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An ecological method for the sampling of nonverbal signalling behaviours of young children with profound and multiple learning disabilities (PMLD)

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Abstract

Background: Profound and multiple learning disabilities (PMLD) are a complex range of disabilities that affect the general health and wellbeing of the individual and their capacity to interact and learn.

Method: We developed a new methodology to capture the nonsymbolic signalling behaviours of children with PMLD within the context of a face-to-face interaction with a caregiver to provide analysis at a micro-level of descriptive detail incorporating the use of the ELAN digital video software.

Conclusion: The signalling behaviours of participants in a natural, everyday interaction can be better understood with the use of this innovation in methodology, which is predicated on the ecology of communication. Recognition of the developmental ability of the participants is an integral factor within that ecology. The method presented establishes an advanced account of the modalities through which a child affected by PMLD is able to communicate.

1. Introduction

A significant barrier to the establishment of a shared understanding between a person with profound and multiple learning disabilities (PMLD) and a caregiver is the inability of the caregiver to comprehend the significance that should be attached to the nonconventional forms of behaviour that are frequently realised by the person with PMLD [1]. Individual's affected by profound and multiple developmental compromise are immobile or have severely restricted mobility and are subject to profound and multiple sensory impairment in combination with profound intellectual impairment. Their capacity to perceive and act upon the interactive situation about them is significantly and severely diminished.

These individuals have complex developmental trajectories. Individuals affected by PMLD remain at a very early stage of development for a prolonged period of time, if not a lifetime. Many individuals with PMLD are unable to produce any clear and consistent signals contingent upon an ongoing real-time interactional situation. They are therefore unable to produce conventional gestures or vocalisations that may serve to communicate a particular need to a caregiver. For example, many such individuals are unable to nod or shake their head, offer a signal of joint reference such as a point or shift in eye gaze, push objects away or grasp objects towards them, shift their body position, or produce conventional affective vocalisations.

Caregivers who have a long term interactional experience with a child with PMLD are often able to intuitively register the response of a child consequent of some form of stimulation. The key point is that the interaction exists precisely because the caregiver considers the child to be a communicator. Our approach is about objectively capturing the movement data that has potential association with a child's response to an interactive situation. Our aim in the present paper is to establish a methodological approach that is motivated by the limitation of

caregivers to explicitly identify fleeting and variable signals indicative of a child's affective response to an interactional situation.

The demonstrative behaviours frequently associated with a person with PMLD are often subtle and fleeting and as such difficult to observe, identify and capture. In this circumstance, any research method employed to examine such modalities of behaviour must be able to realise data that possesses determined objectivity and provides the opportunity for micro-level analysis of all those behaviours which comprise the interaction.

The ecological validity of the methods used to capture behavioural data has not been a typical concern for much of the contemporary research in the communicative behaviours of children with PMLD. We argue that by taking into account the fact that the child/caregiver dyad arises within everyday, naturally occurring interactional situations in which real purpose, both functional and emotional, underpins the motivation for their interaction the research paradigm will be improved. This move will satisfy Neisser's [2] principle of ecological validity as underpinning best practice in behavioural research; a notion also reflected in the work of Bronfenbrenner [3] and Bruner [4, 5].

Foundational research into the communicative signalling of individuals affected by severe and profound and intellectual impairments employed standardised communicative assessment techniques. These were predicated on the participants' ability either to verbalise or produce consistent behaviours such as pointing or head movements [for example, 6, 7-9]. Such strategies have also been applied for children with autism [for example, 10, 11, 12]. These approaches are focused upon the apprehension of a nonsymbolic signal's function or purpose and based on the ability to detect clear and consistent behaviours consummate with those behaviours that signal intentionality.

Consequent to advances in paediatric medicine over recent decades a new group of even more severely impaired children are surviving through the neo-natal period and entering the

social realms of community and education [13]. This population requires a novel approach to social and communicative engagement which can address their inability to produce any clear and consistent verbal or motor signal. It is precisely this absence of transparency in their signalling repertoire that makes the previous functional approaches unviable with the particular population of children with PMLD as defined here [14, 15]. The development of our new approach was motivated by the needs of this novel group which could not be served by existing methods. Furthermore, we argue that consequent of the profound degree of comorbidity the child's capacity to consider the world about them will be primarily in terms of their immediate motor and affective configuration [14]. It is therefore extremely difficult to identify the relation between the child with PMLD's signalling behaviour and the social context in which it arises unless attention is brought to bear upon the affective qualities that underpin the child's response.

The theoretical perspective that we have developed places value on the affective qualities that underpin the behavioural expression precisely because it acknowledges that a child with PMLD who is at an extremely early stage of development will respond affectively rather than functionally. Previous approaches to this issue did not take into account the affective stance of the child because they have defined an intentional communicative act within a functional paradigm which is adequate for investigating children with less severe compromise. The children we have been working with who have more severe and complex comorbidity present new challenges that cannot be addressed through methods used previously because such children are not yet able to produce such clearly recognisable signalling repertoires.

We present a novel research design which was expressly developed to capture behavioural data at a micro-level of description. The virtue of this new approach is that it recognises the ecology, both developmentally and situationally, of the interaction between the person with PMLD and caregiver and thus affords the opportunity to construct an account of the child's

ability to communicate. We argue that this new theoretically motivated methodology can be successfully employed to address key research questions regarding nonsymbolic signalling behaviour. A more detailed formulation of our theoretical argumentation regarding nonsymbolic signalling viewed as intentional communication has been presented separately [14]. This method of investigating nonsymbolic communication has been trialled on a typically developing infant and applied to a small number of participants with PMLD [16].

2. Profound and multiple learning disabilities (PMLD)

Individuals with profound and multiple learning disabilities will have a complex range of disabilities of an organic aetiology that affect their general health and wellbeing and their capacity to interact and learn [17-19]. These include multi-sensory impairment and limited or extremely limited mobility in combination with profound intellectual impairment and extremely limited communication skills [18, 20]. Individuals with PMLD are subject to low levels of behavioural state (degree of alertness) [19]. The degree of comorbidity present frequently includes autism, additional neurological factors such as epilepsy, and debilitating medical conditions giving rise to a complex range of health needs and/or mental health difficulties that result in challenging personal and interpersonal behaviours and high levels of personal support to manage daily needs [18-21] It is suggested that individuals with PMLD will have an IQ score of below 20 [22]. In line with Ware [19], the term PMLD will be used owing to its wide acceptance within educational circles in Britain.

Given the profound levels of comorbidity present there are significant difficulties when seeking to describe an individual's communication abilities. This is primarily due to the inability of an individual with PMLD to produce clear and consistent signals, such as head, facial, limb or body movements or vocalisations, contingent upon the ongoing interaction. Additionally, owing to the heterogeneity present within this population only a small number

of studies have sought to describe the potential signalling behaviours made evident by children with PMLD.

3. Nonconventional nonsymbolic communication

We argue that a shift in the conceptualisation of the communicative paradigm is required in order to expand our means of interacting with individuals affected by PMLD. This new approach places the focus upon the processes underpinning an interaction as against the behavioural forms that are employed within it [14]. This shift was recognised by Siegel-Causey and Downing [23], who advocated the paradigm of nonconventional nonsymbolic communication, and by strategies advocated within the socially mediated pedagogies of Intensive Interaction [24-26] and Responsive Environments [27].

Underpinning the paradigm of nonconventional nonsymbolic communication is the view that individuals with profound intellectual, sensory and motor impairments are able to communicate via the modality of nonconventional nonsymbolic behaviours [23, 28, 29]. These behaviours include the use of gestures, vocal sounds, eye-gaze, touch, posture, body movements and facial expressions all of which have the potential to convey a message to a social partner [28, 29]. Nonconventional nonsymbolic communicative signals are therefore highly context dependent, and significantly determined by the sender's behavioural and perceptual state [30]. The socially mediated pedagogical approaches are predicated upon the recognition that early interaction and learning take place in a dynamic social context. Within this context the child is considered an active and competent participant and the caregiver attributes meaning and intent to the behaviours and responses of the child that arise as a consequence of their joint participation within the interactional situation [26, 27]. This is an approach that is typified within the majority of infant/caregiver interactions [4, 5, 31, 32].

A caregiver must therefore become sufficiently sensitised to the child's personal vocabulary of actions in order to recognise a signal and respond contingently. This requires the caregiver to determine those signals with communicative potential from displacements of a reflexive or self-stimulatory nature.

4. Current methods of behavioural sampling

The Affective Communication Assessment (ACA) [33] was devised as a probe to support and inform appropriate intervention strategies for a child with profound and multiple learning needs by recording the responses of the child contiguous with an interaction with a particular entity (for example: contact with warm water, or hearing a piece of music, etc.). The ACA focuses upon seven aspects of behaviour (vocalisation, facial expression, body proximity, eye contact and orientation of visual regard, physical contact, imitation, and turn-taking) to which one of four potential interpretations are attributed: like, dislike, want and reject. In a separate study, Olsson [34] established data drawn from interactions within regularly occurring classroom-based discourse between a child affected by PMLD and his caregiver. Olsson then repeatedly reviewed the film taken of each interaction in order to afford a transcription of the sequential behaviours made evident by both the child and the caregiver. The analysis sought to determine the nature of the communication strategies employed within each dyad in order to establish a basis for dyad-specific intervention.

We acknowledge that both of these approaches do provide the opportunity to establish a data-set pertinent to each individual child, for example by noting a change in facial expression or a change in the rate of activity or movement of a particular body part, such as the mouth, eyes, or hands. However, there is a limitation in the degree of precision in the data capture with respect to the contribution of the child with PMLD to the interaction as a whole when employing such approaches.

For example, in Coupe O'Kane and Goldbart's [33] study, Matthew, a twelve year-old male child with PMLD, was presented with 17 different entities (including, soft jazz, salad cream, a tickle) on a single day; Louise, a six year-old female child with PMLD, was presented with a similar and numerous diverse range of characteristics. In these case reports there is very limited detail provided pertaining to the exact context in which the probe was conducted. The omission of contextual information in these investigations restricts the utility of such observations for determining whether a response arose owing to an association with the entity or as an artefact such as fatigue, over-stimulation or confusion.

The recording of limited observational detail gives rise to ambiguity of interpretation. For example, Coupe O'Kane and Goldbart [33] simply reported that finger activity increased during a period of interaction. However, details of import such as which fingers moved, what the movements were, how they corresponded to movement in other parts of the child's body, or how this figured within the scheme of the interaction were not provided. Similarly, Olsson [34] reported indeterminate observations such as the child 'moves the hands slightly' and 'makes movements with the mouth (e.g., chewing)' (p. 240).

Common within each of these approaches is the attribution of particular emotional states and inclusion of other types of subjective judgements. For example, Coupe O'Kane and Golbart [33] record behaviours such as 'look of pleasure' and 'nice moan' (p. 17), whilst Olsson [34] states the child 'Turns head strongly' (p. 240). These subjective descriptors are of limited utility in determining the nature of such behavioural responses with robustness or precision.

In studies by Bruce and Vargas [35], Iacono and colleagues [15], and in the nonconventional nonsymbolic communication literature [for example, 23, 28, 29, 30, 36, 37] concerning the identification of intentional communicative acts manifested by children with severe disabilities there have been efforts to determine behavioural typologies, but these are weakened by the limited detail in the recording of the actual behaviours that afford such

attribution. Whilst the caregiver's sensitivity and responsiveness to the child's behaviours are acknowledged to be of paramount importance, there is a paucity of means for obtaining objective and reliable methods of capturing the behaviours which the caregiver might attend to in interacting with a child with PMLD.

We are not suggesting that such behaviours have not been catalogued, but rather that the level of descriptive detail gained by previous methods cannot provide an adequate description of the actual behaviours manifested by the child within the context of a real-time interactional situation. Current observational research and assessment procedures typically overlook the significance of providing contextual coherence in the sampling and recording of communicative events. While these approaches reflect a child-centred observational paradigm they cannot extend to provide a more fundamental account as to how and why the child is capable of engaging in an interaction experience with a caregiver.

Our position is that the methodology applied to the capture of behavioural data must take into account the ecology of the interactional situation in both its developmental and environmental contexts. We suggest it is necessary to consider both the mental state of the child - a state predicated upon both genotypical and phenotypical factors - and the dynamic nature of the interaction, in respect of how the interactional situation is likely to be both perceived and acted upon by the child. To ensure ecological validity, the child's signalling behaviours must be captured amidst his participation within a natural, everyday face-to-face interaction with a caregiver. To achieve these research aims this approach would require a process that realises a data-set that is objective, internally consistent and operates at a micro-level of descriptive detail if it is to be successful in capturing the subtle and often fleeting demonstrative behaviours expressed by a person with PMLD as is described here.

5. An ecological approach towards empirical research design

Of particular bearing upon the empirical examination of the behavioural repertoire of a child affected by PMLD is that the child's participation in such interactions is likely to be mediated at a nonverbal level of activity. Being nonsymbolic, the relationship between any particular signalling behaviour and its referent can only be established through reference to the situational context. We suggest that in order to examine the signalling behaviours that arise within a real meaningful interaction one must adopt an approach that fully addresses the interactional context [14]. Such a research design will need to draw upon the principles advocated within the methodology of participant-observation. Furthermore, it is expected that the behaviours will be particular to each individual child, necessitating the identification of an idiosyncratic sign-referent relation. Each case must be considered unique. This approach will necessitate a research paradigm that facilitates a descriptive account of the behavioural repertoire of the child, and thus the use of qualitative analysis.

When the subject of inquiry are individuals subject to profound and multiple comorbid conditions in which variable response to stimulation is prevalent an experimental approach which requires group homogeneity and controls for artefacts is untenable. In previous research, as reviewed above, the assessment of intentional communication based upon a signal's functionality within a paradigm of typical communicative trajectory was a successful methodological approach. This was due to the fact that many of the participants were able to produce consistent verbalisations and/or gestures. Given this circumstance, these approaches had little need to take into consideration regard for ecological validity. A shift in approach is required in order to explore and understand the potential for social interaction with this novel group of children who have even more severe developmental compromise and complex trajectories. The observational demands presented by this novel group of children are the motivation for the innovation in methodology we detail below.

6. A new theoretical approach towards intentional communication

The severity of an aetiology affecting a child's central nervous system will fundamentally determine the manner by which they are able to interact with their environment [38-46]. The vast majority of individuals affected by PMLD function at an extremely early stage of development. This is particularly so in the case of young children with PMLD who will be functioning at the very early stages in their acquisition of schema, shared attention and the formation of vehicles of expression. There is therefore an inherent difficulty in determining those behaviours realised by a child affected by PMLD that qualify as being intentionally communicative [15, 47]. To make progress with this issue requires an understanding of how the notion of intentionality must change in accord with a child's developmental state [14]. Reflecting the position established by Duranti [48-50], we consider the formulation of intentionality as 'aboutness' is best suited to the consideration of the particular constraints on behaviour experienced by children with PMLD [14]: it is about the manner by which the child directs, or comports, themself towards something. The more refined the relation between a child's activity and the surrounding context so the more definitive the interpretation. Hence, in order to establish the intentionality of a child with PMLD consideration must be given to the effect of compromise in their motor and perceptual abilities and the subsequent impact on their experiencing of the world and their ability to act upon it.

To account for the effect of everyday activity upon a child's ability to interact with the world about them requires recognition of the whole child in both their genotypical and phenotypical contexts. This position is recognised in the work of Werner [51] and Schilder [52, 53] who argue that within the earlier stages of development a child will consider their world primarily in terms of its immediate motor and affective configuration. Inherent to this configuration is a

lability of percept and a rigidity in behavioural response or attitude. Hence, only as a consequence of sufficient development in mental structures will the child come to establish an increasingly stabilised view of the world together with a more adaptable response [51-53]. For a child with PMLD the experience of the world about them will typically remain proximal to their organism, and consequently the manifestation of a vehicle of expression will predominantly arise owing to the effect upon the child's organism of their activity [14, 32]. We suggest this vehicle will be realised across the child's organism, resulting in an array of behavioural forms. Given that such forms appear as a potential response to a particular stimulus, it may be presumed that their multiplicity must give rise to a gestalt configuration imbued with motile and affective qualities to which a singular gloss may be assigned [14].

7. An ecologically valid means of sampling behavioural data

We consider the context of an everyday, naturally occurring interactional situation involving a young child affected by PMLD, a caregiver and a shared object or event. In such interactions, the manifestation of a nonsymbolic vehicle of referential expression by the child will predominantly arise consequent of the effect of a stimulus upon the child's organism [14]. This expression is likely to be idiosyncratic, nonconventional and realised by an array of behavioural forms. The objective of analysing such behaviours as they arise in an interactional context is to provide descriptions of gestalt behavioural configurations imbued with motile and affective qualities; the goal is to use these to infer a singular gloss [16].

To this end we have identified two levels of behaviour, or activity, which require description: the first, at a micro-level, corresponding to the individual behavioural forms that contribute towards the configuration, and the second, at a macro-level, corresponding to the singular interpretant that is inferred. The objective is to determine the micro-level behaviour, its

relation to the interval, the configuration of the vehicle of expression, and the gloss inferred to the configuration.

Previously, within the nonverbal behaviour literature Condon and Ogston [54] have addressed a similar methodological problem. They suggest that in order to realise the relations between a person's behaviour coincident with a naturally occurring interactional situation it is necessary to find 'an empirical, decisional basis for the analysis of an ongoing process across the multiple and interlocking levels of that process as it occurs naturally' (p. 222). Their solution was to film the interactional situation and deploy a micro-analysis to the sound-film data. Condon and Ogston [54] suggest that their solution 'enabled a more precise and accurate analysis of the micro pattern of body motion changes in relation to the segmental pattern of speech' (p. 227). Furthermore, where observational data is held within a video-based format, the original data source may readily be made available for further scrutiny and/or external validation: a significant advantage over descriptions drawn purely from written observational records in relation to the analysis of nonsymbolic signalling behaviour [for example, 43, 44].

The strategy adopted by Condon and Ogston [54] and many others [for example, 55, 56-58] is successful due to the relation between nonverbal and verbal behaviours produced by an individual who is capable of symbolic forms of communication. In employing a micro-level of analysis to the nonverbal behaviours of an infant whilst engaged within an infant/caregiver dyadic interaction, Condon and Sander's approach [59] illustrates the applicability of such data generation to a population functioning at a nonsymbolic level; a factor also recognised by Feldman [60, 61].

The application of such methods to the study of the signalling behaviours of children with PMLD as described here requires an original design that realises sufficient precision to account for the nonconventional nature of their behaviours.

8. The selection of an ecologically valid sign-referent relation

We suggest that the selection of a particular sign-referent relation for the purposes of empirically examining the capacity of a child to effect a communicative act must bear relevance to the child's mental state. To account for a child affected by PMLD this selection must be predicated upon the consequence of affective experiences upon a child at an extremely early stage of development. It is therefore necessary to establish a clear understanding of exactly what those affective experiences will be.

A dichotomous relationship exists between the human organism and the external world: essentially, those things that are found to be satisfying are accepted, whilst those found dissatisfying are rejected [31, 52, 53]. Satisfaction, the feeling of pleasure, is the condition or sensation induced by the experience or anticipation of what is felt to be desirable; its inverse, dissatisfaction, is the feeling of unpleasure. Two states of being are considered to exist in the earliest stages of human development: quiescence or unpleasure [31, 52, 53]. The notion of that which constitutes pleasure undergoes a change in accord with the developing orientation towards the immediate environment [31]. It is primarily the iterative process of need-gratification and frustration-avoidance recurring within regularly experienced circumstances giving rise to affectively invested experiences that Spitz [31] suggests is fundamental to ontogenetic progression. From a state in which the satiation of interoceptive stimulation acts as a fundamental driver to react in order to maintain quiescence, the individual develops towards a state in which need-gratification is mediated via action upon exteroceptive stimulation.

Frustration serves to drive the individual in this early stage of development to act upon the immediate surroundings [31]. Their ability to signal negation is indicative of the ability to perceive particular qualities inherent to the immediate situation, to recognise the

dissatisfaction encountered, and seek distance from it. To maintain a particular activity suggests an ability to recognise the satisfaction that is gained from the encounter, and to act to maintain it. To negate is indicative of a sense of dissatisfaction, to affirm is to indicate satisfaction.

The ability either to accept or reject a situation is predicated upon the capacity of the individual to act upon the situation at hand; a capacity fundamentally predicated upon their affective, or behavioural, state at that moment. The degrees of alertness and involvement of a person with PMLD are acknowledged to be subject to particular compromise and inconstancy [19, 38, 39, 43, 62, 63]. However, the work of Munde and colleagues [44] and Guess and colleagues [42] suggests that the realised activity of any individual upon the immediate situation may be taken as indicative of the individual's behavioural state at that time: essentially, a lack of response suggests a low behavioural state level, an active response is suggestive of higher levels.

Our interest, like that of the caregiver, is in identifying those behaviours that correspond with an active orientation towards the interaction. We argue that these behaviours are indicative of the child's behavioural state at that moment and their affective response to what they have perceived, suggestive therefore of the child's intent within the context of the interaction [14]. Within a child/caregiver interaction, of import is the ability of the caregiver to distinguish those signals with communicative potential from those displacements that arise consequent of reflexive or self-stimulatory activity. In other words, the caregiver needs to distinguish the behaviours that are oriented towards the interaction, that are intentional, from those that are involuntary, or unintentional.

At an early developmental stage the polar relations of negation and affirmation are congruent with the affective states of dissatisfaction and satisfaction. By taking intentionality to be about a person's comportment towards something we propose that the behaviours manifested

by the individual in response to a stimulus that provokes either of these states may be attributed with the particular gloss ‘again’. Crucially, such activity requires only that the child is capable of responding affectively: no higher order cognitive processes, such as those associated with symbolic signalling behaviours, are prerequisite [14].

9. Defining the ‘again’-gloss

Our gloss of ‘again’ incorporates both the term ‘again’ and its inverse ‘not again’ (see table 1). It must be emphasised that the gloss is used to refer to the situation in which the behaviour arises, it does not represent that to which it refers. As such we are taking the position that the meaning can only be attributed through reference to the situational context. The gloss is assigned to the total temporal and spatial situation of the interactional interval. The conditions which determine a situation in which the ‘again’-gloss can be assigned to behaviours are set out below (see table 2).

Insert table 1 about here

Insert table 2 about here

The ‘again’-gloss may be attributed to those behaviours that are interpreted as manifestations of a signal pertaining to the continuation of a current interaction or the request for a re-engagement of an interaction that has been momentarily paused or its inverse, the rejection of an interaction or any attempts to instigate its continuation. The ‘again’-gloss may be attributed to a singular behavioural manifestation or the gestalt behavioural configuration that arises in temporal and spatial relation to a particular stimulus. We consider the stimulus to be

a change in the interactional situation, which is responded to by the child through a change in attitude.

10. The method of micro-level analysis and description

The initial objective is to create a descriptive data set pertaining to the responses realised by a child in correspondence with the conditions that arise within the interactional situation. The further objective is that the data analysis will provide an account for all observable behavioural forms that are manifested within the interval being examined in an objective and comprehensive manner. These are taken as fundamental characteristics of the method of data capture and analysis.

At the initial stage of analysis any presumption as to which behaviours may or may not be relevant to the interaction must be avoided. It is additionally important to provide an objective description of those movement behaviours that palpably affect each anatomical region of the child's body in correspondence with the interactional interval. The process of annotation must incorporate transparent and consistent derivation principles, conventions and terminologies in order to ensure internal consistency. To do so requires a tool through which an annotation may be entered in direct correspondence with any video-recorded data.

We have employed the digital video software called ELAN (European distributed corpus Linguistic ANnotator, available at http://www.lat-mpi.eu/tools/elan/). This software allows for precise time-alignment of annotations with corresponding video-data organised within a system of user-defined tiers [64]. Figure 1 presents an illustrative example of an ELAN screen representation from the analysis of an interaction involving a young male child affected by PMLD [16].

Insert figure 1 about here

The process of data transformation leading to an analysis of each child-participant's behavioural repertoire requires a means of delineating the patterning of movements manifested by the child in response to a changing interactional situation and a set of objective conventions to describe both the behavioural response of the child and its potential relationship to the corresponding interactional interval. These will be described below and their application will be demonstrated through the presentation of a set of sample data drawn from a completed study [16].

10.1 The behavioural unit and the behavioural event

An array of behavioural forms is expected to be realised by a child within a given interval, giving rise to a gestalt behavioural configuration to which a single interpretant, or gloss, may be inferred. The totality of the behavioural configuration may therefore be presumed to give rise to a unit of meaning: that is, at a macro-level, the realisation of a behavioural unit. The behavioural unit constitutes the sign, or signifier, whilst the gloss attributed to its global character constitutes the referent.

Each behavioural unit arises owing to the configuration of salient and sundry movements, or displacements, effected by the child across his body in response to a stimulus. In order to understand the means by which a global character and its interpretant may be assigned to the behavioural unit, a determination of the qualities present within the micro-level displacements that together give rise to the configuration is required. However, we are not seeking simply an account of the child's physiological response to a particular stimulus. Our aim is to establish an account of a child's behaviour within social discourse. In order to account for the dynamic nature of the interactional situation, and in order to avoid isolating individual displacements to their elemental physiological components, an objective,

comprehensive, micro-level description is required of the patterning of movements and postures effected by the child in response to a changing interactional situation. To achieve such a description a structure is required that serves to recognise and encapsulate the configuration of displacements effected by each discrete anatomical region in terms of its motor, temporal and spatial attributes.

As a solution to this problem, we propose that each configuration of displacements effected by a single anatomical region be considered a behavioural event: each behavioural unit is effected via a particular configuration of behavioural events. Each behavioural event may be considered to occur over a time-period designated as an episode.

The following factors serve towards the recognition of an individual behavioural event: the salience of an onset and a termination point within a displacement sequence; the continuity, or flow, that appears across a given sequence of displacements; and the magnitude of the displacement(s). Whilst in some cases a single displacement of a single anatomical region may be considered a behavioural event, in other cases a sequence of displacements of a single anatomical region may be considered as such.

In conceptualising the behavioural event in this manner two benefits are expected. Firstly, as all episodes require description, so all of the behavioural manifestations effected by the child will be taken into account. Secondly, those behavioural events that have particular significance towards the configuration of the behavioural unit will be more readily identifiable and amenable to analysis.

With respect to data generation, we propose two principal iterations: the first, focusing upon a description of the behavioural response, the second, upon the coding and description of the relation judged to exist between the response and the interactional situation. Specific parameters must therefore be assigned to each iteration.

10.2 Annotation conventions

Tiers, linguistic types and controlled vocabularies: Within ELAN every annotation belongs to a tier and every tier is classified within a particular linguistic type [65]. The linguistic type determines the degree of tier dependency and the controlled vocabulary that may be adopted within the template [65].

By assigning an array of independent tiers to each anatomical region (see table 3) the behavioural response of the child can be comprehensively described. Additional tiers may also be assigned, for example, with respect to the activity of the caregiver and additional objects or events. This method of description provides the opportunity to ultimately capture the complete interaction and any synchronicity between actors and agents with the communicative exchange.

With respect to the first iteration, the principle of offering a qualitative annotated style demands that the linguistic type offers a narrative style of input. The employment of any form of coherent and limited coding system to denote a displacement cannot be expected to realise the subtleties demanded of each annotation. As a result, controlled vocabularies cannot be employed in the first iteration. With respect to the second relation iteration, a controlled vocabulary can be employed owing to the existence of a discrete number of potential relations between a signalling behaviour and the corresponding interactional situation (see table 8).

Insert table 3 about here

The employment of standard anatomical terminology: The description employed here adopts the use of the three principal anatomical reference planes - the sagittal, frontal, and transverse planes - that are applied to the human body in the standard anatomical position; that is,

standing erect with the palms facing forward [66]. These three reference planes are considered to remain constant relative to the orientation of the body and apply whether the body is standing erect, sat erect, or supine.

Tables 4 to 7 illustrate the terminology employed within the first iteration to describe a nonverbal response.

Insert tables 4 to 7 about here

Descriptor conventions: The following conventions apply in order to ensure an objective, comprehensive and internally consistent description of the observable behaviours:

- Each annotation to employ standard anatomical terminology.
- Annotations include three descriptor elements: 'MOVEMENT; state; action'.
- CAPITALISATION indicates a MOVEMENT descriptor; entries in lower case refer to state and action.
- Annotations will detail movement in the order: movement in the sagittal plane, then the frontal plane, then the transverse plane.
- Small degrees of movement are considered a MICRO-MOVEMENT.
- Where no movement occurs in an episode 'NO MOVEMENT' will be entered. When a pause in movement occurs as one factor within a sequence, the annotation will be entered in the style '(1)..., (2) NO MOVEMENT..., (3)...'
- The state descriptor indicates conditions particular to the specified anatomical region.
- The action descriptor indicates any form of direct physical or contiguous interaction involving the anatomical region.
- The opening annotation period of a tier details the initial state of the anatomical region in the interval being examined.

- When multiple factors are attributed to an element within a single episode, such as within a sequence of movements, each factor will be denoted by a numeral: for example, '(1) [MOVEMENT]; [state]; [action], (2) [MOVEMENT]; ...; ...'
- When an anatomical region is hidden from direct screen view preventing the production of a sensible annotation '[hidden from screen view]' will be entered.
- When the screen view fails to provide sufficient detail in order to produce an accurate annotation '[indeterminate]' will be entered.
- For the vocalisation tier annotations will only be entered for episodes when a vocal sound is produced.

Relation coding: A limited number of potential relations exist within each behavioural event: a) a clear direct relation between the child and adult, or vice versa, where the behaviour of one appears oriented towards the other; b) a clear direct relation between either the child or the adult towards the stimulus; c) an indefinite relation, one that lacks clarity in its orientation or purpose; d) a behavioural event in which no relation is considered to be present; and finally, e) those behavioural events that cannot be described owing to their being hidden from view, either because the behavioural event occurs off-screen or because it is masked by on-screen activity. Table 8 summarises the controlled vocabulary that may be applied to the dependent relation tier.

In order to establish a clear sense of attribution to the coding, a further dependent tier aligned with the relation tier may be employed within which an annotated narrative description may be entered pertaining to a justification for the coded relation (see figure 1).

Insert table 8 about here

10.3 Data transformation

The process of data transformation is realised across three steps: 1) the identification of those intervals within the filmed interaction that satisfied the definition of an 'again'-glossed interval through review of the film-data; 2) a time-aligned objective and comprehensive description of all of the behaviours effected by the child within the identified interval using the ELAN annotation software tool, employing standard anatomical conventions; and, 3) the coding and transcription of the potential relations between each micro-level behavioural sequence and the 'again'-glossed interval, again using the ELAN tool. Only those behavioural events judged to have contributed to the gestalt configuration of the behavioural unit are selected for further examination.

In order to establish the first iteration describing the movements manifested by the child all behavioural event boundaries and annotation entries are determined by conducting the playback of each filmed interval at a rate of 30% of real-time using the ELAN software tool. A first pass serves to establish the approximate boundaries of each behavioural event and a first-pass annotation entry. A second pass critically determines the boundaries of each episode and refines each annotation entry. A third pass facilitates a critical review of the episode boundaries and the annotation entries.

The separate second iteration, establishing the potential relations between the child's movements and the interactional situation, is facilitated again by reviewing the film-data at a rate of 30% of real-time. In reviewing the interaction as it appears on the ELAN-screen the analysis appears analogous to the task facing the caregiver: to recognise a signalling behaviour and interpret its sign-referent relation within the context of the interaction.

The following example illustrates the results gained through this process of data transformation of a child/caregiver interaction which has been analysed through this method

[16]. This illustrative example is drawn from a particular interval in an interactional situation in which the child, who is lying in a supine position, receives into his right hand a set of light metallic bracelets from the caregiver (KA). The stimulus is the break in contact that occurs between the child's right hand and the set of bracelets he has set into a twirl.

With onset times ranging from 5.965 to 6.545 seconds, the behavioural array is marked by the near simultaneous onset of behavioural events effected by the eyelids and brow, head, mouth, left hand, left arm, right hand, right arm, and torso. The rapidity and magnitude of the reciprocal movements realised by each anatomical region give rise to an attribution of a negative, or distressed, affective state: a state that continues through the remainder of the vignette. This impression is further emphasised by the vocalisation produced from 7.986 seconds. It is the manifestation of this array of behavioural events that gives rise to a clear sense that the global character of the behavioural unit satisfies an attribution of "again"; that is, towards a resumption of the engagement with the stimulus situation as it was in which direct contact was obtained between the right hand and the set of bracelets.

Figure 2 illustrates the style of annotation that objectively describes the displacements and denotes their relation to the interactional situation within each behavioural event that is judged to contribute towards the behavioural configuration. The timeline presented in figure 3 denotes the onset and termination of each behavioural event and serves to illustrate the temporal juxtaposition across behavioural events and therefore the shape of the configuration. Each of the behavioural events that contribute to the behavioural configuration are indicated by shading. In this illustration the behavioural configuration continues beyond the end of the sample period. What is of direct interest is the change in behavioural response that occurs within this interval.

Insert figure 2 about here

Insert figure 3 about here

By realising a description and analysis of the child's response at a micro-level of detail this methodology serves to filter out those behavioural forms of lesser significance and thereby provide a means of identifying those behavioural expressions that are particularly suggestive of a signalling effort by the child. By examining a number of 'again'-glossed intervals that occur within different interactional situations involving the same child with their caregiver using the same micro-level descriptive and analytical processes we argue that this methodology serves to determine emergent patterns within each child-participants signalling repertoire. By taking into consideration the developmental status of the individual child we argue that it is then possible to appreciate identifiable behavioural expressions that arise consequent of the effect of a particular form of stimulus as legitimate signalling data [16].

11. Discussion

The magnitude of multiple compromise that affects a child with PMLD has considerable consequences both in terms of the child's development and the means by which they may interact with a caregiver. Whilst the current literature has broadly acknowledged such consequences there has been little consideration of the affective stance of the child with respect to their capacity to act intentionally. Current approaches, reviewed here, typically define the intentional communicative act within a functional paradigm. This method is adequate for investigating children with less severe compromise. However, those children considered here who have more severe and complex levels of developmental compromise present new challenges which cannot be addressed through methods used previously. This is because such children are not yet able to produce such behavioural signals. The expanded and

elaborated theoretical perspective that we have developed acknowledges that a child with PMLD and who is at an extremely early stage of development will respond affectively rather than functionally. In this way our method is able to provide an account for the behaviour expression which may be potential in the interactions of a child with PMLD and a caregiver. For children with such severe and complex developmental compromise the first useful step is to identify productive signals. These children may never go on to develop any further repertoire of volitional expressive signals, although that may be an idealised developmental expectation. We therefore cannot assume that such a child affected by PMLD will necessarily produce signals with the purpose or intent to influence the behaviour of the caregiver as is expected of a child following a typical or near-typical trajectory. It is likely to be unrealistic to presume that such intentional signalling behaviour needs to be readable beyond the caregiver who has a long term interactional experience with the child. It must be acknowledged that a child affected by PMLD as described here is at an extremely early stage of development and is most likely to remain at that stage for a very long time, if not a lifetime.

In order to appreciate the contribution of a child with PMLD to the interaction it must be recognised that the capacity to act intentionally changes in accord with the developmental status of the individual. We argue that those corporeal behaviours that create the impression to the caregiver of a comportment by the child towards some aspect of the interaction should be taken as a conscious response to it when the child is at an extremely early stage in the formation of vehicles of expression. That response will be as a consequence of the child's experiencing of the interactional situation. This experience will be predicated upon the capacity of the child to perceive and act upon that situation. For the child with PMLD it is precisely these capacities that are subject to massive compromise.

Within the context of a face-to-face interaction between a young child affected by PMLD and a caregiver, we have provided a new methodological approach which achieves a more precise description of their nonverbal signalling behavioural repertoire. We have presented a new framework founded on the motive to ensure ecological validity within a participant-observation interaction. To this end we devised new theoretical terms, approaches to data capture, and means of deriving an analysis. The goal of this new methodology is to realise more precise observational data for description.

The principal innovation of our approach is to take into account the ecology of the interactional situation in terms of the mental state of the individuals participating within the interaction and the dynamic nature of that interaction. Those interactional intervals in which a stimulus provokes either one or the other of the most definitive dichotomies of affective experiences - namely, pleasure or unpleasure - are selected for examination. This determination is motivated by the principle that in effecting a response that appears in temporal relation to the stimulus the child is acting conscious of the effect of that stimulus. This selection recognises that the response to a polarity of affective experiences requires only that the child is capable of responding affectively; any response manifested by a child who is at an extremely early developmental stage may therefore be recognised as legitimate behavioural evidence.

By attributing what we define as ‘again’ to those intervals that appear temporally related to periods imbued with the affective experiences of pleasure or unpleasure this selection satisfies the requirement for behavioural data to which a sign-referent relation may be inferred. It therefore affords an examination of the capacity of the child to effect a communicative act.

We argue that the method of micro-level data capture and analysis that has been advanced here is sufficient to describe each individual behavioural form manifested across the child’s

anatomy. The description that is derived from this analysis is then employed to identify both the individual material form of the nonverbal behaviour and its relationship within the gestalt configuration that is realised across the child's anatomy. This new methodological approach provides a more precise micro-level description of the child's response within a particular interactional interval. This is then applied to further analysis of the behavioural events to achieve identification of those behavioural forms that possess particular communicative significance.

A restricted coding system employed in real-time to identify a movement or response in children with such idiosyncratic behavioural repertoires cannot be expected to capture the subtleties that must be recorded if an accurate observation is to be established pertaining to an individual child's behavioural repertoire. We suggest that only by establishing a narrative style of input utilising standard anatomical terminology as established within our methodology can we realise the research goal of a more universal understanding of the affective response to a social interaction of a child at an extremely early stage of development.

Many caregivers who have long term interactional experience with a child with PMLD are able to conduct a movement inventory that is indicative of the child's potential receptive or expressive repertoire. Our methodology is intended to provide an account well beyond what could be captured by such a movement inventory to detail and determine movements that can be hard to observe or identify in real-time because they are so fleeting and idiosyncratic.

For some children with PMLD critical responses may well take the form of a slight tensing or relaxing in parts of the body in response to a stimulus. These responses may only be appreciated by a caregiver who is in direct physical contact with the child. Our fine-grain anatomically based observational and analytical approach, which enables repeated viewing of an interactional interval at a rate much slower than real-time, allows for the objective

identification of such responses. The fact that these behavioural responses are recorded on video also has the advantage of facilitating the validation of the accuracy and reliability of the behavioural data. An important strand in future research will be to compare the information gained from this micro-level process with the intuitive judgements of a caregiver in order to determine similarities and differences between the observations arising from each approach. The use of such a fine-grained observational and analytical process has been designed specifically to examine the behavioural repertoire of individuals whose response to any given stimulus appears to lack any obvious consistency or stability in their manifestation. The practical advantage of this new approach is that the process of data selection can be readily applied to the examination of the everyday, naturally occurring triadic interactional situations that arise between a child, their caregiver and a mutually shared activity or object. One scenario for the application of this methodology would be to analyse nonsymbolic signalling behaviour during an interaction whereby an activity or object can be introduced by the caregiver, withdrawn and reintroduced. In each stage of the sequence the response of the child can be observed, described and analysed using this data capture and description.

There are practical limitations to our approach. Firstly, such a fine-grained methodology demands considerable time and effort to transcribe and analyse in sufficient detail any video recording of the individual movements manifested by the child across their anatomy. Secondly, due to the highly variable manifestations of compromise in individuals with PMLD the detailed knowledge that is accrued by these means will be particular to that individual. Its utility will remain limited to the particular child and cannot be generalised in any narrow sense. It is intended that practical application of this method must focus upon those individuals for whom it has proven extremely difficult to ascertain the potential modalities of expressive signalling behaviour.

However, from a research perspective one of the potential benefits of using this method is that it could lead to a more universal understanding of the affective response to a social interaction of individuals at the very early stages in their acquisition of schema, shared attention and the formation of vehicles of expression. The understanding gained from this approach may then serve to further support the capacity of the wider community of caregivers, including parents, teachers and health professionals, in their interactions with a child affected by PMLD.

12. Conclusion

Given the developmental asymmetry that is present between a child with PMLD and their caregiver any interaction between them is subject ultimately to the control of the caregiver. Identifying those behaviours which signal the basic desires of the child is therefore paramount if the caregiver is to act in a manner that supports the child's capacity to realise a greater degree of self-determination and therefore control over the input they receive.

We argue that by developing a methodology which more fully addresses affective responses to the interaction process we have expanded the potential for understanding the intentions of children with complex developmental trajectories functioning at an extremely early stage of acquisition.

We have provided a detailed description that serves towards the establishment of an objective, comprehensive and internally consistent descriptive data-set employing the ELAN digital video software. This method has been successfully employed to capture the behaviour intervals of three children with PMLD and one typically developing infant to date [16]. It is intended that future research will extend its application.

We argue that this innovation in methodology will contribute towards a new and fuller understanding of the expressive nonverbal behavioural repertoire that the young child with

PMLD contributes to the interactional situation. As a consequence, this approach may provide valuable insight of benefit to the child by establishing the ground upon which their voice may be given true recognition and to the caregiver by enhancing their ability to act in service of the interaction.

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Declaration of interest

The authors report no declaration of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1

Defining the ‘again’-gloss

Synonym	Antonym
accept	against
acceptance	not again
anew	no more
for	refusal
more	reject
repeat	rejection
repetition	

Table 2

The conditions associated with an ‘again’-gloss attribution

‘again’	‘not again’
Condition 1: The behaviours coincident with the period of engagement with a particular phenomenon are sufficient to infer that the child has drawn a sense of satisfaction from the interaction. Condition 2: The behaviours consequent of a severance of engagement with the phenomenon are sufficient to infer that the child has drawn a sense of dissatisfaction owing to this change in circumstance, where the behaviours of the child in the period immediately prior to this change had satisfied condition 1.	The behaviours coincident with the period of engagement with a particular phenomenon are sufficient to infer that the child has drawn a sense of dissatisfaction from the interaction.

Table 3

The independent tiers and annotation content

Independent tier label	Annotation content
Eye gaze	Movement and direction of eye gaze.
Eyelid & brow	Movement and state of the eyelids and brow.
Head	Movement of the cervical spine (neck) and facial features (excepting the eyes, brow and mouth).
Mouth	Movement, state and action of the lips, tongue and mandible.
Left hand	Movement, state and action of the fingers and thumb, the state and action of the palm, and movement and state of the wrist.
Left arm	Movement of the left scapula and shoulder, and movement, state and action of the elbow and forearm.
Right hand	Movement, state and action of the fingers and thumb, the state and action of the palm, and movement and state of the wrist.
Right arm	Movement of the right scapula and shoulder, and movement, state and action of the elbow and forearm.
Left leg	Movement of the hip, and movement and state of the knee.
Left foot	Movement, state and action of the left ankle, foot and toes.
Right leg	Movement of the hip and movement and state of the knee.
Right foot	Movement, state and action of the right ankle, foot and toes.
Torso	Movement of the vertebral column (spine and thorax) and the pelvis.
Vocalisation	Vocal sounds produced by the child, indicated by type and/or IPA notation.

Table 4

Standard anatomical terminology for movement [66]

Term	Movement type
Extension	Straightens or opens a joint.
Flexion	Bends a joint or brings the bones closer together.
Adduction	Movement of a limb medially towards midline (or brings the fingers or toes together).
Abduction	Movement of a limb laterally away from midline (or spreads the fingers or toes apart).
Medial rotation	Rotation towards midline.
Lateral rotation	Rotation away from midline.
Rotation	Pertains only to the head and vertebral column.
Circumduction	Involves a combination of flexion, extension, adduction and abduction of the shoulder or hip joint; together these actions create a cone-shaped movement.
Lateral flexion	Pertains only at the axial skeleton when the neck bends laterally to the side.
Elevation	Movement superiorly.
Depression	Movement inferiorly.
Supination	Rotation of the forearm that moves the palm from a posterior- to an anterior-facing position or a superior facing position.
Pronation	Rotation of the forearm that moves the palm from an anterior- to a posterior-facing position or an inferior facing position.
Protraction	Movement anteriorly of the scapula, clavicle, head or jaw.
Retraction	Movement posteriorly of the scapula, clavicle, head or jaw.
Anterior tilt	Downward rotation of the pelvis.
Posterior tilt	Upward rotation of the pelvis.
Lateral tilt	Asymmetrical elevation of the pelvis.
Deviation	To wander from the usual movement.
Reciprocal motion	Alternating motion in opposing directions.
Hyper	Movement beyond the normal range of motion.
Micro-movement	Fine degree of movement.

Table 5

Standard anatomical terminology for movement specific to the hand and foot [66]

Term	Movement type
Proximal and distal interphalangeal articulation	Movement of the proximal and distal joints between the finger bones.
Metacarpophalangeal articulation	Movement of the joints where the fingers meet the palm.
Opposition	Movement of the carpometacarpal joint of the thumb when crossing the palm towards the small finger.
Inversion	Movement of foot sole towards the median plane.
Eversion	Movement of foot sole away from the median plane.
Plantar flexion	Flexion of the foot inferiorly, occurring at the ankle.
Dorsiflexion	Extension of the foot superiorly, occurring at the ankle.

Table 6

Standard anatomical terminology for direction and position [66]

Term	Position
Superior	Closer to the head.
Inferior	Closer to the feet.
Posterior	Further towards the back of the body.
Anterior	Further towards the front of the body.
Medial	Closer to midline.
Lateral	Further away from midline.
Distal	Further away from midline (when referring to the limbs).
Proximal	Closer to midline (when referring to the limbs).
Ipsilateral	On the same side of midline.
Contralateral	On the opposite side of midline.
Palm (directional term Palmar)	Front of the hand/Sole of the foot.
Dorsum	Back of the hand/Top of the foot.
Digit notation.	1 = thumb, 2 = index finger, 3 = middle, 4 = ring, 5 = small.

Table 7

Terminology to indicate the state or orientation of an anatomical region

Anatomical region	State or orientation type	Term
Eye gaze	Direction of eye gaze.	upward gaze, primary gaze, downward gaze and the six cardinal positions of gaze: up/right, right, down/right, up/left, left and down/left [67].
Eyelid & brow	Degree of eye opening.	closed, half-closed, half-open or open.
	Position of brow.	low, neutral or high
Head	DIrection of forehead.	upward, primary, downward, up/right, right, down/right, up/left, left and down/left.
Mouth	Degree of mouth opening.	closed, half-closed, half-open or open [68].
	Mouth shape	spread, neutral or rounded [68].
Hand	Palm shape.	flat or cupped.
	Degree of digit flexion/extension.	hyper, full or partial.
	Degree of digit abduction/adduction.	hyper, full or partial.
Arm	Shoulder or elbow flexion/extension.	hyper, neutral (= straight arm), obtuse or acute.
Leg	Hip or knee flexion/extension.	hyper, neutral (= straight leg), obtuse or acute.
Foot	Degree of digit flexion/extension.	hyper, full or partial.
	Degree of digit abduction/adduction.	hyper, full or partial.

Table 8

The controlled vocabulary applied to the relation tier

Code	Relation
C/A	Direct relation between child and adult.
C/S	Direct relation between child and stimulus.
A/C	Direct relation between adult and child.
A/S	Direct relation between adult and stimulus.
I	Indeterminate: indefinite relation between child and adult and/or stimulus.
N	None: no relation between child and adult and/or stimulus.
H	Hidden from screen view.

Figure 1

Illustrative example of the completed ELAN-screen for an ‘again’-glossed interval

Figure 2

Behavioural events contributing to the 'again'-glossed configuration.

Anatomical Region	*Time code (ss.msec): Displacement*	*Relation/Relation Transcription*	
Eyelid & brow	06.235 - 07.050: DEPRESSION OF BOTH EYLIDS; terminates with both eyelids closed, brow at neutral.	C/S	
	07.050 - 07.335: [left eyelid and brow hidden from screen view] NO MOVEMENT; right eyelid closed, right brow at neutral.	C/S	
Head	06.203 - 11.440: (1) MEDIAL ROTATION; to primary, (2) RECIPROCAL LATERAL/MEDIAL ROTATIONS TO/ FROM MIDLINE (4 CYCLES), (3) LATERAL ROTATION; terminates at down/right.	C/S	
Mouth	05.965 - 07.240: ASYMMETRICAL OPEN/CLOSE; asymmetrical right-side contraction greater than left-side.	C/S	
	07.995 - 08.740: NO MOVEMENT; maintains mouth closed neutral.	C/S	
	08.740 - 09.600: OPENING; to half-closed neutral.	C/S	
Left hand	06.435 - 11.440: (1) EXTENSION OF DIGIT 1, PROXIMAL AND DISTAL INTERPHALANGEAL EXTENSION AND METACARPOPHALANGEAL EXTENSION AND ABDUCTION OF DIGITS 2-5; wrist maintained in-line with arm axis; (2) PROXIMAL INTERPHALANGEAL FLEXION OF DIGITS 2-5, (3) RECIPROCAL FLEXION/ EXTENSION OF DIGIT 1, PROXIMAL AND DISTAL INTERPHALANGEAL RECIPROCAL FLEXION/ EXTENSION (2 CYCLES); wrist maintained in-line with arm axis.	C/S	All displacements are suggestive of a negative affective state coincident with the continued stimulus state.
Left arm	06.430 - 08.095: (1) HORIZONTAL ABDUCTION OF SHOULDER, (2) MEDIAL ROTATION OF SHOULDER, PRONATION OF FOREARM, (3) ADDUCTION OF SHOULDER, FLEXION OF ELBOW.	C/S	
	08.095 - 11.440: (1) ABDUCTION AND MEDIAL ROTATION OF SHOULDER, (2) ADDUCTION OF SHOULDER, (3) RECIPROCAL EXTENSION/FLEXION OF ELBOW, (4) ABDUCTION OF SHOULDER, EXTENSON OF ELBOW.	C/S	
Right hand	06.230 - 07.480: EXTENSION OF WRIST; maintains all digits partially flexed and abducted.	C/S	
	07.480 - 08.060: METACARPOPHALANGEAL EXTENSION AND ABDUCTION OF DIGITS 3 AND 4.	C/S	
	08.060 - 10.545: NO MOVEMENT; maintains all digits partially flexed and abducted, wrist partially extended.	C/S	
Right arm	06.545 - 09.060: (1) FLEXION OF ELBOW, LATERAL ROTATION OF SHOULDER, RECIPROCAL PRONATION/SUPINATION OF FOREARM, (2) RECIPROCAL ABDUCTION/ADDUCTION OF SHOULDER, PRONATION OF FOREARM, EXTENSION OF SHOULDER AND ELBOW, (3) HORIZONTAL ABDUCTION AND LATERAL ROTATION OF SHOULDER, EXTENSION OF ELBOW, SUPINATION OF FOREARM.	C/S	
Torso	06.185 - 08.840: RECIPROCAL LATERAL FLEXION OF SPINE, RECIPROCAL MEDIAL/LATERAL ROTATION OF SPINE AND THORAX.	C/S	
Vocalisation	07.986 - 09.135: /ʌ̆.ʌw/	C/S	

Figure 3

Timeline illustrating the shape of the ‘again’-glossed configuration.