recordings of the experimental sessions of the pairs of participants that met the inclusion criteria but none of the exclusion criteria were transcribed for analysis. Transcription was created by connecting the external storage device to a HP 14-bp060sa 14" Laptop and playing recordings using Windows Media Player displayed on a HP Compaq LA2405wg 17" screen. Each session was transcribed in an individual word document and saved under pair number 1-6 after the random order they were transcribed. They shall from here on be referred to under these pair numbers. Initial transcriptions included; what each of the participants said throughout their experimental session, which was coded as being said by either the Director or Matcher, and the start time and completion time of the session, as well as the completion time of the Tangram picture sets (hereby referred to as trials).

Data Analysis

Each pair of participants were treated as a single case. Each transcription, alongside the corresponding video recording, was analysed alongside each repetition of each independent variable. The first and last word said on each level of activity was recorded and analysed both across scales of nested activity and across trials. Total word counts were made for words frequently spoken at each independent variable. This data was analysed for trends, level and variability both within and between subjects.

Interobserver Agreement

Given the novelty of assessing verbal responses over predefined scales, an emphasis on the importance of interobserver agreement was given. Data gathered from 50% of all sessions were assessed for interobserver agreement. A random selection of three of six of the single cases were in their entirety assessed by a second researcher. One independent researcher viewed the video recordings with un-coded transcriptions of data gathered from one pair, whilst another independent researcher viewed video recordings alongside the un-coded transcriptions of a further two pairs. The independent researchers were given the description of the dependant variables and asked to record the verbal responses occurring at each level of scale. These recordings where compared to the original recordings of the primary researcher.

An interobserver agreement ratio was then conducted using point-by-point agreement ratio (as described by Kazdin, 2011). Whether observers agree was assessed at each point in the process of the multiscale activity; determined by the description of the dependant variables. Where the two researchers had noted the same verbal response as occurring at one level, it was scored as agreement. Where researchers had noted different verbal responses as occurring at one level it was noted as disagreement. The total agreements were divided by the total number of

agreements plus the total number of disagreements and the total multiplied by 100. Mean

agreement coefficients all three pairs exceeded 80% (89%, 91% and 95%).

Results

A total of 25191 words were transcribed, with a mean word count per experimental

session 4199 (N=6; SD=446). During the course of six 30 minutes sessions, there was a total of;

34 replications of the start of the multiscale activity (MSA), 33 replications of the end of the

MSA, 100 replications of the start and end of nested activity 1 (NA1) and 300 replications of the

start and end of nested activity 2 (NA2). Furthermore, an additional analysis was conducted on

the start and end of a smaller scale – nested activity 3 (NA3). This was conducted on a random

selection of 50% of the pairs, of which there are 417 replications of the start and end. Number of

completed levels for each pair, along with total words spoken per session and total words spoken

per minute are presented in Table 1. Total words spoken per trial is presented in figure 2 and

time taken per trial is presented in figure 3. There is a visible deceasing trend in both words

spoken per trial and time taken per trial for all pairs.

Certain verbal responses occurred at the start of each of the activity levels. See table 2 for

a translation of these words from Norwegian to English. The most commonly occurring words at

the start and end of each level of activity were; "Ok", "Ja" (Yes, Yeah), "Også" (Also, As well)

or "Og så" (And then). The multiscale activity (N=34) was started with the word "Ok" 41% of

the time and "Ja" 29% of time. NA1 (N= 100) was started with the words "Også" or "Og så"

28% of the time and "Ok" 29% of time. NA2 (N=300) was started with the word "Også" or "Og

så" 49.3% of the time and NA 3 (N=417) was started with the word "Også" or "Og så" 61.1% of

the time. Other words spoken at the start of nested activity levels at a smaller percentage are

presented in Table 3. Figure 4 shows a strong visible increasing trend of "Også" or "Og så"

being spoken as the scale of the nested activity decreases followed by a weaker visible decreasing trend of "Ok" being spoken as the scale of the nested activity decreases; "Også" or "Og så" was spoken with a greater frequency as the scale of the nested levels of activity decreased with each pair and "Ok" was spoken at a smaller frequency as the scale of the nested activity decreased for most pairs.

The multiscale activity and each of the nested activity levels were all most frequently ended with the word "Ja" with little variability across activity levels. Percentages of words spoken at the end of each of the activity levels are presented in Table 4. Compared to it's normalised word count per 1000 words, "Ja" was spoken at a much higher frequency at the end of the trials. There was however, no visible increasing or decreasing trend of "Ja" being spoken either across trials or across activity scale. Figure 5 presents a trial by trial count of "Ja" being spoken at the end of NA2 in comparison to the normalised word count for "Ja". A mean normalised word count for each of the most commonly used words at the start and end of activity levels is presented in table 5.

Discussion

The aim of this study was to explore whether patterns of verbal responses were observable and measurable in a controlled setting in which pairs of participants are asked to complete multiscale activities with smaller scale tasks functionally related to the multiscale activity. Verbal responses as dependant variables occurring at eight independent variables of pre-defined levels of scale in the hierarchy of the multiscale activity were analysed. The verbal responses were analysed based on their frequency of occurrence at the start and end of each of the levels of scale. Trends across levels of scale were analysed. The results suggest that some

patterns of verbal responses were observable along the scale of the multiscale activity and it's

nested components.

 'Ok' was most frequently spoken at the start of the multiscale activity and there was a

decreasing the trend in the occurrence of 'okay' at the start of each level of activity as the scale

of the nested activity decreased. This was in contrast to 'også ' / 'og så' (and / and well) that

occurred frequently at the start of both NA2 and NA3 and showed an increasing trend as scale of

activity decreased. 'Ja' (yes) was the most frequently occurring verbal response at the end of the

multiscale activity and each of the nested activity. The occurrence of 'ja' (yes) was quite stable

across scales of activity and showed no increasing or decreasing trend. All pairs used both less

time and spoke less words over the course of the trials, however trends in verbal responses

occurring at the start and end of each level of scale showed no decreasing trend.

Bangerter and Clark (2003) also found that with their American participants that 'okay'

occurred most frequently at the start of what is defined in this study as the multiscale activity,

with a decreasing trend of 'okay' occurring at the lowest scale of activity they reported. Whilst

this may strength then current results in terms of the same verbal operant occurring at similar

levels of scale, it must be noted that Bangerter and Clark found the opposite use of 'okay' with

their Swiss German participants, where 'okay' occurred more frequently at the lower scale of

activity they reported and less frequently at the higher scales.

However, given the nature of the behaviour analysed; verbal behaviour we must also

consider Skinner's (1957) definition of verbal behaviour which is shaped in the verbal

communities it occurs. The verbal response 'okay' may have a different function in a Swiss

German speaking verbal community than it does in a Norwegian or American community.

Patterns in verbal responses have been observed across scale in a multiscale activity in three different verbal communities (American, Swiss German and American) giving the results a greater generalisability. This suggests that although topographically similar verbal responses may have different functions, patterns verbal responses based on their function may be observed within a multiscale activity.

This research suggests that multiscale activities may potentially be used as a means of prediction of behaviours and nested behaviours within them. However more exploratory research on the nature of patterns of behaviour within multiscale activities is first encouraged. Whether nested behaviours control behaviour has yet to be research and further research is encouraged using multiscale activities and scales of activities nested within as the independent variable in more lab research. It is not yet known whether patterns of other behaviour may be observable in a multiscale activity.

Cooper, Heron and Heward (2004, p.24) define predictability as "the systematic co-variation between two events". Thus, the higher probability one event occurs in proximity to another event, the greater the likelihood that one event will occur in proximity to the other in the future. This type of predictability alone however, only gives a correlational relationship. From a correlational relationship it is impossible to detect cause and effect relationships. This aim of this study was not to detect cause and effect relationships between levels of scale and verbal responses and it is important it is not interpreted as such. This is study begins a potential research base for exploring nested behaviours from a multiscale perspective and describes patterns of behaviour that occur at several pre defined scales and is the first attempt to measure patterns of behaviour from such a perspective, in an attempt to explore whether it was possible to measure patterns of behaviour on such a scale.

It is worth nothing that in behaviour analysis as a process of cooperation is often analysed as an interlocking behavioural contingency and described as the third level of selection (Glenn, 1988). During the process of cooperation the behaviour of one individual serves as a stimulus for a response in the behaviour of another individual which in turn serves as stimulus for a response from another individual. The effect on the environment occurring as a result of an interlocking behavioural contingency is referred to as an aggregate product. An aggregate product is something that could not have been achieved through the behaviour of one person alone and is a result of the interlocking behavioural contingencies of more than one person (Carvalho & Sandaker, 2016). The pairs of participants cooperating to produce a completed tangram picture task in this study may be viewed as in interlocking behavioural contingency. The aim of this study was not to analyse interlocking behavioural contingency as units of analysis themselves, but to analyse the verbal responses produced by the individuals in the process of their interlocking behaviour, necessary to complete the tangram picture task in the form of a multiscale activity.

This study had some limitations, such as in order to minimise confounding variables in this initial descriptive study included a strict inclusion and exclusion criteria was implanted. This resulted in a large reduction in the initial sample size as many participants did not report having Norwegian as their first language. Several pairs were excluded as they did not understand the instructions. Future replications of this study are encouraged to either use the first trial as a training trial or visually show both participants an example of a completed tangram sheet before beginning the experiment.

Given that results were achieved using human observation, human error may be the greatest threat to reliability of these results. However, the transcriptions were analysed alongside

video recordings of The Matcher's hands completing the puzzle so that physical markers of completion of a level of scale were visible. Video recordings of the sessions also allowed for multiple viewings of the sessions where necessary and a high IOA from 2 other researchers on 2 different samples of the data was found.

With voice recognition technology evolving, future research may make use of such technology. Voice recognition technology may soon give reliable transcriptions of experimental sessions and analyse patterns of verbal responses in the data. These patterns may be assessed for stereotypy or correlation to other data based on activity scales that may be inputted directly into a computer, such as pressing buttons to complete a puzzle on multiple scales. This would remove any chance for researcher bias based on the verbal responses and the researchers' learning history with the verbal responses. The extent to which activities may be scaled up have yet to be analysed. A puzzle may be deemed a relatively small multiscale activity from the perspective of placing behaviours in a more fluid and coherent narrative, however this research suggests that patterns of behaviour within a multiscale activity may be both measurable and observable.

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Table 1

Number of completed multiscale activities (MSA) and nested activities (NA2, NA3) per pair

alongside total words spoken per experimental session and words spoken per minute

Pair Number	MSA	NA 2	NA3	Total Words	Per Min
1	7	21	63	4315	180.4
2	5	15	45	4753	147.4
3	5	15	45	4336	132.5
4	6	18	54	3418	114.5
5	6	18	54	4332	134.7
6	4	13	39	4037	133.4
Total	33	100	300	25191	-

Table 2

Translation of Norwegian words to English words

Norwegian Word Spoken	English Translation
Ok	Ok
Ja	Yes
Også (Og / Så)	Also (And, As well)
Jepp	Yep
Sånn	There, Like, Then
Yes	Yes
Da	Then
Den (Det / Denne)	The, That, This
Mhm	Mhm
Mmm	Mmm

Table 3

Percentage of activity levels that were started with each marker word for the multiscale activity (MSA) and each of the nested activities (NA1, NA2, NA3). Percentages have been rounded to the nearest 1%

Marker Word	MSA (N=34)	NA1 (N=100)	NA 2 (N=300)	NA 3 (N=417)
Ok	41%	28%	17.3%	5.3%
Ja	29%	18%	11.7%	3.6%
Også (Og/så)	3%	29%	49.3%	61.1%
Sånn	6%	2%	-	0.4%
Da	9%	3%	1.0%	0.2%
Yes	3%	-	-	-
Den(Det/Denne)	-	10%	9.0%	10.4%
Other	9%	10%	12.7%	18.9%

Table 4

Percentage of activity levels that were ended with each marker word analysed for the multiscale activity (MSA) and each of the nested activities (NA1, NA2, NA3). Percentages have been rounded to the nearest 1%

Marker Word	MSA (N=33)	NA1 (N=100)	NA2 (N=300)	NA 3 (N=417)
Ok	6%	18%	18.3%	12.7%
Ja	64%	72%	72.3%	70.3%
Jepp	6%	4%	2.7%	2.6%
Sånn	9%	3%	0.3%	-
Yes	3%	-	0.3%	0.5%
Mhm	-	1%	2.3%	9.6%
Other	12%	2%	3.7%	8.2%

Table 5

Mean normalised word count (occurrence per 1000 words) for the most commonly used marker

words for all pairs throughout each experimental session

Marker Word	M	SD
Ja	63.7	21.5
Ok	19.1	10.6
Også	70.3	20.8
Mhm	2.5	3.3
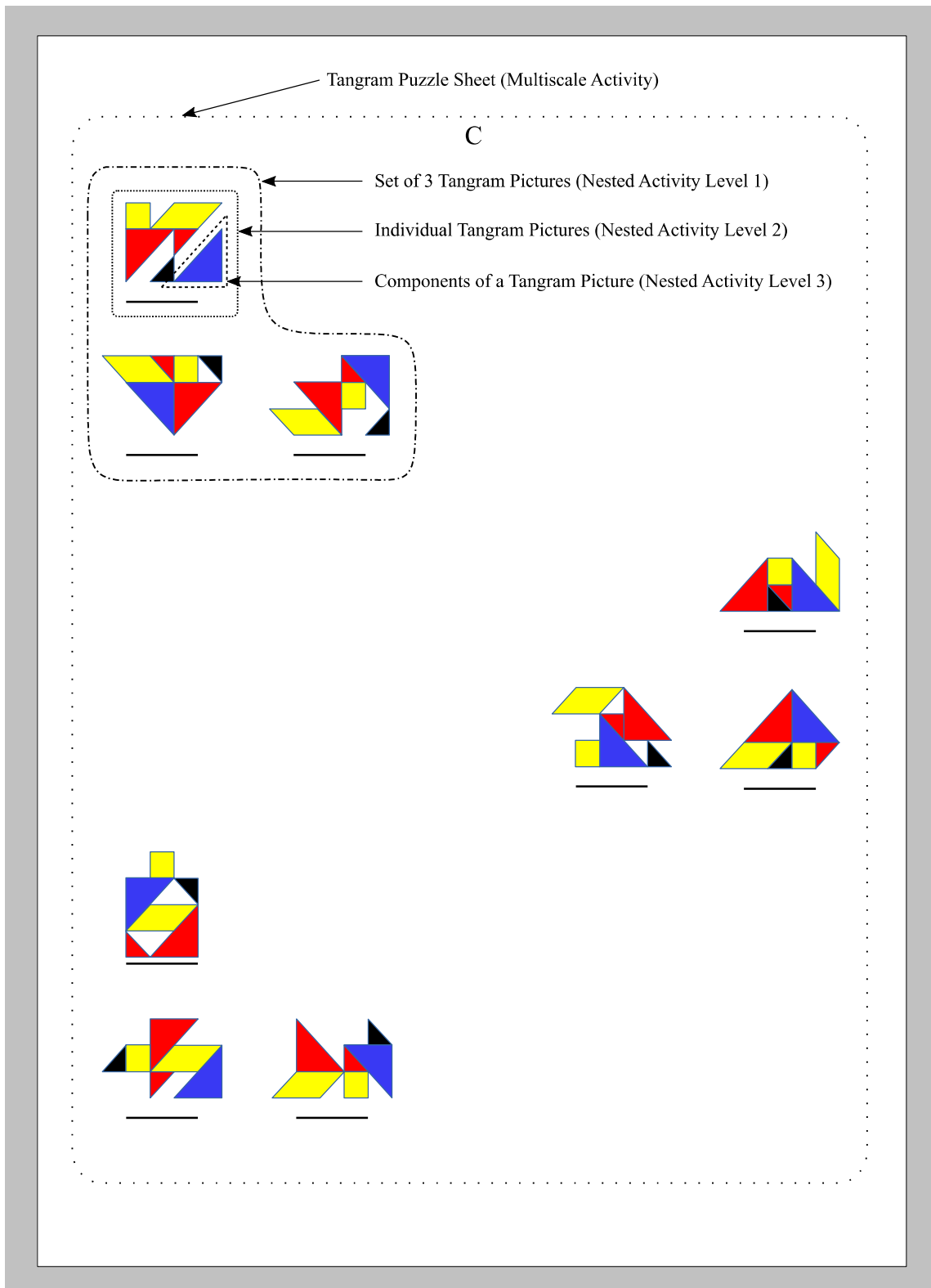
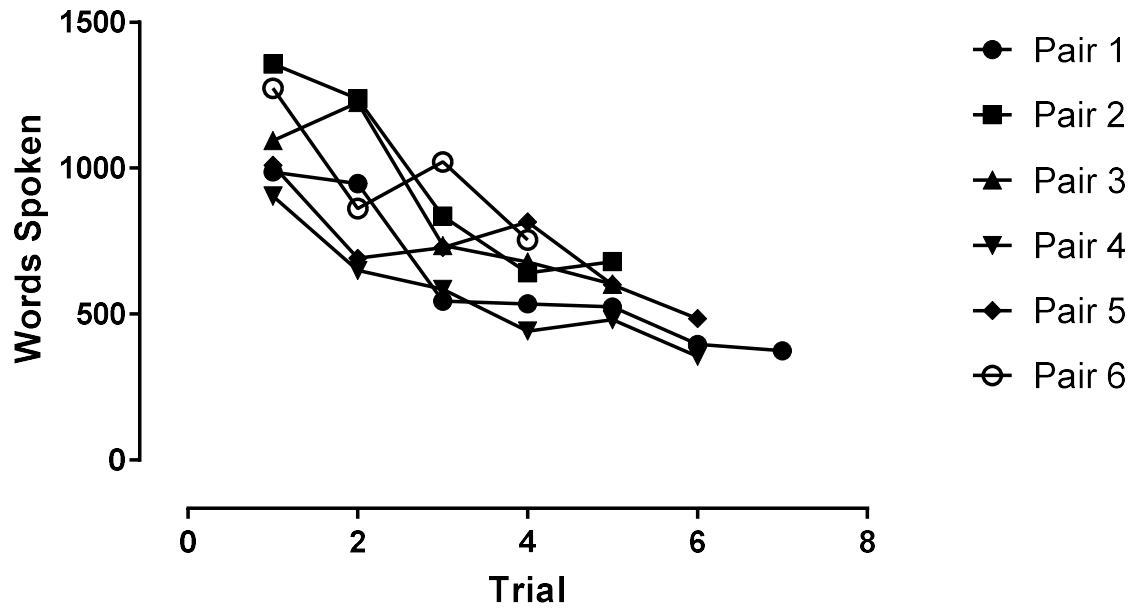*Figure 1*. Example Tangram Picture Solution with pre-defined nested activity levels inserted.

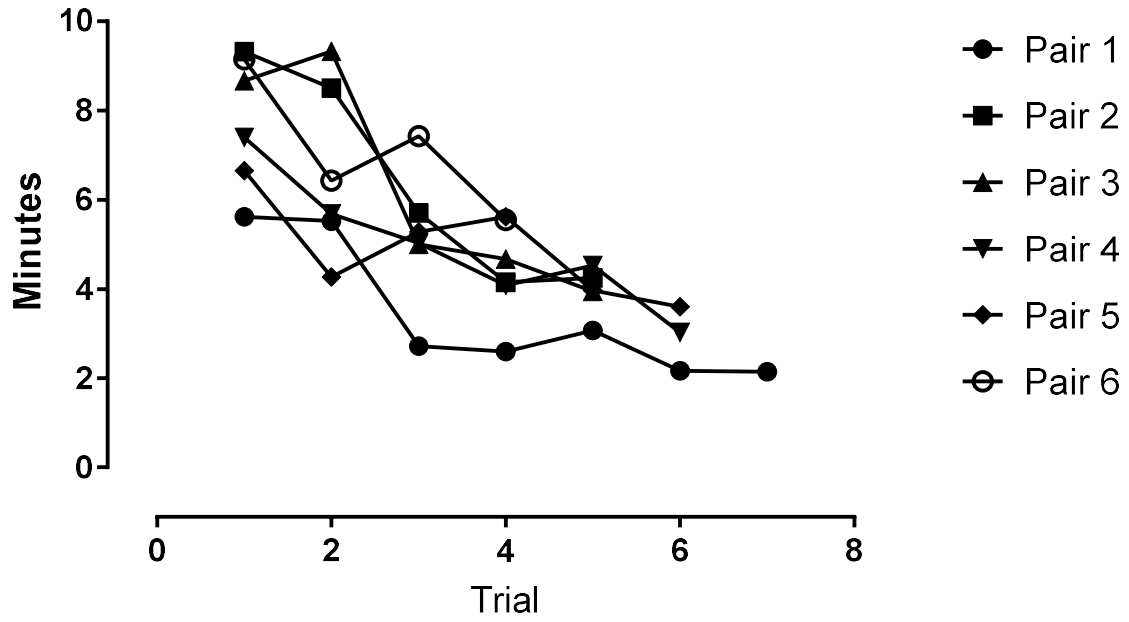*Figure 2*. Total words spoken per trial for each pair of participants.

Figure 3. Time in minutes taken to complete each trial for each pair.
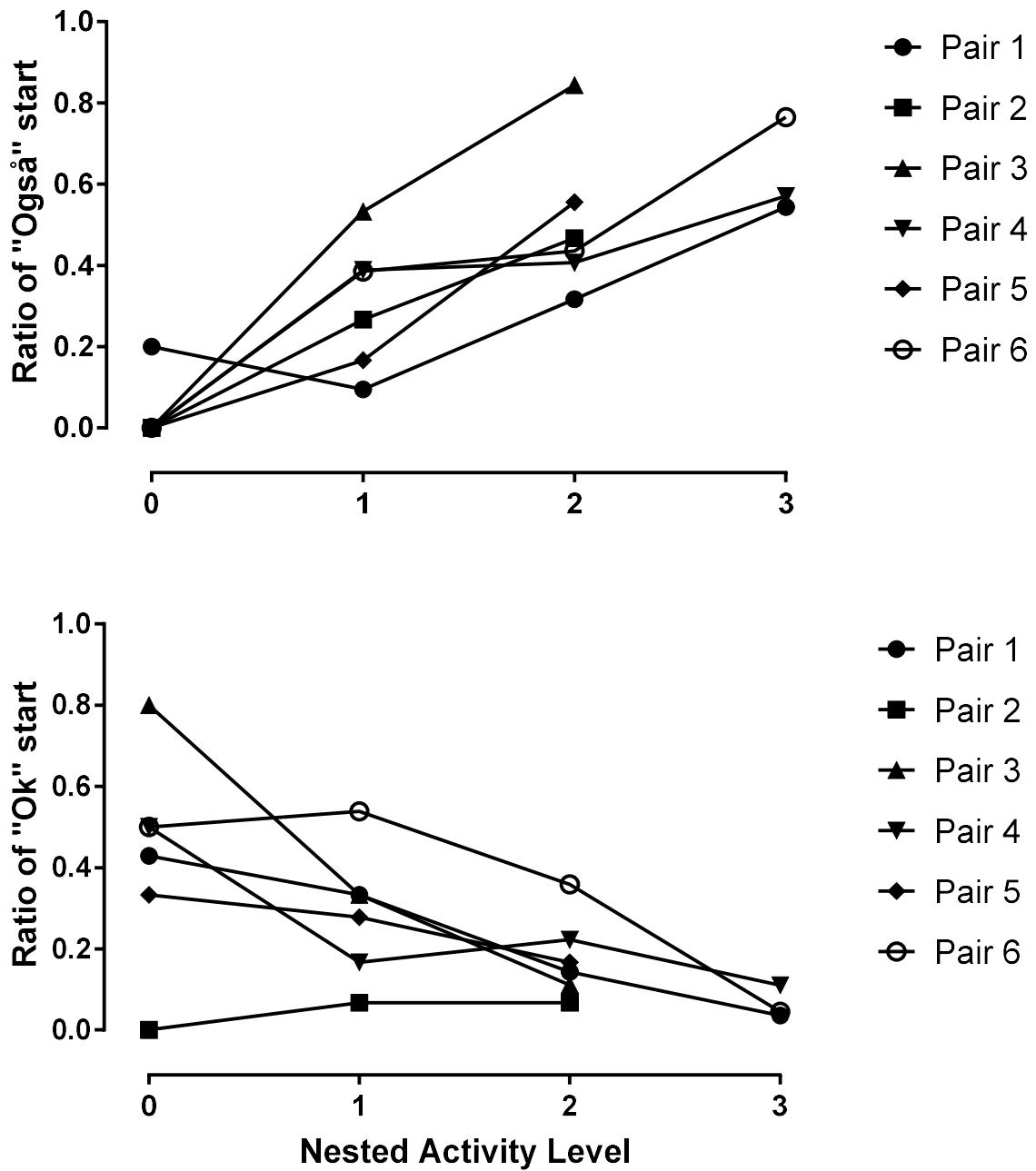
Figure 4. Percentages of the different scales of activity (presented in ratios) that began with the word "Også" and "Ok" for each pair. (0 = MSA, 1=NA1, 2=NA2 and 3=NA3).
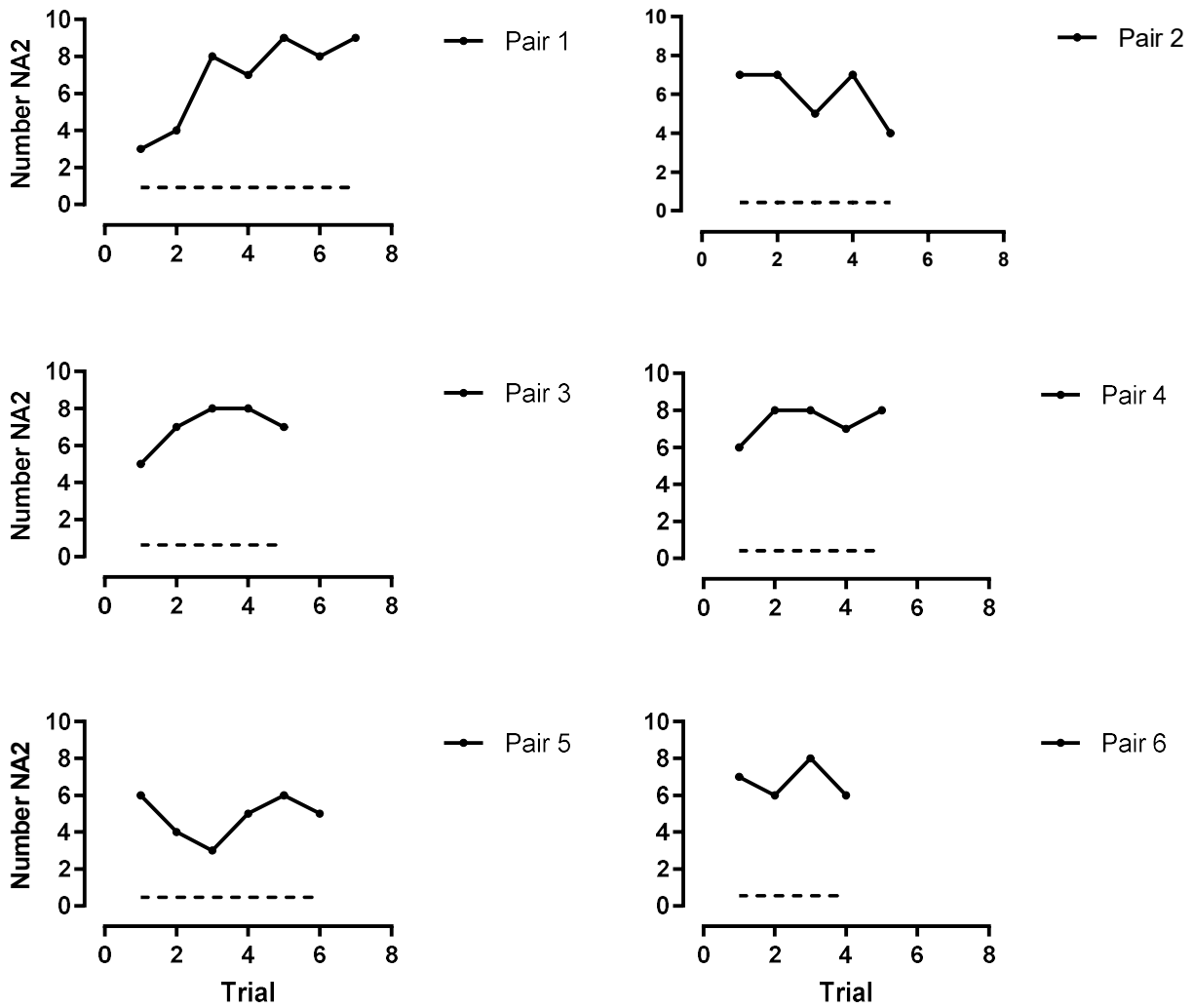
Figure 5. Trial by trial count of nested activity 2s (NA2) ending with "Ja". The dotted line represents the normalised "Ja" count per 1000 words.