

# ITB Journal

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## Editorial

I am delighted to introduce the 24th edition of the ITB Journal, the academic journal of the Institute of Technology Blanchardstown. The first paper by Smith and Nolan, explores the contribution of facial expressions improving comprehension and acceptability in sign language avatars. This work deals with Irish Sign Language (ISL) and examines the Deaf community's responsiveness to sign language avatars. The hypothesis is that augmenting an existing avatar with the seven widely accepted universal emotions will make it more human-like and improve usability and comprehension for the ISL user. The authors compare an augmented set of avatar utterances against a baseline set, focusing on two key areas: 1) comprehension and 2) naturalness of facial configuration. The evaluation results reveal that, in a comprehension test, the avatars are lacking various linguistic attributes.

The second paper, by Conor Pyle, characterises serial verb constructions in two dialects of the Western Desert language of Australia, Pitjantjatjara and Yankunytjatjara. Within a Role and Reference Grammar (RRG) analysis, the paradigm allows the author to look at the constituents for representation of logical structure and marking of macroroles, while finding that core and peripheral argument phrases are marked by case with ergative nominal marking and accusative pronoun marking. Simple verbs use endings for tense, aspect, mood and status and the RRG operator projection shows the nature of linkage between the verbs involved in multi verb structures. Importantly, there is a serial participle marked on the members of these constructions and a finite verb that is typically clause final. These meet the criteria for serial verb constructions and in nuclear junctures there is evidence of sharing of arguments and a single action implied. Serial verbs can form nuclear or clausal cosubordinate nexus junctures.

In the third paper, Judith Gottschalk discusses both macro- and micro-levels of persuasion in data visualizations in persuasive tools for language learning. Her hypothesis is that persuasive data visualizations decrease reading time and increase reading accuracy of graph charts. Based on Tufte's (1983) data-ink maximization principle the paper introduces a framework for persuasive data visualizations on the persuasive micro level that employs a conception of de-emphasizing non-data and emphasizing data-ink, based on Few (2013). Persuasive data visualization for a performance-optimizing tool called Learning Journey Online is presented.

We hope that you enjoy the papers in this issue of the ITB Journal.

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# Emotional Facial Expressions in Synthesised Sign Language Avatars: A Manual Evaluation

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## ABSTRACT

*This research explores and evaluates the contribution that facial expressions might have regarding improved comprehension and acceptability in sign language avatars. Focusing specifically on Irish Sign Language (ISL), we examine the Deaf<sup>1</sup> community's responsiveness to sign language avatars. The hypothesis of this is: Augmenting an existing avatar with the 7 widely accepted universal emotions identified by Ekman [1] to achieve underlying facial expressions, will make that avatar more human-like and improve usability and understandability for the ISL user. Using human evaluation methods [2] we compare an augmented set of avatar utterances against a baseline set, focusing on 2 key areas: comprehension and naturalness of facial configuration. We outline our approach to the evaluation including our choice of ISL participants, interview environment and evaluation methodology. The evaluation results reveal that in a comprehension test there was little difference between the baseline avatars and those augmented with emotional facial expression also we found that the avatars are lacking various linguistic attributes.*

## Keywords

User-centered design, Deaf, Sign Language synthesis, Emotion, Natural variance, Avatar, SiGML, HamNoSys, Accessibility, Disability, HCI.

## 1. INTRODUCTION

ISL is the indigenous language of the Deaf Community in Ireland, standing apart from English and Irish. There are approximately 5,000 native users of ISL in the Republic of Ireland [3], while it is estimated that some 50,000 non-Deaf people also know and use the language to a greater or lesser extent [4]. Unlike spoken language, signed languages have multiple articulators designated: Manual features (MF) which are the hands/arms and non-manual features (NMF), everything else. Emotion and prosody are expressed in SL primarily through NMFs [3], which are widely accepted to carry up to 70% of a sign's meaning<sup>2</sup> and this, therefore, makes emotion a significant factor in the credibility and acceptance of an avatar. The average reading age of Deaf school leavers is comparable to that of an 8-9 year old hearing child [5]. Thus there is a requirement for communication materials in a sign language format yet the costly production of sign language video means that these materials are limited. Synthesised sign language avatars are a cost effective solution to this requirement. This paper outlines how an existing synthesised avatar framework is currently being used to evaluate comprehension levels of signing avatars amongst a portion of the Irish Deaf community. Particularly, the study investigates the effect of adding emotional facial

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<sup>1</sup> The uppercase "D" in the word "Deaf", indicates Deaf as a culture as opposed to a medical condition.

<sup>2</sup> Anecdotal evidence based on interaction with the Deaf community [13]

expressions (EFEs) and the advantages, if any, of a human-like avatar versus a caricature-like avatar.

## **2. EVALUATION FRAMEWORK**

In order to conduct any form of evaluation one must first have an avatar in place along with some synthesised output. With this in mind a subset from the well-established Signs of Ireland (SOI) corpus [6] and the JASigning [7] synthesised sign language avatar system were chosen as the instruments to work with. These technologies are discussed further in the subsequent sections.

## **3. ELICITATION**

The development of a new corpus is not a straightforward process, particularly with regards to the elicitation of data. Common difficulties include time limitations, attracting participants, authenticity of the data collected not to mention confidentiality and other ethical issues. For these reasons the building of a corpus was never within the scope of this project. Currently there are only 2 corpora with ISL content: the aforementioned Signs of Ireland (SOI) corpus [6] and the patient–receptionist dialogue corpus [8]. The latter of these 2 corpora has been fully transcribed with HamNoSys and outputs using the JASigning platform. Using this corpus would save much time with the transcription process allowing it to be circumvented entirely. The patient–receptionist dialogue corpus is very much focused on the domain of patient–receptionist dialogue. This fact, plus the fact that the dialogue is staged, makes it well suited to its purpose: the machine translation of sign languages with a small dataset.

The SOI corpus on the other hand is well established and as one of the largest digitally annotated signed language corpus in Europe, it gives a rich selection of utterances with emotional facial expressions (EFEs). The primary purpose of the corpus is to record ISL as it is currently used in Ireland. As a result, the subjects of the corpus were encouraged to relax and sign naturally. Corpus data, in which the signer is relaxed and using his/her natural sign may be the best material to impartially evaluate the comprehension of a sign language avatar.

Through a simple keyword search the story ‘A Scare in Belfast’, was selected from the SOI corpus and identified as having a high level of EFE content. A manual inspection of the data confirmed that all 7 emotions were present. Each EFE was manually identified and annotated using the ELAN software in which the SOI corpus was initially constructed. Five segments of the story contained a high concentration and variety of emotional content were therefore the best candidates for the evaluation.

The SOI corpus contains natural authentic sign language usage. However, as is true of all systems, errors may occur. For example during the elicitation process the content may be recorded with an incorrect or lesser-known sign, in the transcription process the transcriber may incorrectly identify a sign or further down the pipeline the software may display a sign incorrectly. In an effort to avoid such errors we selected content from the, well-established, SOI corpus. The content from this corpus being ‘natural’ signing by native ISL users is difficult to challenge in its authenticity. One area in which the creators of the corpus would not mind being challenged is the accuracy of the ISL. There are many linguistic ‘errors’

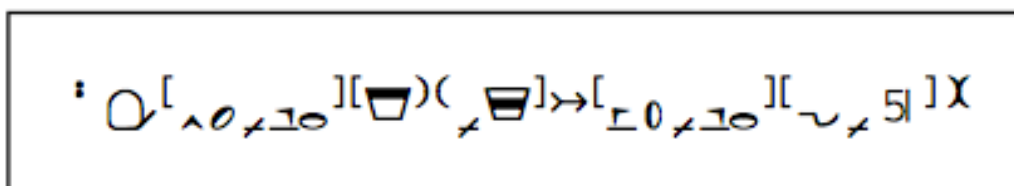
throughout this corpus as a result of grammatical ‘mistakes’ or the introduction of a non-ISL sign. However, these ‘errors’ are representative of how ISL users currently use the language and are exactly what the SOI corpus was designed to record. By using the SOI corpus content we have gained some content that may indeed have some linguistic ‘errors’ but, more importantly, it has an authenticity that cannot be challenged. In an effort to avoid errors with regards to the HamNoSys transcription, only one experienced transcriber was involved in transcribing the content and only a small set of 154 utterances was transcribed so that time could be allocated to rechecking transcriptions. A breakdown of the utterances by emotion is provided in Table 3-1. To avoid software errors we used the JASigning framework, which is currently the state-of-the-art tool for sign language synthesis. It has inherited many of the limitations of HamNoSys and some rendering bugs have yet to be resolved. Overall we found it a useful and proficient tool with a very useful modular structure.

**Table 3-1 The frequency of which each EFE appears**

EFE	Frequency
Happy	18
Disgust	15
Anger	10
Fear	10
Contempt	8
Surprise	4
Sad	2



**Figure 1 Avatars Luna and Anna**



**Figure 2 HamNoSys transcription for the sign "Stop"**

```

<hns_sign gloss="BEGIN">
  <hamnosys_nonmanual>
    <hnm_mouthpicture picture="BE:"/>
    <hnm_head tag="TL"/>
    <hnm_extramovement tag="X69"/>
  </hamnosys_nonmanual>
  <hamnosys_manual>
    :
  </hamnosys_manual>
</hns_sign>

```

**Figure 3 SiGML notation including 'extra movement' tag**

## 4. BASELINE SYSTEM

The Virtual Humans group at the University of East Anglia (UEA), Norwich, are leaders in the field of synthesised SL avatars, this accomplishment is a result of their JASigning framework [7] [9]. Initially conceived during the ViSiCAST project and further developed during the eSIGN and subsequent projects, the framework, the driving force behind avatars such as Anna (Figure 1), was developed with a modular structure such that researchers not associated with the initial project can easily pick up the technology and build it.

Figure 4 gives a high level overview of the JASigning framework. The framework can receive input in the form of HamNoSys. The Hamburg Notation System (Figure 2) or Ham-No-Sys is one of the few well-established transcription systems, and developed by the Institute for German Sign Language and Deaf communication at the University of Hamburg for all SLs [10]. HamNoSys is a phonetic notation system purpose-built for use by linguists in their detailed analytical representation of signs and sign phrases as opposed to as a writing system for SLs.

A transcriber may represent a signed utterance at the phonetic level using HamNoSys. In this work, all transcriptions were carried out by the 1<sup>st</sup> author. The HamNoSys is then represented in the computer readable markup language known as SiGML (Signing Gesture Mark-up Language) [11] (See Figure 3). SiGML defines a set of XML tags for each iconic symbol in HamNoSys. The eSIGN Editor tool does this automatically and has the ability to output SiGML at this point or send it to the animation synthesiser, AnimGen. AnimGen enriches the SiGML data with the avatar geometry data such as vertex coordinates and rotation values. This combined data is fed into the avatar-rendering engine which will produce a 3D avatar in real-time.

### 4.1 Improving the baseline system

Many of the limitations of the eSIGN Editor can be overcome using the existing framework. What makes JASigning popular amongst researchers is the modular structure. The framework

has been developed so that a vast amount of fine-tuning or basic changes may take place without having to delve into a labyrinth of code. The framework takes input from a number of external XML and property files, which can be altered to affect facial morphs, movement speeds, to change avatar and a whole lot more. For this evaluation it was possible to create seven new facial morphs using the ARPtoolkit [11]. The new morphs contain the facial configuration and movement for each of the seven emotions outlined by Ekman [1]. These being: happiness, sadness, anger, disgust, contempt, fear and surprise. Using the ARPtoolkit, it is possible to export the files required to create and run an avatar locally using the SiGML service player, which by default pulls down the avatar data from a server based in UEA. For these new morphs to take effect, some XML files need to be updated and the properties file needs to be pointed to the newly created, local avatar. After identifying, visually, which signed utterances required the addition of EFEs, the final step was to add the new markup to each. By manually adding the EFEs markup to each SiGML file it was possible to circumvent the limitations of the eSign Editor, therefore enriching the existing output while using the existing framework. Figure 3 illustrates how EFE is added using the ‘hnm\_extramovement’ tag, where ‘X69’ represents the EFE ‘disgust’.

## 5. EVALUATION

The multichannel visual nature of the sign language avatars as well as the requirement to identify a level of understandability made an automatic evaluation unfeasible, leaving a manual evaluation as the only viable option. A manual evaluation was undertaken with 15 sign language users over a 2-day period on site at the newly developed Deaf Village of Ireland (DVI). The evaluation was designed such that all participants are native ISL users and a demographic balance was achieved. Barriers such as different levels of technical knowledge and pre-formed opinion of the technology would be identified early in the interview. Some barriers, like communication, for example, were overcome with the support of a certified ISL interpreter.

All of the 5 story segments selected were recreated as closely as possible to the original using the JASigning platform described in section 4, resulting in a set of digital videos varying in duration from 9 seconds to 73 seconds. Each of the 5 story segments was present with 1 of 4 different avatars: (a.) Anna, a ‘human looking’ avatar with baseline encoding, (b.) Luna, a caricature avatar, again with baseline encoding and both (c.) AnnaE and (d.) LunaE enriched with EFEs (see

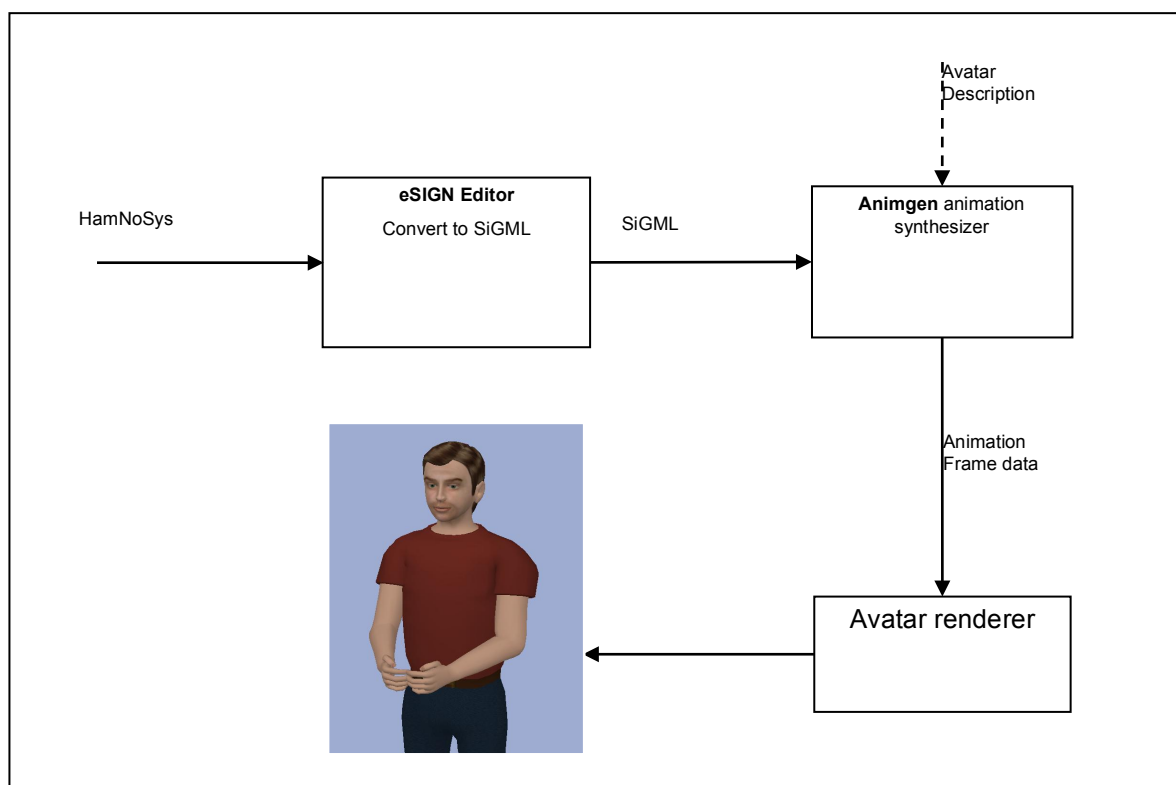
Table 5-1). This resulted in a total of 20 avatar videos. Each participant was presented the videos in a different order, the sequence of which was derived using a Latin square model in an effort to avoid learning. To further this effort and to lessen the interview duration, no participant saw all 5 videos. The longest video was always shown in isolation or with 1 other to prevent fatigue in the participant. After watching each video the participants were asked a number of comprehension questions as well as being asked to score their own comprehension of the video content on a scale of 0-5. During a trial run of the evaluation it became obvious that some context was required and each video would need to be watched a second time, therefore, the same set of questions were asked after both viewings in a bid to track the level of comprehension after each pass.



The recruitment of voluntary participants was challenging given the closed nature of the Deaf community. Nevertheless, thanks to the efforts of the Irish Deaf Society (IDS) a total of 15 participants took part. Evaluations, each 30 minutes in duration, took place over a 2-day period. Participants were asked a series of questions in an interview scenario. A digital video camera designated ‘camera 1’ captured footage of each interviewee as he/she watched the avatar videos and responded to the interviewers questions. A second camera, ‘camera 2’, filmed the ISL interpreter as he/she interpreted the conversation between participant and the interviewer. The room layout is illustrated in Figure 5.

The format of the interview stayed consistent throughout. Participants initially answered a set of establishing questions consisting of demographic information as well as some exploratory questions designed to establish their level of exposure and acceptance towards new technologies with particular focus on signing avatars. The participants had their first glimpse at the avatars in phase 2. In this phase each participant was asked to watch an avatar video and then answer some comprehension questions based on that video. The video was viewed a second time and the same set of comprehension questions was asked again.

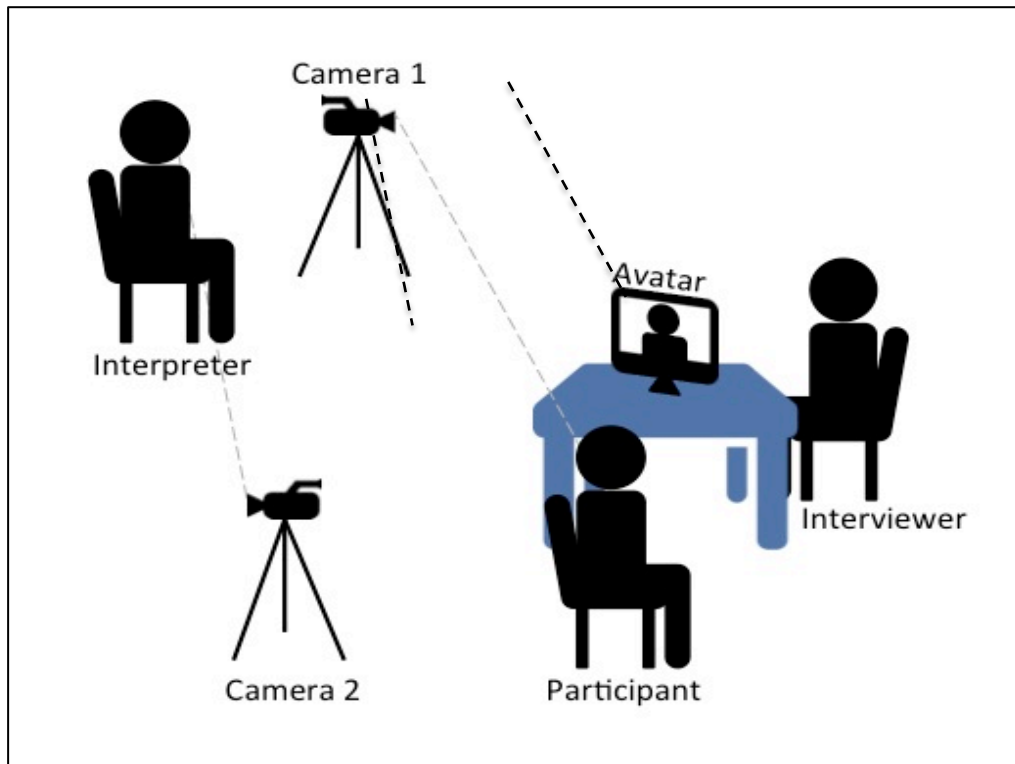
This process was repeated for each video in a given participants’ video-set as designated by the Latin square model. The final phase of the interview, phase 3, was designed to allow the participants direct feedback regarding each avatar. Focusing primarily on the participants’ acceptance/non-acceptance of the avatars, what use they might see for them in the future and how their own views may have changed since seeing the avatars in person.



**Figure 4 the JASigning framework**

**Table 5-1 Avatars used**

	<b>EFE encoding</b>	<b>Realism</b>
<b>Anna baseline</b>	No	Human looking
<b>Luna baseline</b>	No	Caricature
<b>AnnaE</b>	Yes	Human looking
<b>LunaE</b>	Yes	Caricature



**Figure 5 Evaluation room layout**

## 6. RESULTS

Demographically, a broad range of participants took part in the evaluation. All 15 participants were aged between 19 and 60, with 60% of those falling into the 31 to 40 age bracket. There was a comparatively even number of males to females with female participation slightly lower at 40%. As the evaluation took place in Dublin, it is not surprising that 67% of participants were from the province of Leinster. Munster was the only province with no representation as representatives of the other 2 provinces: Ulster 30% and Connaught 13% took part. 93% of the participants listed ISL as their first language with 87% attending a Deaf-only school as a child. On a scale of 0 to 5, all participants ranked themselves either 4

or 5 for ISL competency, 87% ranking themselves a 5. 27% of participants studied ISL at 3<sup>rd</sup> level.

## 6.1 General findings

During the 1<sup>st</sup> phase of the interview, before participants had been shown the avatars, 40% of all participants declared that they had never been exposed to signing avatar technology before. The remainder indicated only limited exposure, with only 7% having had hands on experience of the technology. Surprisingly, 20% of participants indicated no interest in 3D graphics, including 3D animated movies. When asked if difficulties might arise when introducing avatar technology to the Deaf community, 67% of participants said there would be some difficulties. The majority of these cited: the lack of facial expression, and robotic-like movement as the primary factors in this. All participants indicated a preference for a human signer. 33% of participants fear that signing avatars will replace sign language interpreters in the future and 60% indicated a willingness to use this technology if it improves to an acceptable point.

73% of participants declared themselves as having a general interest in new gadgets and technologies, identifying smartphones and tablets as their most used gadgets. When asked if they prefer web content to be word-based or signed video<sup>3</sup>, 53% said they would prefer content in both formats, 27% would prefer signing video only and the remaining 20% would prefer English text. 33% of the participants stated that they often have problems reading English text on the web. Participants stated that this was a common issue on websites with a lot of jargon or advanced English. In phase 3 of the interview, after watching the avatar videos, participants were asked which medium is preferable for web content. 53% of participants listed signing video as their first choice for web content and the remaining 47% listed written English as their first choice (Figure 6). It is noteworthy that not one participant selected a signing avatar as their first choice for web content. Yet, 27% did choose avatars as their second choice and 73% chose avatars as their third choice. When asked directly if they would use a signing avatar video 47% said they would if the avatar was of a high enough quality. This is a 13% decrease from the 60% acceptance rate recorded in the first phase of the interview (see Figure 7). The fact that 90% of participants said that the avatars movements do not look natural is a definite factor in this. Frequently, participants stated that the avatars looked “stiff”, “robotic” and “required a lot of effort to read”. When asked if the avatars had been easy to understand, 50% said “no”, 10% said “yes” and 40% said “sometimes”.

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<sup>3</sup> A pre-recorded video of a ‘real person’ using sign language to provide an alternative to text on the web.

**Table 6-1 Attributes - Anna vs. Luna**

Attribute	Anna	Luna
Emotion	-3	-3
Facial movement	-1	-3
Eyes (engaging)	0	2
Eyes (size)	0	-4
NMF amount	-3	-3
Fingers/Hands/arms	0	2
Body movement	-1	0
Naturalness	-4	-8
Presence	-2	0
Content	-3	-4
Clear signing	-1	0
Finger spelling	-4	-4
Singing space	-3	-3
Timing/Flow	-1	-3
Clothes/hair/colours	0	-1
Suitable for adults	2	0
Suitable for kids	0	2
<b>Total</b>	<b>-24</b>	<b>-30</b>

As to whether the participants preferred a caricature avatar (Luna) or a more human like option (Anna): 40% preferred Luna, 50% preferred Anna and 10% said they had no preference either way (Figure 8). Generally, participants commented that Anna would be a better choice of avatar for formal content whereas, Luna would be best suited to content for children. A number of participants mentioned that Luna's longer fingers worked well and Anna's face is better suited to deliver facial expression. Luna's larger eyes received a mixed reaction; some felt they made the avatar more engaging while other participants considered them too big, one participant mentioned that they were "alien like". In an effort to quantify these comments each positive comment was assigned a weight of '1' and each negative comment was assigned a weight of '-1'. These weightings were recorded in a matrix for each of the most commonly remarked upon attributes. A summary of this matrix is displayed in

Table 6-1. It is clear that many of the attributes and characteristics that were strongly disliked such as emotion, naturalness, NMF amount, fingerspelling and signing space, were related to linguistic clarity and linguistic performance of the avatar. This would suggest that the avatars perform poorly with the more fundamental linguistic aspects of ISL. For the most part the

attributes that scored  $\geq 0$  are more aesthetic in nature and may lend themselves more to personnel taste.

Again, in phase 3, participants were asked: if the technology was improved, where could this technology be used in the future? 80% of participants would like to see the technology used to translate web content, 47% said it may be a valuable teaching aid or suit a classroom environment, 43% believe it suitable for television signing and only 17% think that it could be a suitable replacement for live interpreters in a sensitive setting. Other uses suggested include: social networking, a VOIP alternative, console gaming, and video relay interpreting (see Figure 9).

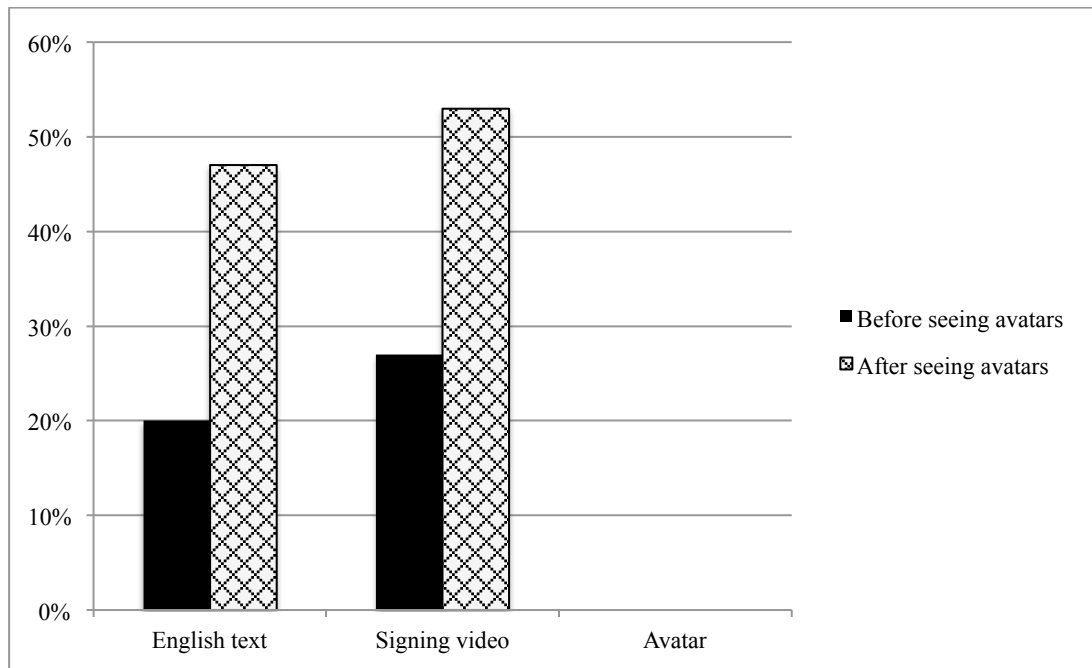
## **7. COMPREHENSION**

Results indicate that participants, when directly asked, underrated their own comprehension on each avatar video shown. Figure 10 shows that, on average, participants self-scoring across all avatars, at 46%. This is considerably lower than the score achieved in the comprehension exercise 60%. In the case of avatars that had been enriched with EFEs, the self-applied score was 14% lower. At the other extreme, in the case of the avatar Anna (with and without EFEs), the score was 44% lower. This indicates that the participant's perceived comprehension is substantially lower than their actual comprehension, which may be one reason for the low uptake of this technology amongst the Deaf community.

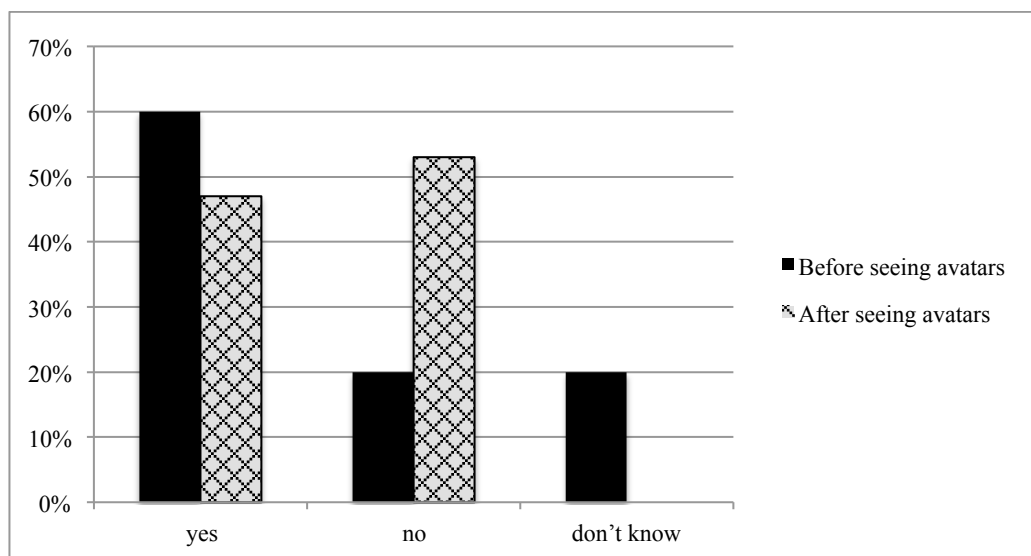
The most surprising result was the difference in comprehension score between baseline avatars and those augmented with EFEs. The results indicate that participants understood 62% of the content delivered through the baseline avatars yet when EFE was added the comprehension level fell to 60% (Figure 10). This would seem to indicate that instead of improving comprehension, the addition of EFE had a negative effect albeit marginal.

A further breakdown of the results in Figure 11 gives a clearer picture as to how each of the four avatars performed. AnnaE recorded a higher comprehension score than LunaE scoring 64% and 54% respectively. Anna also scored higher with the baseline encoding, scoring 4% higher than Luna with 63% and 59% respectively. Again we note the gulf between the EFE and baseline avatars.

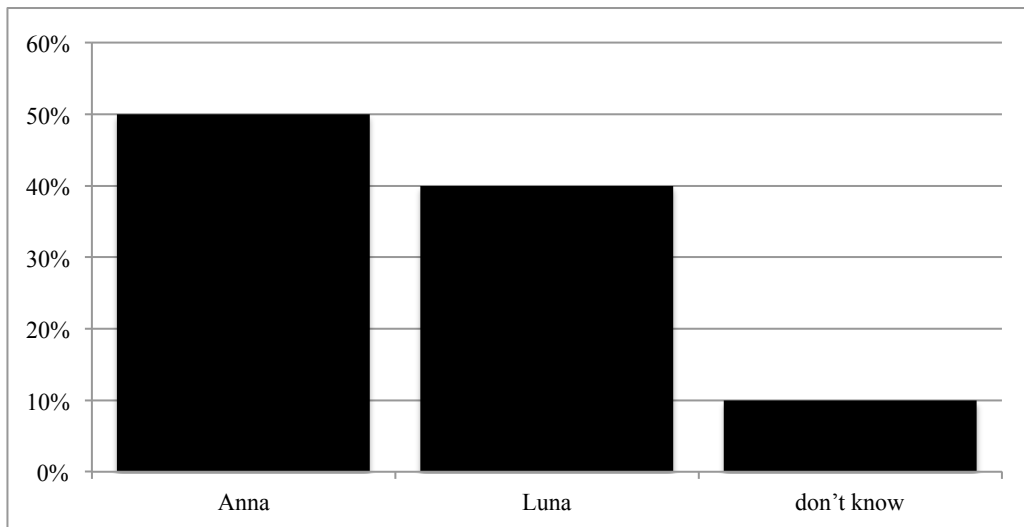
These results demonstrate that the addition of EFEs for comprehension was more successful with the 'human looking' avatar than with the caricature avatar. In addition, these results also confirm that regardless of EFEs, Anna was the easier avatar to comprehend.



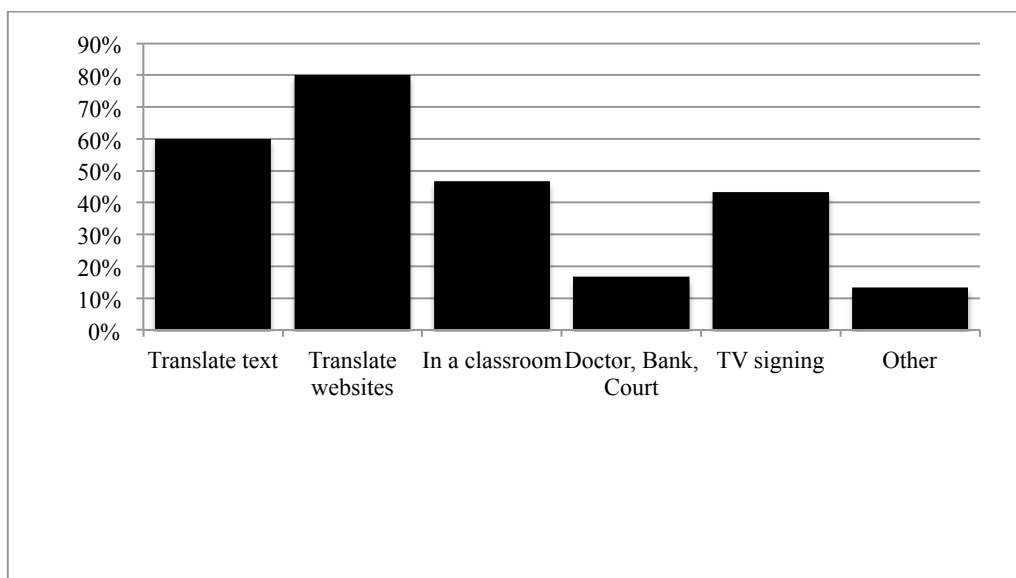
**Figure 6 Participants' preference (text, video, and avatar)**



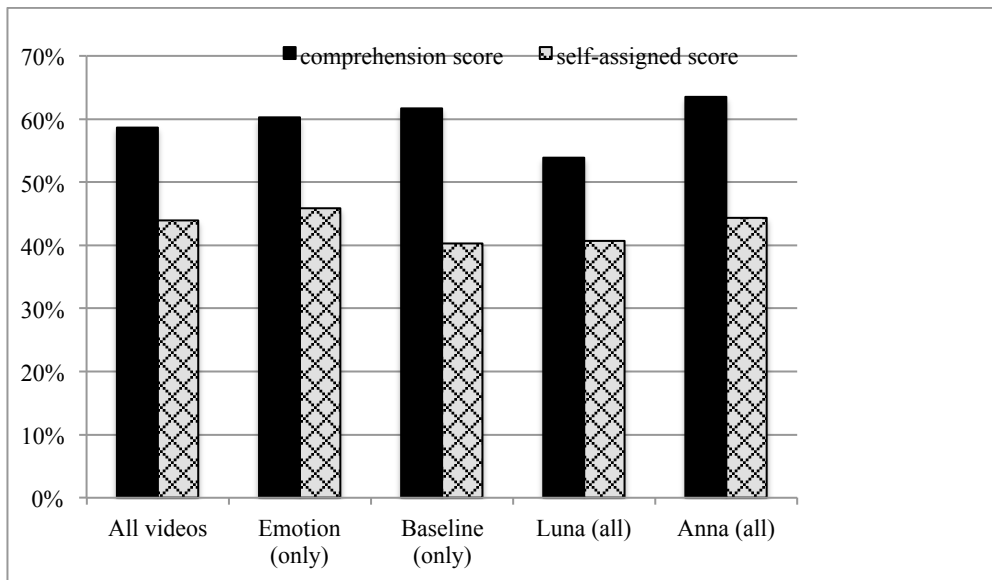
**Figure 7 Would you use a signing avatar video?**



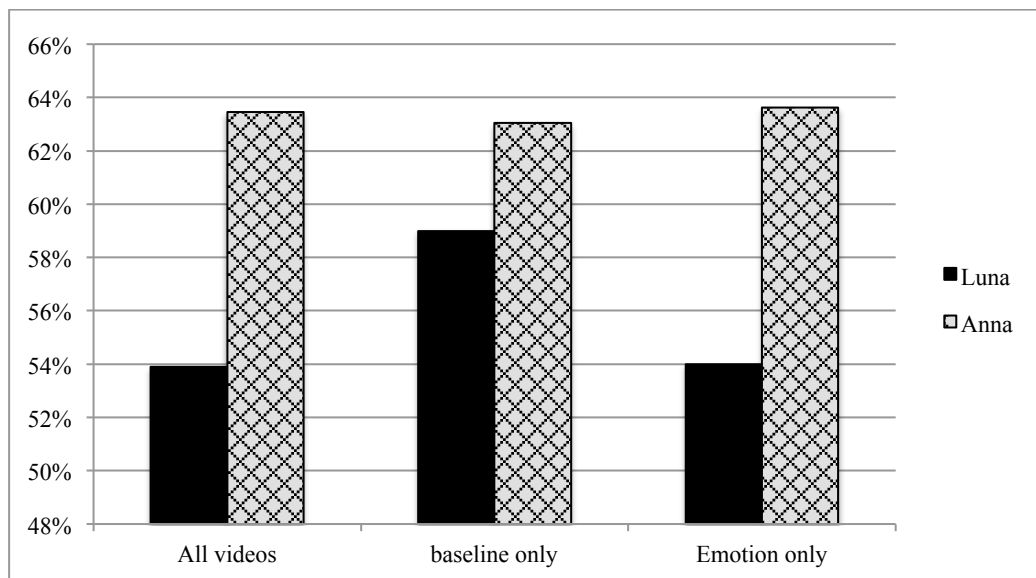
**Figure 8 Avatar preference**



**Figure 9 Possible use for avatar technology**

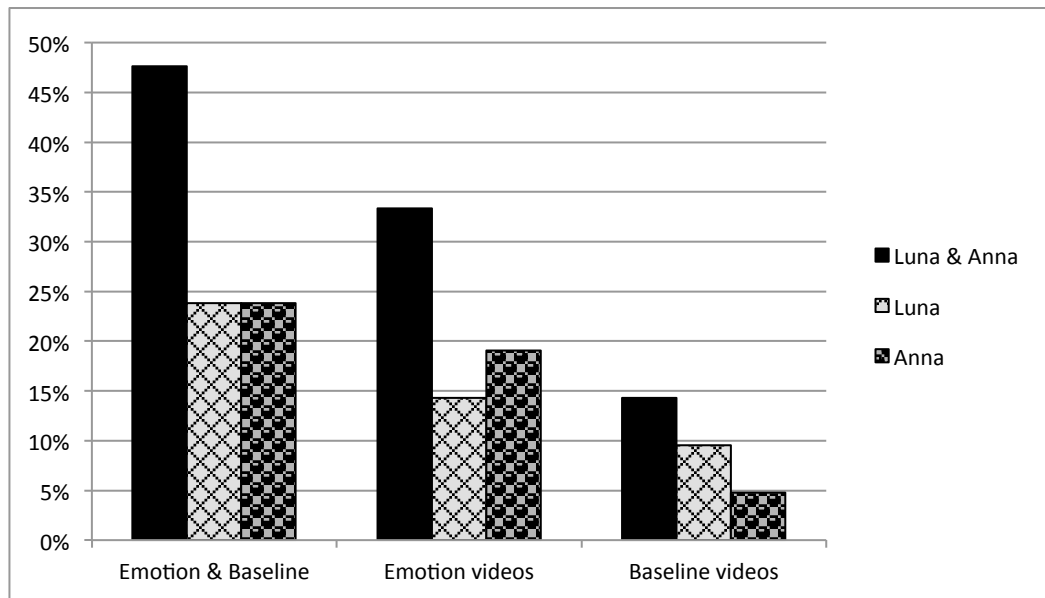


**Figure 10 Comprehension score vs. self-assigned score**

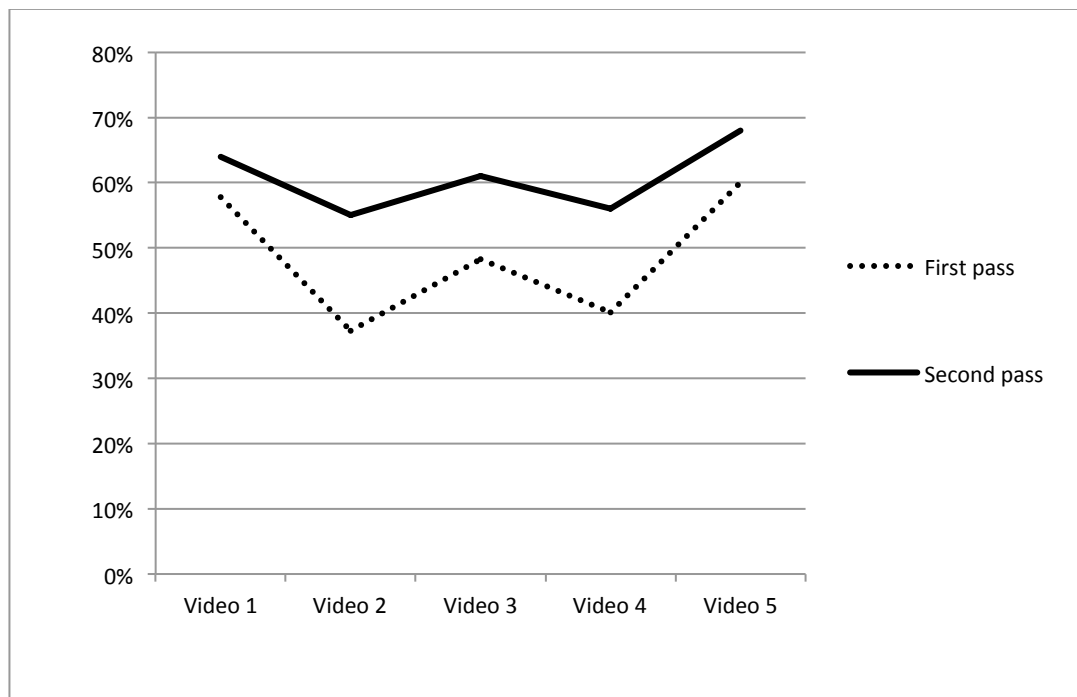


**Figure 11 Average comprehension score by Avatar**





**Figure 12 Did you see emotion?**



**Figure 13 Average comprehension score - 1<sup>st</sup> and 2<sup>nd</sup> viewing**

After watching each avatar video, participants were asked if they had seen emotion. Figure 12 shows that participants' recognised emotion in 48% of all videos. 33% of the videos in which emotion was identified, EFEs were added to the baseline coding. Emotion was also identified in 14% of videos with no additional EFEs. This may be due to participants incorrectly identifying basic facial movement as an attempt at EFEs. In addition to this, participants' remarks indicate that Luna's permanent smile was a cause of some confusion.

As stated earlier in this paper, each participant was asked to watch each video twice e.g. After watching a video once, a participant would be asked a series of comprehension question then directly afterwards the participant was asked to view the video a second time and asked the very same set of questions again. It is acknowledged at this point that the score for the second pass is skewed by a degree of learning. It must also be noted, however, that due to inexperience with the technology, participants struggled to capture any information from the first viewing of each video as previously experienced during a trial evaluation.

Figure 13 illustrates a comparison between the average comprehension score achieved based on each video for the first and second viewings, this include EFE and baseline scores for all avatars. It is clear that comprehension scores are higher after the second viewing of each video. The difference between the score for the first and second pass ranges from 6% for video 1 up to 18% for video 2. We believe the cause of this is the video content. Video 2 contains finger spelling, place names, role shift and classifiers; although, all of the videos contain these to some extent, video 2 has a higher concentration. This also accounts for the fact that video 2 has the lowest average comprehension score in both the first and second pass. The second trough in the graph represents a lower comprehension score for video 4. At 73 seconds and 77 utterances, video 4 is the longest video in the set. It also contains much of the same difficult content as video 2. Videos 1 and 5 are two of the shortest videos in the set and contain little of the difficult content described for video 2 and 5.

## **8. CONCLUSION**

The primary focus of the evaluation was to ascertain whether or not the addition of emotional facial configuration increased the understandability of a signed utterance. The results presented here would indicate that this is not the case. In fact, Figure 10 shows that the addition of EFEs made very little impact with the score for the baseline avatars and the EFEs augmented avatar almost identical, overall having a marginally negative effect of -2%.

Also evident from the results is the higher comprehension levels achieved with the avatar Anna. Anna was designed to be as close to human looking as possible while using lower levels of 3D data for speedy rendering. This result could have a significant impact on future development of sign language avatars and their facial configuration. Commonly, participants commented that Anna looked quite the serious avatar and that Luna may be better suited for children. It was also suggested that a repertoire of avatars be available for various tasks. Such a repertoire would have a place for both Anna and Luna. The fact remains, however, that regardless of preference, participants understood Anna better than Luna. Participant's remarks and the results highlighted in Figure 8 & Figure 11 enlighten us to a possible reason for this: The EFEs are more easily identified in the AnnaE avatar. The difference in

participants own perception of emotion recognition between Luna and Anna is marginal at 5% (Figure 12) but when we also consider the relatively high false positive of the baseline Luna avatar (10%) we can surmise that the participants, at least 42% of the time, falsely identify emotion in Luna. This is most likely due to the avatars perpetual smile (see Figure 1).

Figure 13 indicates a comprehension score of between 55% and 68% (or and average of 61%) on the second viewing of the videos and an average of 49% on the initial viewings. The most common use suggested for this technology was the translation of websites (Figure 9), in that instance, given the level of control provided to the user for video on the web, the score achieved after the second viewings is relevant. For practically every other purpose, again see Figure 9, the scores achieved after the first viewing are of the utmost importance. These figures are encouraging but show that there is much work yet to be done before the various Deaf communities can use these avatars widely. As to why the mean comprehension level is low, particularly on the first viewing,

Table 6-1 highlights a number of attributes of linguistic importance that scored badly amongst participants. One must surmise that these linguistics attributes are directly linked to the participants' comprehension and indeed the perceived comprehension scores reported in Figure 10. Although the average comprehension scores indicate only a minor effect of EFEs,

Table 6-1 indicates that attributes such as emotion and NMF are desired by the Deaf community and furthermore, are required to improve comprehension.

We saw in Figure 6 that, predictably, the majority of participants preferred signing video with a real person for web content. It was surprising, however, to see that there was an almost even split in those that chose English text and signing video. This revelation would seem to contradict much of the literature available on the level of the deaf community's literacy skills [5]. This may, in part, be a result of the relatively young demographic: 89% are less than 50 years of age and 67% are less than 40. Another contributing factor to this revelation may be the 73% interested in new technologies reported in section 6.1. It is reasonable to infer that daily use of mobile devices such as smartphones and tablet computers for casual web

browsing, SMS and email would result in more exposure to the written word and therefore a higher level of literacy.

It is interesting to see (in Figure 7) that, despite 60% of participants indicating a willingness to use this technology before seeing the avatar videos, only 47% held that view after viewing the avatar videos with the caveat of increased performance. This indicates that the avatar quality presented was below the standard that was anticipated by the participants. This is compounded by low perceived comprehension score (Figure 10) in addition to the results in Figure 6, in which no participant chose avatar video as their first choice of web content and only 27% chose it as their second choice. All hope is not lost however; hearts may be lightened by the 47% willingness to engage with the technology as well as the 20% of participants who answered “Don’t know” and of course, the willingness of participants to elect some potential uses for the technology in the future (Figure 9).

Qualitative feedback suggests the avatars are an applicable technology that has not yet evolved to a point for mainstream use. Common remarks include “robotic”, “unnatural”, “stiff” and in one case a participant coined the new phrase “it looks avatary”. This feedback alongside the statistic that 90% did not think the avatars looked natural demonstrates that there is still a lot of work to be done with regards to the avatars movement. Feedback relating to the speed and timing of signs illustrates a need for work in this area, in particular, an appropriate synchronization of manual feature and non-manual feature and timing at the sign level, particularly for finger spelling. Finally, feedback regarding facial movement and emotional expression indicates that there is still quite a long way here also. Although some change in facial configuration may be applied at the texture-map and polygon morph levels, an improvement in the naturalness of movement and timing have a huge effect on facial movement also and perhaps these are a more suitable place to begin making changes.

## **9. FUTURE WORK**

Much work must be done to achieve a usable, comprehensible avatar with particular focus on the linguistic attributes that fared badly in

Table 6-1. A further investigation would be beneficial to identify why these attributes fared badly and how best to deliver a solution that will not only address these attributes but, by proxy, also increase the comprehension level.

## **10. ACKNOWLEDGMENTS**

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# Serial Verb Constructions in Pitjantjatjara and Yankunytjatjara

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## ABSTRACT

*This study looks at serial verb constructions in two dialects of the Western Desert language of Australia, Pitjantjatjara and Yankunytjatjara. With a Role and Reference Grammar analysis, the paradigm allows us to look at the constituents for logical structure, and marking of macroroles. We find that core and peripheral argument phrases are marked by case with ergative nominal marking and accusative pronoun marking. Dependent marking is on the phrase level and there is no verb agreement for number, gender or person marking on the verb. Simple verbs use endings for tense, aspect, mood and status. The operator projection shows the nature of linkage between the verbs involved in multi verb structures. There is a serial participle marked on the members of these constructions and a finite verb that is typically clause final. We look at whether these meet the criteria for serial verb constructions and find that in some nuclear cases there is evidence that they do, with sharing of arguments and a single action implied. Serial verbs can form nuclear or clausal cosubordinate nexus junctures.*

## 1 Introduction

Several linguistic features have motivated this study. We will look at whether the serial verb construction often found in African, Asian and Austronesian languages is evidenced in the Western Desert group. Dixon (2006:344ff) states that serial verb constructions are not common in Australia but looks into evidence that they may exist in Dyirbal. The fact that many structures are common between Australian languages, in particular those outside the Top End, provides a fascinating window into how languages evolve and spread.

The grammar will be discussed under the paradigm of Role and Reference Grammar (henceforth RRG). RRG is intended to be able to be used globally for the description of any language so is a good candidate in which to conduct the study. RRG's layered structure of the clause will allow us to look at the arguments and non-arguments of the predicate and how they are marked in P/Y. We will look at simple verb constructions to see how tense, aspect and mood are marked, and then use this to study multi verb constructions. Central to this is a study of nexus juncture relationships. The operator projection will allow us to see the scope of the operators, and therefore the type of joins at nuclear, core and clause level. With the constituent projection, we can show how the arguments are shared, whether clauses are subordinate, and whether any multiple verbs can be classed as serial verb constructions. RRG also has the concept of macroroles as shown in the logical structure and this is important in comparing ergative and accusative systems to determine the actor and undergoer. Where arguments are shared by two adjoining predicates there is a suggestion of serial verb formation.

## **1.1 Methodology**

Data from the published literature and online resources will be used to investigate and illustrate each point. Leipzig glossing will be provided with a free translation. The RRG projections will be used in places to show the underlying construction and the logical structure as codified by RRG will show the semantic macroroles. The last section will sum up the findings, put them into context and propose possible avenues for future research.

## **1.2 Structure of the paper**

After looking at the background of P/Y, an outline of RRG and the nominal case system, we will look at the verbs in P/Y. There are four verbal conjugations in Pitjantjatjara and Yankunytjatjara (Goddard, 1993:11). Light verbs ('having', 'being') can become adjectival suffixes to nominals. We will analyse different types of multi verb system, looking at examples of serial verb constructions, coordination and subordination. In serial verbs a sequence of verbs act as one predicate (Aikhenvald, 2006). A detailed look at the sharing of predicate arguments will help shed light on the type of nexus and level of juncture. Causation is one example of where multiple verbs may co-occur both in nuclear and causal constructions. This will touch on the clause linkage theory as described in Song (1996:110-111), which can be used to establish how closely bonded the clauses in a sentence are.

# **2 Background to Pitjantjatjara, Yankunytjatjara and the Western Desert languages**

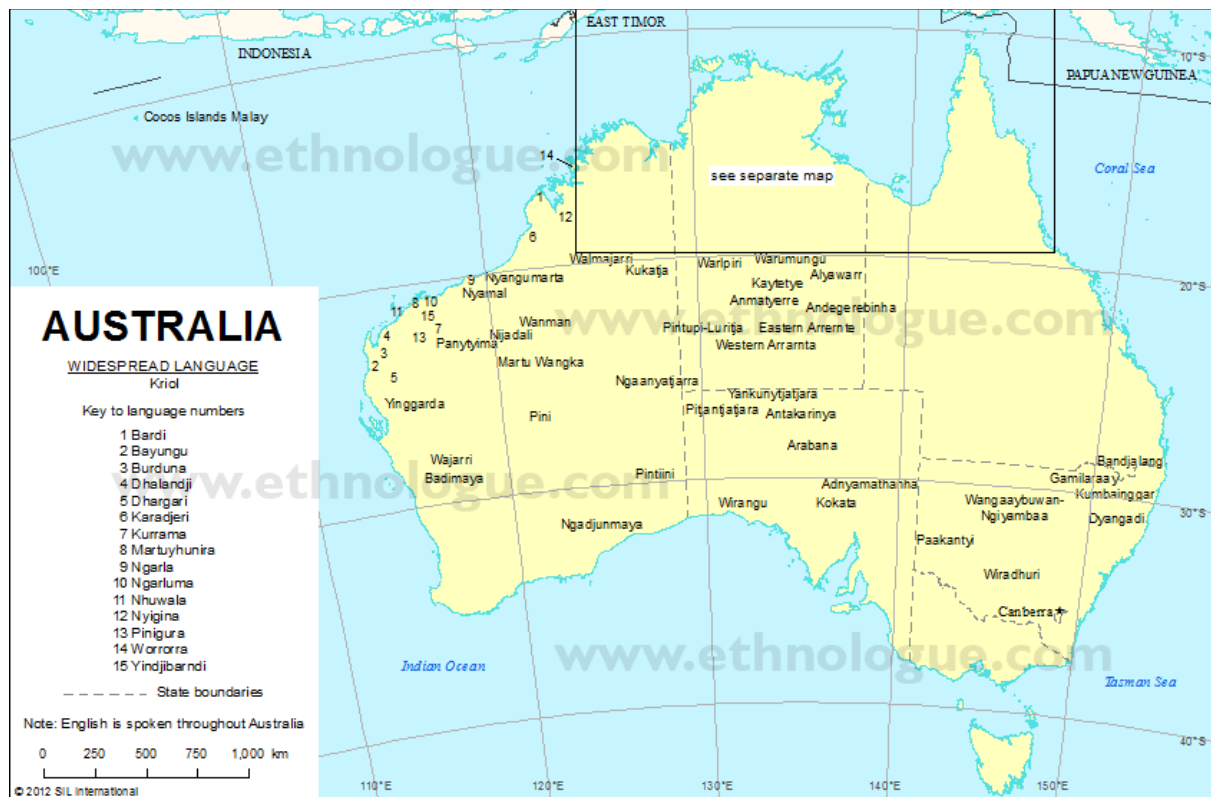
## **2.1 Australian languages**

There were around 250 Aboriginal languages before Europeans arrived in 1788 (Bower, 2010). These were spoken in social groups ranging from less than a hundred to several thousand members. It has been estimated that there were an estimated 600 social units or tribes, neighbouring tribes often speaking dialects of the same language. Around 50 languages have become extinct and 100 endangered; there are attempts to resuscitate some of them through intensive language description and teaching (Dixon, 2011:18).

There are some features in general that Australian languages share. Almost all have three numbers in pronominals; single, dual and plural (Dixon, 2011:3). Another general characteristic of Australian languages is agglutination. There are three basic word classes, based on how they inflect: verbs using suffixes to indicate tense, mood and so on; nominals inflecting for case; and particles with no inflection (Blake, 1987:2-3). The use of suffixes is widely used in changing one part of speech to another (Blake, 1987:8). The ergative case system found in around 15% of world languages applies to almost all Australian ones, and marking generally allows freedom of word order (Blake, 1987:9-10).

Phonologically the vowels a, i, and u and longer versions are found in the majority; with voiced/unvoiced consonants there is usually no distinction (Blake, 1987:10). However the languages vary widely in the number of phonemes. Dixon (2011:3) cites as extremes Nyawaygi from near Townsville with 12 consonants and 3 vowels; Cape Yorks, Anguthimri with 29 consonants and 17 vowels. P/Y has 17 consonant and 6 vowel phonemes.

The distribution of Pitjantjatjara and Yankunytjatjara is illustrated in figure 1, just south of the centre of the map. Figure 2 shows the higher concentration of languages in the Top End.



**Figure 14: Australian language locations.**

From [http://www.ethnologue.com/map/AU\\_\\_](http://www.ethnologue.com/map/AU__)





(1990:1) cites 4000-5000 speakers of Pitjantjatjara and 2-300 of Yankunytjatjara. While regarded as strong, studies have been done on the vitality of Yankunytjatjara in Coober Pedy (Naessan, 2008). There are suggestions that Yankunytjatjara is under pressure from Pitjantjatjara and Standard Australian English (SAE). Gale (2011) discusses Yankunytjatjara as being taken over by Pitjantjatjara; recently steps are also being made to revitalise a related moribund language, Ngarrindjeri, through teaching.

### **3 Description of the Role and Reference Grammar (RRG) paradigm**

This section will outline RRG so that we can see how it will assist in analysing serial verb constructions. This will involve a discussion of elements at all levels of the sentence, clause, core (arguments) and nucleus (predicate); and a look at how operators work on these elements. The choice of RRG is motivated by its universality; its emphasis on communication; and by the fact that it can be used to look at semantic structure in particular the behaviour of predicates. The universality means we can study non Indo-European languages, of which Western Desert is one, on a neutral basis. By the analysis of predicate and argument structures we have the foundation for an in depth look at serial and multi verb constructions and how arguments are shared; this will also entail an analysis of juncture and nexus types. The constituent and operator projections will be discussed; how the data can be broken down and lexically decomposed showing the macrorole arguments.

#### **3.1 Role and Reference Grammar**

Role and Reference Grammar (RRG) is a structural-functional theory of grammar that represents syntactic structure through the meaning and function of words (Pavey, 2010:53). Thus it combines a semantic and communicative approach (Nolan, 2012:2ff). Similar semantic categories are to be found in all languages; but they are expressed differently syntactically. By linking syntax to semantics, a neutral environment is achieved that can be used for the study of any language. It is emphasised that RRG only includes features in clauses that have universal validity (Van Valin, 2001:205). The goal of RRG is a description and explanation of linguistic phenomena and an understanding of the cognitive basis of language (Van Valin & LaPolla, 1997:2-4). RRG is a minimalist grammar and is monostratal (Van Valin, 2007; Van Valin & LaPolla, 1997:21).

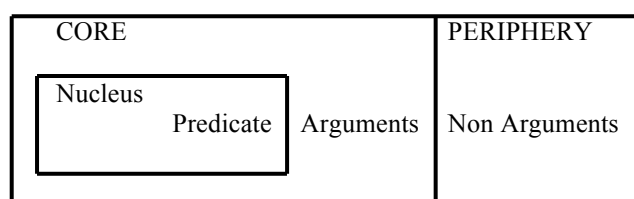
#### **3.2 Representation of clauses**

Van Valin & LaPolla (1997:25) posit these universal distinctions:

- Predicating versus non predicating elements.
- Noun phrases and adpositional phrases that are arguments of the predicate versus those that are not arguments.

Every language makes a distinction between predicates and arguments, regardless of lexical classes. There may be structures without a predicate and argument, for example in Lakota, *magázu* ‘it is raining’; but the majority of clause patterns show predicate and argument (Van Valin & LaPolla, 1997:27).

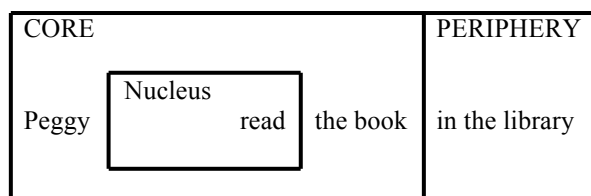
The basic semantic categories of the clause are predicates, arguments and non-arguments (Pavey, 2010:53). The syntactic units are the nucleus, core and periphery. The nucleus contains the predicate (Van Valin, 2001:206); the core contains the nucleus and the arguments of the predicate; the periphery contains the non-arguments, adjunct modifiers of the core (Van Valin, 2007). These three are universal features of clauses, shown in every language (Aikhenvald, 2009). This is known as the layered structure of the clause (LSC); each layer is semantically motivated (Nolan, 2012:5). This is shown in figure 3:



**Figure 16: Layered structure of the clause (LSC)**

The predicate tells us what is going on in a clause and is very often a verb. The nucleus may also contain a copula or auxiliary if there is a non-verbal predicate (Pavey, 2004), or it can contain a verb and noun stem (Van Valin & LaPolla, 1997:28).

A typical example with a verbal predicate is in figure 4:



**Figure 17: Example of LSC in English with verbal predicate**

Noun and verb are posited as universally valid categories, based on reference (nouns); and predication (verbs) (Van Valin & LaPolla, 1997:28).

As well as these universal features, others occur. Outside the core but inside the clause, there may be pre and post core slots. Outside the clause but inside the sentence, left and right detached positions may also exist (Pavey, 2004; Van Valin & LaPolla, 1997:35-36).

The following is an example of a pre-core slot (PrCS):

- (1) *That book* you put on the table  
\*that book you put it on the table

No pronoun is needed if *that book* is in the PrCS.

This is a left detached position (LDP):

- (2) *That book*, you put it on the table:

This is grammatical if *that book* is in the LDP. If the noun phrase (NP) is a semantic argument, a referring pronoun ‘it’ is needed in the clause (Van Valin & LaPolla, 1997:35-36).

The pre-core slot may contain question words in English, or fronted elements such as ‘bean soup I can’t stand’ (Van Valin, 2005:5-7). If, for example, there is new information that needs focus, it needs to be within the clause and thus in the pre-core slot to be within the illocutionary force operator. The detached phrase is usually on the left. Adverbials often occur here, and are separated from the clause by a pause. When an element functions as a semantic argument, a pronoun is required in the core referring to it, as in the above example (ibid.)

A ‘core argument’ is a syntactic, rather than a semantic notion. For an element to appear in the core of a clause, there must be an argument in the semantic representation, but the opposite is not true; an argument in the semantic representation can occur in an extra core slot or detached position, as we saw in (1) and (2) (Van Valin & LaPolla, 1997:38). The universal elements (nucleus, core, periphery and clause) are semantically motivated, while the non-universal ones (detached phrases, core slots) are not semantically motivated but pragmatically motivated (Van Valin & LaPolla, 1997:39). In the clause, the head is the predicate and the dependents are arguments. Arguments do not have to be independent words: head marking is achieved via affixes on the predicate; these affixes are the arguments and the coreferential noun phrases are optional. Dependent marking is achieved by case or adpositional marking (Pavey, 2010:79).

The head marking language Lakhota has pronominal affixes on the verb as the core arguments, rather than independent phrases as in dependent marking languages. The opposition between dependent marking and head marking is not absolute; there are some dependent marking languages with head marking features and vice versa. Italian, Spanish, Polish and Croatian are basically dependent making languages, but have verb agreement which expresses person and number of the subject, meaning no independent pronoun is necessary (Van Valin & LaPolla, 1997:33-34). Pitjantjatjara and Yankunytjatjara have an alternative system of pronominal enclitics (Goddard, 1993:21) which act as arguments. However they are clitics of the first element of the clause rather than head marking.

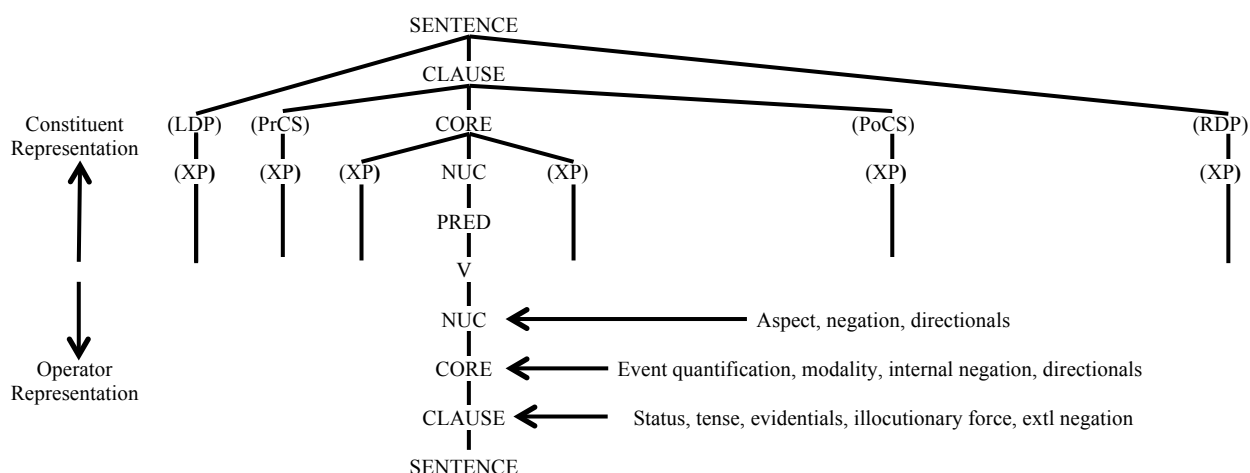
The sentence constituents are represented in tree diagrams as in the figures below.

### 3.3 Operators

As well as the predicate, its arguments and the periphery, clauses may contain operators. These act to modify different parts of the clause. There are several types. Negation and illocutionary force are the only universal ones; negation is the only one that can act on all three levels of clause, core and nucleus. Operators are a closed class of grammatical categories (Pavey, 2010:62ff). The following are the kinds of operator and the level they modify:

- Nuclear: aspect/negation/directionals
- Core: event quantification/modality(deontic)/negation(internal)
- Clause: status/tense/evidentials/illocutionary force/negation(external)

The general schema in figure 5 after Nolan (2012:9) shows how the constituent representation ties in with the operator representation.



**Figure 18: Constituent and operator representations**

In the example in figure 6, ‘did’ is a clause operator with both illocutionary force (IF) and tense (Van Valin, 2001:207). The position of the tense operator signals IF in English (Nolan, 2012:8). The core medial shows declarative IF, core initial interrogative IF, and its absence shows the imperative. In the LSC, the syntactic categories at the bottom realise the units. The arrow of the periphery shows it is an adjunct, optional modifier of the core (Van Valin & LaPolla, 1997:31). There is a distinction between direct core arguments and oblique core arguments (Van Valin & LaPolla, 1997:29). Languages have different ways of showing this distinction, often by case or adpositional marking. The English example in figure 6, based on Nolan (2012:9), has prepositional marking.

‘What’ in an example like this is a non-core direct argument, rather than an adjunct. ‘What’, ‘Joe’ and ‘Mary’ are syntactic and semantic arguments. ‘Joe’ and ‘Mary’ are core arguments. We could have oblique arguments in the pre-core slot too, for example, ‘To whom did John show the book’ (Van Valin & LaPolla, 1997:38). The term ‘reference phrase’ is often used instead of ‘noun phrase’ in recent work (Nolan, 2012:9).

The LSC allows representation of free order and head marking languages as well (Van Valin & LaPolla, 1997:33). The projections can deal with any word orders- lines can cross as in the constituent example in figure 7 from Pavey (2010:56-57); the data is from Jiwari (Pama-Nyungan, Australia).



semantics' (Van Valin & LaPolla, 1997:68). Functional (or 'operator') elements such as determiners have a separate projection and cannot therefore appear as heads of phrases.

There are five basic predicate classes of events or states, with a basic distinction between static and non-static: 'State', 'Activity', 'Achievement', 'Semelfactive' and 'Accomplishment' (Pavey, 2010:94). To these can be added 'Active achievement (ibid.)'/'Active accomplishment' (Nolan, 2012). These are based on Aktionsarten and have good cross linguistic validity.

The basic two classes are state and activity (Pavey, 2010:97). The other classes build on these, using predicate modifiers in the logical structure (Chang, 2007). We place the predicate in bold with a quote (Pavey, 2010:108) to show the logical structure (LS) (Van Valin, 2007) and arguments in brackets afterwards. These predicates are not intended to represent words in any language but rather semantic metalanguage (Chang, 2007). Abstract predicates cannot have more than two arguments, so three argument verbs need more complex constructions (Van Valin, 2007). The following is based on Nolan (2012:11,33ff), Pavey (2010:109ff), Van Valin (2001:210-211) and Van Valin (2007).

### 3.4.1 State

These involve feelings, conditions and properties. The LS is **predicate'**(x) or **predicate'**(x, y).

The following are examples of stative predicates.

- (3) **cold'**(ice-cream) 'the ice-cream is cold'
- (4) **be'**(Marie, [**clever'**]) 'Marie is clever'
- (5) **be-in'**(park, pond) 'the pond is in the park'

### 3.4.2 Activity

These involve action. The LS is **do'**(x, [**predicate'**(x)]) or **do'**(x, [**predicate'**(x, y)]).

In (6) and (7) there are examples of activity predicates.

- (6) **do'**(Peadar, [**run'**(Peadar)]) 'Peadar is running'
- (7) **do'**(Lara, [**compose'**(Lara, symphony)]) 'Lara is composing a symphony'

**do'** is a part of the logical structure of all activity predicates; [**do'** (x, Ø)] is an unspecified activity (Van Valin, 2007).

### 3.4.3 Achievement

Achievement is an instantaneous change of state. In the logical structure INGR is added to a state or activity.

- (8) INGR **exploded'** (lightbulb)  
'the lightbulb exploded'

### 3.4.4 Accomplishment

Accomplishment is a change of state that takes time and has an inherent endpoint. This is shown by adding BECOME to a state or activity.

- (9) BECOME **melted**' (candle)  
'the candle melted'

### 3.4.5 Semelfactive

Semelfactive is instantaneous with no change of state. This is shown by adding SEML to a state or activity.

- (10) SEML **see**'(John, answer)  
'John glimpsed the answer'

### 3.4.6 Active achievement/accomplishment

Active achievement/accomplishment (Nolan, 2012:11) is an activity with an endpoint added. This thus combines meanings.

- (11) [**do**'(Henry,[**walk**'(Henry)))] & [INGR **be-at**'(park,Henry)]  
'Henry walked to the park'

### 3.4.7 Summary

The predicate classes and their properties are summarised in table 1.

Table 2: Predicate classes

	Static	Dynamic	Endpoint	Instantaneous	Change of State
State	yes	no	no	no	no
Activity	no	yes	no	no	no
Achievement	no	no	yes	yes	yes
Accomplishment	no	no	yes	no	yes
Semelfactive	no	some	no	yes	no
Active achievement/ accomplishment	no	yes	yes	no	no

## 3.5 Causation

Each of these has a corresponding caused event or state (Pavey, 2010:101-102). This takes the form of A CAUSE  $\beta$  where A and  $\beta$  are logical structures of any type (Van Valin, 2007). CAUSE signals a causative relation between two predicates. Pavey (2010:115) gives the following example:

- (12) [**do**'(Bob, $\emptyset$ )] CAUSE [BECOME **dead**'(postman)]  
'Bob killed the postman'

The DO agentive builds on this (Pavey, 2010:115):

- (13) [DO (Bob, [**do**'(Bob, $\emptyset$ )] CAUSE [BECOME **dead**'(postman)])]  
'Bob murdered the postman'



In ditransitive constructions traditionally there are a subject, object and indirect object; but semantic representations in RRG only take two arguments. These need to be paraphrased, for example:

(14) [do' (x, Ø)] CAUSE [BECOME/INGR **predicate'** (y,z)]

In the LS, **predicate'** could be **have'**, **be-LOC'** or **exist'**.

So 'give' is lexically decomposed as follows, where x is the actor, z the theme and y the recipient (Nolan, 2012:42-44):

(15) [do' (x, Ø)] CAUSE [BECOME **have'** (y,z)]

For example an action of giving could be decomposed as:

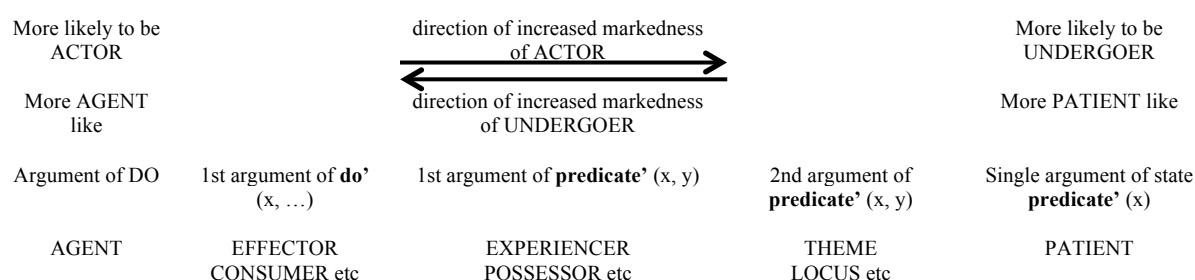
(16) [do' (Sue, Ø)] CAUSE [BECOME **have'** (George,book)]  
'Sue gave George the book'

### 3.6 Semantic macroroles

Sentences contain predicate arguments with roles traditionally described as the instrument, theme, patient and many others. These can be bulked up or generalised to two semantic macroroles. These macroroles draw a distinction between generally agentive 'doers' and those that are 'affected' by the action (Pavey, 2010:118-119; Van Valin & LaPolla, 1997:140). The actor and undergoer as these macroroles are termed, are not synonymous with the syntactic subject/object (Van Valin, 2007). So the actor can be the subject of an active voice transitive verb or the object of 'by' in a passive construction. The undergoer is the direct object of an active voice transitive verb and the subject of a passive verb (Van Valin, 2001:30). In English, either the actor or the undergoer may be the subject. English allows many argument types to be actor or undergoer; but some languages are stricter, for example only allowing animate or quasi animate entities as actor (Van Valin & LaPolla, 1997:142-143).

Arguments in the logical structures are mapped onto the macroroles (Pavey, 2004). Generally the 'x' in a two argument construction is the more actor like. Transitivity in RRG is expressed in terms of the number of semantic macroroles a verb takes. An intransitive verb takes one macrorole (actor or undergoer). A transitive one takes two, an actor and an undergoer. A ditransitive has both macroroles and a 3<sup>rd</sup> argument, the non macrorole direct core argument (Van Valin, 2007). Atransitive verbs have no macroroles, for example snow'. Irregular verbs have rules that are stored in the verb's lexical entry (Van Valin, 2001:211). These may have syntactic arguments but a different number of macrorole arguments. M-transitivity is the number of semantic macroroles a predicate takes; S-transitivity is the number of syntactic arguments (Nolan, 2012:13).

There is an actor undergoer hierarchy, with the most actor like being the role decomposed as DO, involving a conscious wilful agent. At the other end of the spectrum, a patient would be more a more marked choice as an actor (Pavey, 2010:120). This can be summarised as in figure 8 (Pavey, 2010:118-120):



**Figure 21: Actor undergoer hierarchy**

In head marking, the order of affixes on the root gives the information, rather than the order of the words or case. So for example the actor argument can be expressed as a proclitic, and undergoer and third argument as enclitics (Pavey, 2010:138).

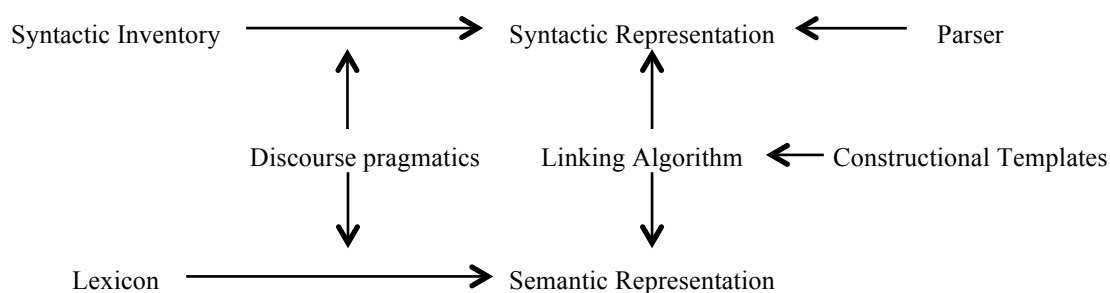
Having identified the macroroles, we can use them to identify the unmarked word order in languages, thus English, often called an SVO language has the order ACTOR PREDICATE UNDERGOER (Pavey, 2010:137ff).

Not all arguments in a logical structure representation are macroroles. For example a locative state predicate such as *be-on'* only has one macrorole, the undergoer; 'pigeon' in this example (Pavey, 2010:124):

- (17) The pigeon is on the table  
**be-on'** (table, pigeon)

### 3.7 Linking algorithm

The grammatical procedures in a language use a linking algorithm from the syntactic representation to the semantic representation and back (Van Valin, 2001:209). There is a single level of syntactic representation, mapped directly to the semantic representation (Van Valin & LaPolla, 1997:21). The syntactic inventory refers to the set of templates that can be combined (Van Valin, 2005:15). This is shown in figure 9:



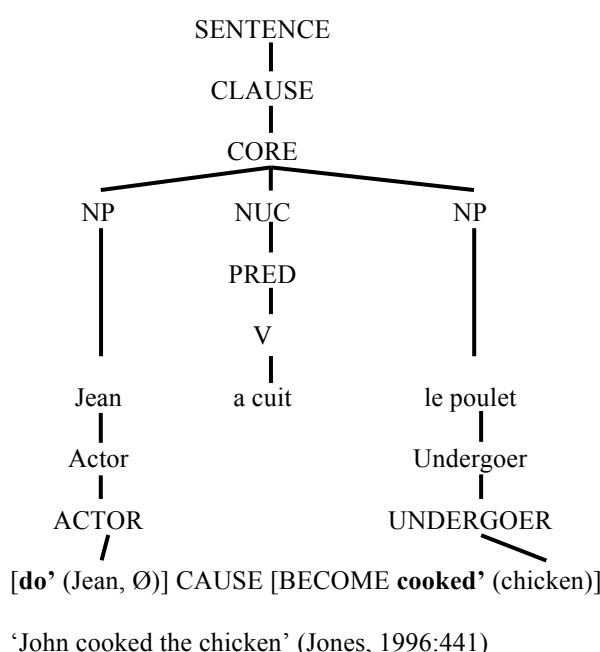
**Figure 22: Linking algorithm**

Semantics is linked to syntax for the speaker's perspective and syntax to semantics for the addressee's process (Pavey, 2010:298). In this way meaning is conveyed from speaker to listener via syntax. The semantic representation takes into account the lexicon, in other words the meanings of the predicates, and not just the effect of operators on predicates (Pavey,

2010:93-94). Multiple levels of syntactic representation are not necessary (Van Valin & LaPolla, 1997:21). There is a single level from the syntactic representation via the linking algorithm to the semantic representation.

The constituents are shown as sentence, clause, core, predicate and arguments; the semantic representation shows the event. The actor-undergoer hierarchy is the main interface between the syntactic and semantic representations, and allows mapping between them (Pavey, 2004).

For example in French, a causative example in figure 10 shows how the constituent representation ties into the semantic representation, based on Nolan (2012:17).



**Figure 23: Representation of causative**

The logical structure of this causative contains **do'**, CAUSE and BECOME, involving action, causation and accomplishment. The chicken as the undergoer is the single argument of the state predicate **cooked'**.

In this case, the causative may add to the number of macrorole core arguments, semantic arguments and independent syntactic core arguments (Pavey, 2010:169). A semantic and a syntactic argument are added to a non-causative predicate by the expression of the causer argument, which has actor macrorole status (Pavey, 2010:162-164). This changes both the meaning and the morpho-syntactic form of the sentence. The semantic valence is increased by adding the causer; the grammatical valence increases if another argument is added (Payne, 2006:258).

The completeness constraint states that the semantic and syntactic elements must be accounted for and match (Van Valin, 2007). All arguments in the semantic representation must be realised in the syntax and all referring expressions in the syntax must be linked to something in the semantic representation. Semantic roles as opposed to grammatical relations are claimed to be universal (Nolan, 2012:14-15).

### 3.8 Privileged Syntactic Argument

Subject and object are not considered universal (Pavey, 2004). Instead the Privileged Syntactic Argument (PSA) is used in RRG. Nolan (2012:14) calls this the restricted neutralisation of semantic roles and pragmatic functions for syntactic purposes. Pavey (2010:143) says this means that either the actor or undergoer can be the PSA, but that it is restricted to macroroles. This is termed the syntactic PSA.

Pavey (2010:143) states that the PSA controls verb agreement. The PSA may be the actor of a transitive predicate; the actor or undergoer of a single argument or intransitive predicate; or the undergoer in a passive construction. This last occurs in English and Irish (Nolan, 2012:14). However some languages do allow non-macrorole direct core arguments to be the PSA (Van Valin, 2007). Unlike semantic macrorole selection which is universal, PSA selection is language specific (ibid.).

The PSA selection hierarchy is similar to the actor/undergoer one; in accusative languages the most actor like is the PSA; in ergative languages (such as is Western Desert (Goddard, 1993:8)) the most undergoer like one fulfils this and is in absolutive case (Van Valin, 2007). In the ergative pattern, single arguments of intransitive verbs pattern like undergoers of transitive verbs (Pavey, 2010:150-152).

### 3.9 Juncture

Complex sentences may have a core with two nuclei, a clause with two cores or a sentence with two clauses. Sentences with more than one clause, core and/or nucleus have different kinds and levels of connection between the units, known as juncture (Pavey, 2010:219-220).

- Clause level- independent clauses with their own arguments, e.g. ‘Gary bought some puppies and he gave them to Jake’
- Core level- cores sharing an argument, e.g. ‘Jake told Gary to leave the room’
- Nuclear- juncture has one set of arguments, e.g. ‘Jake forced open the door’

This can be summarised as:

- [CORE...[NUC PRED]... + ... [NUC PRED]...] nuclear juncture
- [CLAUSE...[CORE ...]... + ... [CORE ...]...] core juncture
- [SENTENCE...[CLAUSE ...]... + ... [CLAUSE ...]...] clausal juncture

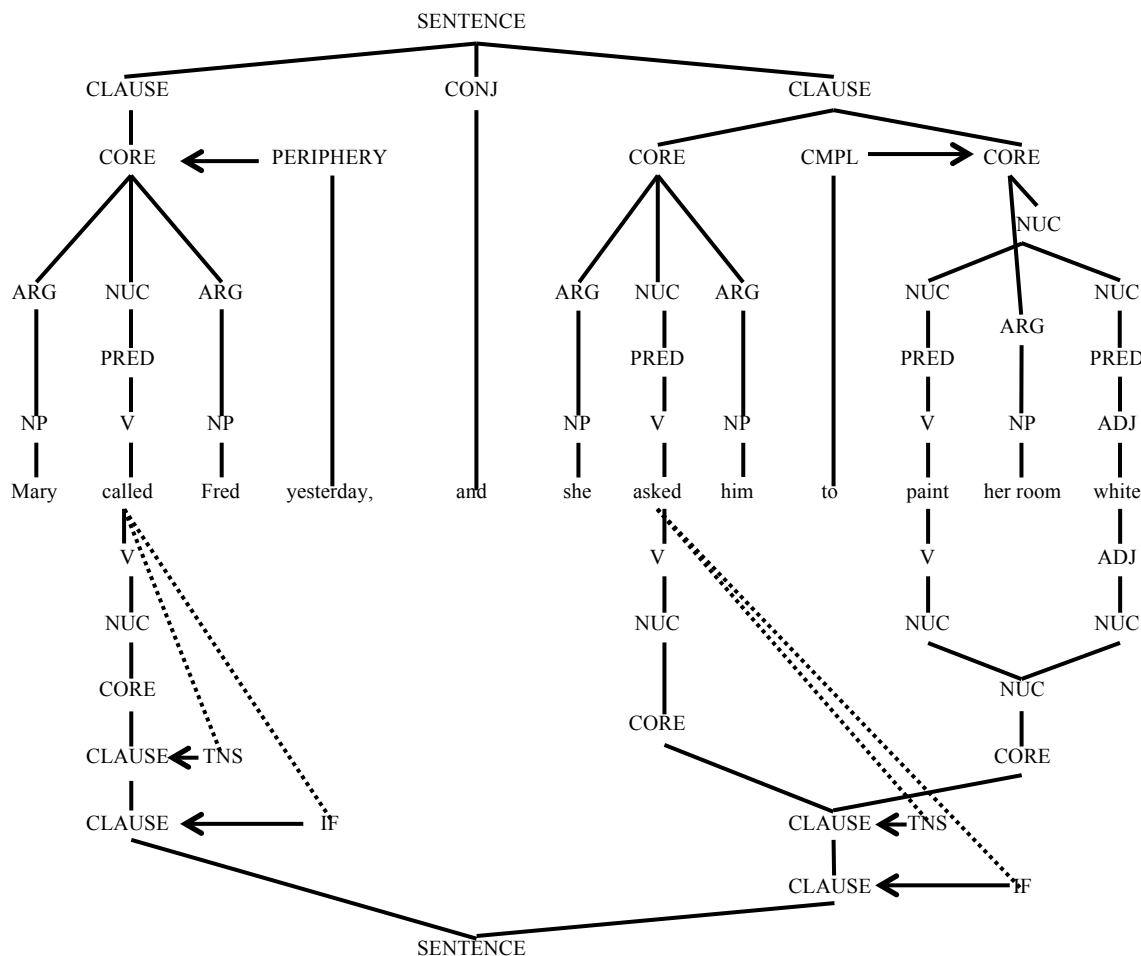
The unmarked linkage paradigm has units of the same level being linked. Marked, asymmetric linkages may occur for example between clause and core (Van Valin & LaPolla, 1997:442).

These can be joined by the following nexus types:

- Coordination- two or more units of the same type, joined symmetrically.
- Subordination- one unit is embedded in another. The subordinate clause is structurally dependent on the main clause. The sub clause is usually finite, marked for tense and agreement, expressing an event within another event.
- Cosubordination- two or more units are symmetrically joined, but one is dependent on another through the operator (Pavey, 2010:223-225).

There is a linear order of operator morphemes (Pavey, 2010:77), with the clausal furthest from nucleus. The clausal has scope over the core and nucleus. In P/Y we see the verb endings combine tense and IF at the clause level and aspect at the nuclear level. The inchoative ending *-ri* is appended before the verb endings.

In coordinated clauses, none are dependent and they are in sequence, with or without coordinating conjunctions. In subordinated ones the main clause is ‘modified’ by one or more subordinate clauses (nominal, adjectival, adverbial, temporal, conditional or relative) (Van Valin & LaPolla, 1997:441). Clausal coordination with core and nuclear junctures are shown in figure 11 from Van Valin & LaPolla (1997:464).



**Figure 24: Clausal, core and nuclear juncture**

Thus the juncture-nexus combinations give us nine types (Pavey, 2010:227). Most languages do not have all nine (Van Valin & LaPolla, 1997:455); English has seven, lacking nuclear coordination and subordination. We look at some examples in the following sections.

### 3.9.1 Clause cosubordination

Two clauses are joined; but an operator has scope over both. In this example declarative illocutionary force and past tense are shared by both clauses:

(18) ‘Paul drove to the store and bought some beer’ (Van Valin & LaPolla, 1997:455)

### 3.9.2 Core coordination

The deontic modality operator *must* has scope only over ‘tell Bill’ so the two cores are coordinate (Pavey, 2010:225). ‘Tom’ is the subject only of ‘tell’.

(19) ‘Tom must tell Bill to open the door’

The constituent structure of core coordination is shown in figure 12 (Van Valin, 2005:188-189).

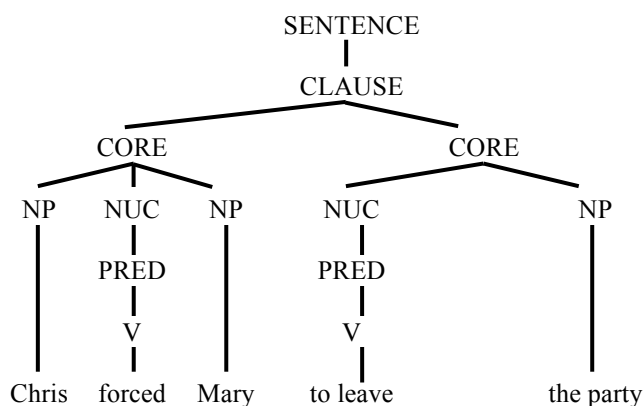


Figure 25: Core coordination

### 3.9.3 Core subordination

The subordinate clause may modify the core with respect to time, space or manner. Alternatively the core or clause functions as a core argument of the main predicate (Pavey, 2010:230-231).

(20) ‘The snow fell after I washed my car.’

(21) ‘That Shane won the competition surprised everybody.’

The example in (21) may be lexically decomposed as a causative, with the subordinate ‘that Shane won the competition’ being the x argument. The dependent unit can have its own operators.

(22) **do’(x,0) CAUSE INGR feel’(everybody, surprise)**

The clause can be a subject: *that it is raining* comes as no surprise. Or an object: Max regretted *that he had insulted Susan* (Van Valin & LaPolla, 1997:442). In these cases, the clauses act as core arguments which show subordination at core level (Van Valin, 2005:189). Some languages have nominalised constructions, e.g. Fijian (Pavey, 2010:231), and as discussed below, P/Y.

### 3.9.4 Core cosubordination

The deontic modality operator *must* has scope over both cores (Pavey, 2010:225) so is an example of cosubordinate nexus. ‘Tom’ is shared as subject by both cores.

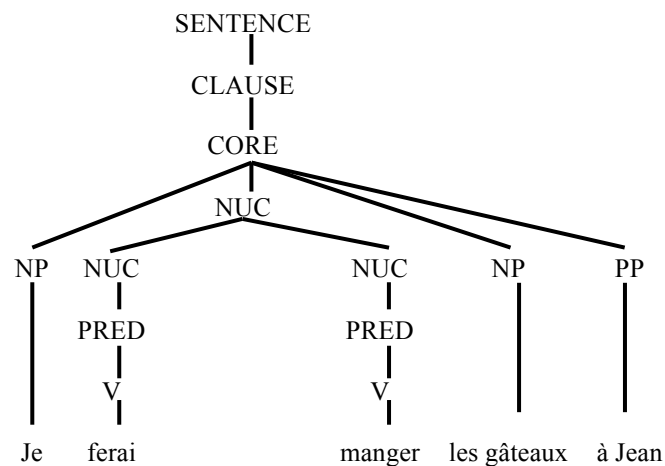
‘Tom must try to open the door’

### 3.9.5 Nuclear cosubordination

Aspect is a nuclear operator and in this example progressive aspect marker *-ing* has scope over both nuclei (push and open) so is a case of nuclear cosubordination (Pavey, 2010:234).

(23) ‘Kerry is pushing open the door’

The constituent structure of nuclear cosubordination is shown in a French causative in figure 13 (Van Valin, 2005:191):

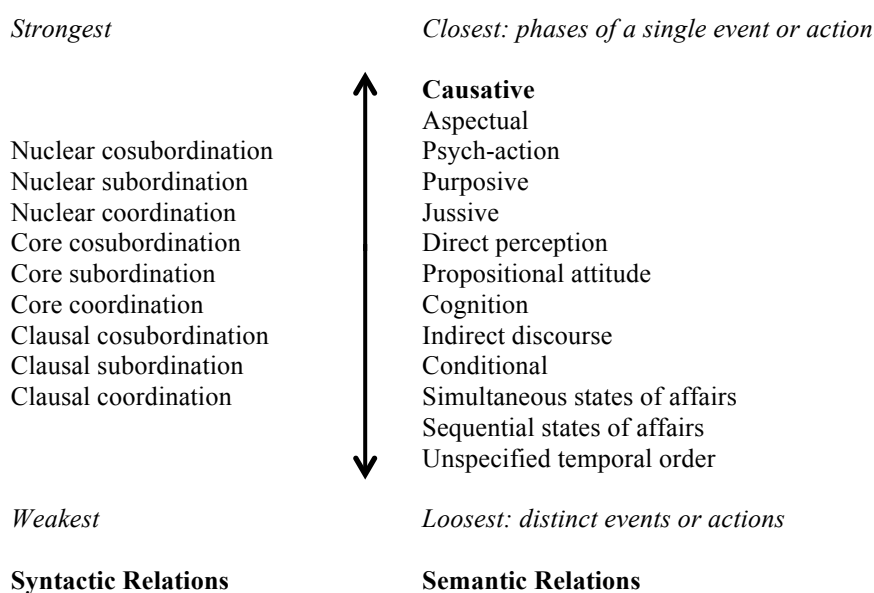


**Figure 26: French example of nuclear juncture**

As a general rule, the causative suggests the events described by two predicates are strongly interconnected. These have a more tightly connected syntactic structure, of which nuclear cosubordination is the strongest. Simple sequential actions have the weakest and loosest connections; clausal coordination lies at the loose end of this extremity (Pavey, 2010:245).

### 3.10 Summary and further constructions

We have looked at the three levels of juncture and three types of nexus. The link between nexus juncture and actions is shown in figure 14, drawn from Van Valin & LaPolla (1997:480-481). This will be of importance when we discuss multiple verb constructs.



**Figure 27: Syntactic and semantic relations**

Serial verb constructions (SVC) may be core or nuclear junctures (Pavey, 2010:236). An SVC is a sequence of verbs that act as single predicate, with no marker of coordination, subordination or syntactic dependency of any sort and conceptualised as a single event. They are monoclausal; the intonation is the same as monoverbal, with one tense and aspect. There may be sharing of core and other arguments. Each component must be able to occur on own. Individual verbs may have same or different transitivity values (Aikhenvald, 2006:1). Multi verb including serial verbs constructions occur in Pitjantjatjara and Yankunytjatjara (Goddard, 1993:25-26) so we will look at how the arguments are shared and what levels of nexus occur.

#### 4 The nominal system in P/Y

In Pitjantjatjara, nouns and adjectives have similar endings and along with demonstratives can head a noun phrase (NP), so they are together classed as nominals (Bowe, 1990:4). The shared endings include inflections and derivational suffixes (Dixon, 2011:272).

There is a general distinction in languages between head marking which occurs on the predicate, and dependent marking which is achieved through the use of cases (Pavey, 2010: 79-81). In head marking, the affix on the verb represents the argument of the predicate, with coreferential noun phrases being optional. The rich set of case marking in P/Y indicates dependent marking.

While case marking can lead to freedom in word order (Pavey, 2010:316), sentences in Pitjantjatjara have a basic SOV order (Bowe, 1990:viii). Furthermore there is a constraint on the ordering of elements within the noun phrase. As we will see there is also a system of



enclitics that can represent predicate arguments, so we will look at whether this represents limited head marking.

Dixon (2011:294) groups case functions into core and peripheral. The core ones are case markings on the required nominal arguments for a predicate. The peripheral ones may be local, describing the location or movement of the action, or syntactic, adding further information such as the indirect object or goal. The cases for P/Y are shown in table 2. These functions represent the RRG elements in the layered structure of the clause; containing the core with the arguments and the periphery with non-arguments.

**Table 3: P/Y case system**

		Common	Proper
Core	ABSolutive (S, O)	-Ø (- <i>pa</i> )	- <i>nya</i>
	ERGative (A)	- <i>ngku</i> (- <i>tju</i> , - <i>tu</i> )	- <i>lu</i>
	VOCative		-Ø
Local peripheral	LOCative	- <i>ngka</i> (- <i>tja</i> , - <i>ta</i> )	- <i>la</i>
	ALLative	PURP + - <i>tu</i>	LOC + PURP+ - <i>tu</i>
	ABLative	- <i>nguru</i>	LOC + - <i>nguru</i>
	TRANSverse	- <i>wanu</i>	LOC + - <i>wanu</i>
Syntactic peripheral	DATive	LOC	
	PURPositive	- <i>ku</i>	
	CAUSal	- <i>tjara</i> , LOC, ABL	
	INSTRumental	LOC	
	AVERSive	LOC + - <i>tawara</i>	
	GENitive	PURP	

## 4.1 Nominals

Verbs are classed as transitive or intransitive depending on their argument structure which is lexically defined (Bowe, 1990:8). Transitive verbs have two participants; intransitive verbs have one. Bowe (1990:23) discusses Pitjantjatjara base form verbs in terms of their valency, in other words how many core arguments are required. Pavey (2010:123) notes that the syntactic, semantic and macrorole valences need not necessarily be the same: we will see examples where a semantic role can be in a syntactically peripheral case.

Three roles are identified in intransitive and transitive verbs: S- the single argument of an intransitive verb; A- subject of a transitive verb, with a semantic role of agent; O- the object of a transitive verb. Bowe (1990:14-15) discusses these as syntactic roles, but uses the term P for the object of a transitive verb.

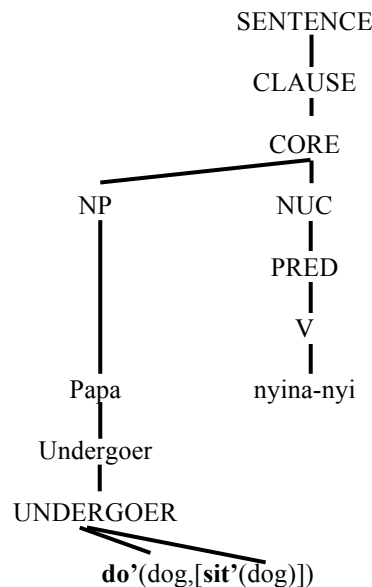
Intransitive S has no special ending in P/Y, *papa* ‘dog’ in this example from Goddard (1993:8):

- (24) Papa nyina-nyi  
Dog-ABS sit-PRES  
‘The dog is sitting.’

Semantically this is represented in this logical structure:

(25) **do'**(dog,[**sit'**(dog)])

The mapping from constituent projection to logical structure is shown in figure 15. *papa* is in absolutive case, which has no ending; this may also be marked as a –Ø ending.



**Figure 28: Intransitive verb, constituent projection mapping to logical structure**

With a transitive verb, *papa* gets the ergative case if it is the doer of the action, or A. In this example *tjitji* ‘child’ is the undergoer, or object O, with absolutive case (Goddard, 1993:7):

(26) Tjitji          papa-ngku patja-nu  
 Child-ABS dog-ERG bite-PAST  
 ‘The dog bit the child.’  
**do'**(dog,[**bite'**(dog, child)])

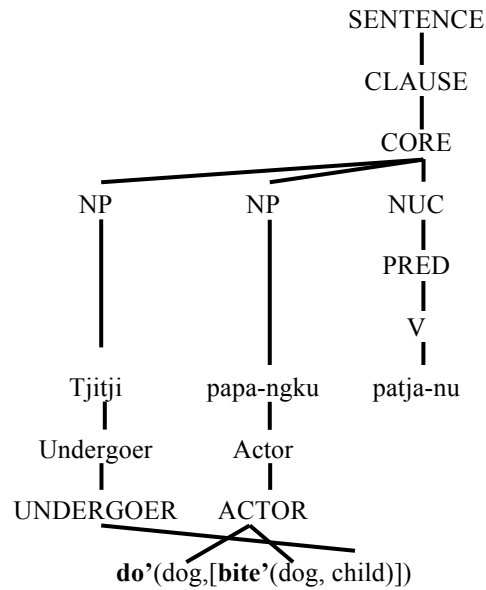
This ties to the constituent projection as in figure 16; the order of arguments is determined by the case with ergative the first argument, the actor.

As we can see the word order can vary from the more rigid pattern in English. If the roles are reversed, the cases follow:

(27) Tjitji-ngku papa      patja-nu  
 Child-ERG dog-ABS bite-PAST  
 ‘The child bit the dog.’

With states in P/Y no verb is required. In other words the predicate is non-verbal (Pavey, 2010:57). Goddard (1996:210) has this example:

(28) Kungka nyara    paluru    kunyu yunpanya    kutu    munu mangka    walata alatjika.  
 Woman that.one 3sg    REP    good.looker really and head.hair long    absolutely  
 ‘The woman in the story was stunning looking and had really long hair.’



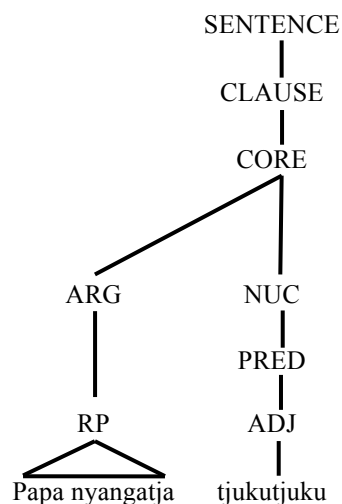
**Figure 29: Transitive verb, constituent projection mapping to logical structure**

Semantically this is stative, so the logical structure is **be'** (woman, [**good-looking'**]) and **have'** (woman, long.hair]). The noun *kungka* 'woman' is in the absolutive case. Such verbless clauses exist in all Australian languages (Dixon, 2002).

Verbless predicates occur for both non-volatile and volatile attributes. This example of a non-volatile attribute is from Goddard (1993:13):

- (29)    papa nyangatja        tjukutjuku  
          dog this.one-ABS    small  
          'this dog is small'

This may be lexically decomposed as **be'** (papa,[**small'**]). Figure 17 shows the constituent projection with the predicate containing an adjective.



**Figure 30: Verbless state predicate**

Ninti Ngapartji (2009: lesson 3) has this example with a name, note the marking of the absolutive.

- (30) Ngayuku ini Matilda-nya  
 1sgPOS name Matilda-ABS  
 ‘My name is Matilda’

No verb is required for volatile attributes either (Goddard, 1996:121):

- (31) Ka-la nyina-ra ula-ngi, ‘Wala-ngku ngunytju mantji-la!  
 And-1plNOM sit-SERIAL cry-PAST.CONT quickly-ERG mother get-IMP  
 Ngayulu paltjatjiratja!’  
 1sgNOM hungry  
 ‘We used to sit there crying (as the food cooked) Quick Mum, get it out! I’m hungry!’

In the ergative pattern, single arguments of intransitive verbs pattern like undergoers of transitive verbs (Pavey, 2010:150-152). In P/Y, these get the absolutive case rather than determining verb agreement patterns. In this case, the Privileged Syntactic Argument is the undergoer *papa* in (27) and this patterns like the single argument *papa* in (24). As Myers (1978:13) puts it, every action has an undergoer. So a person being hit undergoes hitting, and a person sitting undergoes sitting. In this way the S and O roles would pattern together. As discussed in section 3.9, the PSA controls verb agreement (Pavey, 2010:143); however in P/Y there is no person, gender or number marked on the verb.

An attributive, demonstrative or quantifier can all function as the NP (Bowe, 1990:38); this example is a demonstrative:

- (32) Panya-ngku ngayu-nya nya-ngu  
 DEF-ERG 1sgACC see-PAST  
 ‘The one we have been talking about saw me.’

Verbs in Pitjantjatjara are generally either transitive or intransitive (Bowe, 1990:25-26). One exception is *inka* which can vary between transitive and intransitive. We can see in the logical structure how the arguments for the predicate can vary depending on the valency. The subject is marked absolutive or ergative as appropriate:

- (33) Tjitji kulunypa inka-nyi  
 Child young-ABS play-PRES  
 ‘The young child is playing around.’  
**do**’(child, [**play**’(child)])
- (34) Minyma-ngku inma inka-nyi  
 Woman-ERG song-ABS sing-PRES  
 ‘The woman is singing a song.’  
**do**’(woman, [**sing**’(woman, song)])

The ergative ending differs depending on whether the noun is a name for a person or place, or not (Goddard, 1993:14). A common noun has *-ngku* as ergative, as we have seen.

- (35) Wati-ngku ngintaka pu-ngu  
 Man-ERG perentie.lizard-ABS hit-PAST  
 ‘The man hit the perentie lizard.’

Names or proper nouns have different endings, *–lu* for ergative:

- (36) Tjani-lu ngintaka pu-ngu  
 Johnny-ERG perentie.lizard-ABS hit-PAST  
 ‘Johnny hit the perentie lizard.’

Words in Yankunytjatjara are allowed to end in a consonant whereas in Pitjantjatjara they are not; in the latter the suffix *–pa* is added to consonant stems as the stem must end in a vowel (Goddard, 1993:2). This can be regarded as an allomorph of the absolutive case (Dixon, 2011:492).

Thus P/Y is one of the several varieties of Western Desert that are reported as having suffixes marking the intransitive subject as well as the direct object with personal names and consonant stems (Blake, 1987:30). Interestingly another Western Desert dialect, Ngaanyatjara from the neighbouring Warbarton ranges has *–lu* as the ergative marker for common nouns as well as personal names (Douglas, 1958:17) so does not distinguish.

A ditransitive verb such as *u* ‘to give’ can have two objects, both in absolutive case (Bowe, 1990:24):

- (37) Minyma-ngku tjitji mai u-ngu  
 Woman-ERG child-ABS bread-ABS give-PAST  
 ‘The woman gave the child some bread.’

As in the logical structure a predicate can only have a maximum of two arguments, this has a causative connotation: [**do**] (woman, Ø) CAUSE [BECOME **have**] (child, bread)]

Bowe (1990:25) in discussing the verb *wangka* ‘to tell’, says there are two structures that can be used. Both the beneficiary and the patient can in the absolutive case, with the obligatory direct object or patient being closest to the verb:

- (38) Minyma-ngku tjitji tjukurpa wangka-ngu  
 Woman-ERG child-ABS story-ABS tell-PAST  
 ‘The woman told the child a story.’

Alternatively, the indirect object or addressee can get the locative case:

- (39) Minyma-ngku tjitji-ngka tjukurpa wangka-ngu  
 Woman-ERG child-LOC story-ABS tell-PAST  
 ‘The woman told the child a story.’

The case can also be used with verbs of emotion (Bowe, 1990:16). So what may appear as a transitive verb semantically is syntactically intransitive; the sole predicate argument *kulunypa* ‘toddler’ is thus in the absolutive:

- (40) Kuluny-pa      ngampu-ku   mukuri-nganyi  
 Toddler-ABS   egg-PURP   like-PRES  
 ‘The toddler likes eggs.’

This construction is known as the antipassive (Blake, 1987:57-58), which is found in several Australian languages. The sentence becomes intransitive by the A becoming S and the O becoming an oblique case, here the purposive, being a complement. This produces a sentence with lower semantic transitivity, and changes its PSA (Pavey, 2010:160-161).

## 4.2 Pronouns

Pitjantjatjara has free and bound pronouns (Blake, 1987:183-4). Pronouns have a nominative/accusative system (Bowe, 1990:8) and singular, dual and plural number (Bowe, 1990:11):

- (41) Ngayu-lu   tjitji            nya-ngu  
 1sg-NOM   child-ABS   see-PAST  
 ‘I saw the child.’
- (42) Ngayu-lu   a-nu  
 1sg-NOM   go-PAST  
 ‘I went.’
- (43) Tjitji-ngku   ngayu-nya   nya-ngu  
 Child-ERG   1sg-ACC   see-PAST  
 ‘The child saw me.’

Most Western Desert dialects have bound pronouns that occur following the first constituent in the clause (Blake, 1987:103), rather than attached to the verb. They share this feature with a small number of other Pama-Nyungan languages. The bound pronouns in Pitjantjatjara are short forms that are not separate words but attach themselves to the last word of the first phrase in a sentence or to a connective word such as *ka* ‘and, but’ and *munu* ‘and’ (Ninti Ngapartji, 2009: lesson 7). For example, the pronoun *ngayulu* ‘I’ has the short form equivalent *-na*.

- (44) Ngayulu      a-nu  
 1sgNOM      leave-PAST  
 ‘I left.’
- (45) A-nu-na  
 Leave-PAST-1sgNOM  
 ‘I left’.

In this example, note there is no requirement for a verb, similar to examples (28) and (29):

(46) Nyuntu kura  
2sgNOM bad  
'You're bad.'

(47) Kura-n  
Bad-2sgNOM  
'You're bad.'

As these bound pronouns attach to any class of word they are clitics rather than suffixes according to (Pavey, 2010:37). Verbs with clitic pronominals are discussed further in Dixon (2011:362) with an example from Western Desert:

(48) Pu-ngku-rna-nta  
Hit-FUT-1sgNOM-2sgACC  
'I will hit you.'

As clitics, these pronominals are appended after case suffixes (Ninti Ngapartji, 2009: lesson 12).

(49) Tjawa-kutu-na a-nanyi  
Shop-towards-1sgNOM go-PRES  
'I'm going to the shop.'

The order of pronominal clitics is subject preceding object:

(50) Putu-na-nta alti-ngu  
Cannot-1sgNOM-2sgACC call-PAST  
'I couldn't call you.'

These are summed up in table 3, based on Ninti Ngapartji (2009: lesson 12).

**Table 4: Full and enclitic pronouns**

<b>Singular</b>	Subject		Object	
1 <sup>st</sup> Person	<i>ngayulu</i> (I)	<i>-na</i>	<i>ngayunya</i> (me)	<i>-ni</i>
2 <sup>nd</sup> Person	<i>nyuntu</i> (you)	<i>-n</i>	<i>nyuntunya</i> (you)	<i>-nta</i>
3 <sup>rd</sup> Person	<i>paluru</i> (he/she/it)	<i>-0</i>	<i>palunya</i> (him/her/it)	<i>-0</i>
<b>Dual</b>				
1 <sup>st</sup> Person	<i>ngali</i> (we two)	<i>-li</i>	<i>ngalinya</i> (us two)	<i>-linya</i>
2 <sup>nd</sup> Person	<i>nyupali</i> (you two)	<i>pula</i>	<i>nyupalinya</i> (you two)	<i>-0</i>
3 <sup>rd</sup> Person	<i>pula</i> (those two)	<i>pula</i>	<i>pulanya</i> (those two)	<i>-0</i>
<b>Plural</b>				
1 <sup>st</sup> Person	<i>nganana</i> (we)	<i>-la</i>	<i>nganananya</i> (us)	<i>-lanya</i>
2 <sup>nd</sup> Person	<i>nyura</i> (you all)	<i>-ya</i>	<i>nyuranya</i> (you all)	<i>-0</i>
3 <sup>rd</sup> Person	<i>tjana</i> (they)	<i>-ya</i>	<i>tjananya</i> (them)	<i>-0</i>

In terms of core relations, this three way nominative/ergative/accusative case distinction and presence of subject/object cross referencing bound pronouns is common in Australia (Blake,

1987:23-24). Arguments in simple sentences can be represented by nominal, pronouns, pronominal clitics (Bowe, 1990:24). If there is no NP representing an obligatory argument, the 3<sup>rd</sup> person pronominal is implied (Bowe, 1990:13).

Bowe (1990:11-12) has these examples in terms of the agent/patient; the absolutive and ergative cases may receive further clitics:

(51) Tjitji-na                      nya-ngu  
Child-ABS-1sgNOM see-PAST  
'I saw the child.'

(52) Tjitji-ngku-ni              nya-ngu  
Child-ERG-1sgACC see-PAST  
'The child saw me.'

A subordinate clause can be marked with the clitic too. It gets the ergative case making first as it relates to a transitive verb in the main clause:

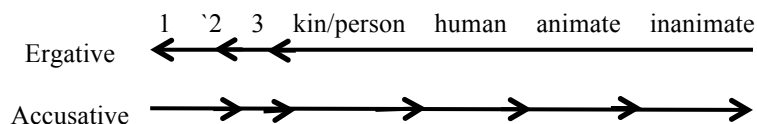
(53) Paluru   ngalya pitja-ntjatjanu-ngku-ni              mai u -ngu  
3sgNOM back   come-ANT(SS)-ERG-1sgACC food   give-PAST  
'When she came back, she gave me some food.'

### 4.3 Discussion

There is split ergative/nominative system for nouns and pronouns. Furthermore there is a distinction in certain case markers for nouns and proper nouns in many grammatical cases.

The existence of a nominative/accusative system has been related to animacy, control and the propensity to be the topic of a clause: these all have a tendency to be nominative (Blake, 1987:21). Pronouns fulfil these criteria. Common nouns are more likely to carry special marking when they are the subject of a transitive verb than are proper nouns or pronouns (Bowe, 1990:15). In the case of Pitjantjatjara, proper nouns are grouped with common nouns rather than pronouns in getting the ergative marking.

There is a hierarchy of pronouns and nominal likelihood to be nominative/accusative or ergative/absolutive. This is shown in figure 18 from Blake (1987:21-22). The accusative construction is most likely with pronouns; ergative constructions are most likely with inanimate nouns: the arrows show possible cut off points:



**Figure 31: Hierarchy of nominal/accusative versus ergative/absolutive**

Pitjantjatjara has been described as having a system of declensions with few irregularities (Hilliard, 1968:105-106). However from this study there do not appear to be declensions that group nominals and have different endings. As Myers (1978:13) notes, nouns in Pitjantjatjara have no gender or plural form. Rather the endings show case referring to function, and vary



depending on whether the head of a NP is a proper noun or not. There are also variants in ergative and locative cases for consonant endings, by assimilation of articulation. It can be seen that many of the peripheral case endings include the locative or instrumental in addition to the specific case ending, so these may be regarded as prepositional suffixes that have evolved into case endings.

Case marking is on the noun phrase, with the head noun and associated constituents within. Thus there is no case agreement within the NP for adjectives or other forms. Sub clauses and adverbs or manner are marked to agree with the NP they modify.

In English, there can be case marking on pronouns and the use of prepositions to mark case on noun phrases. Case marking and agreement rules depend on reference to macroroles and direct core argument status (Pavey, 2004). The P/Y case system similarly can be mapped to macroroles, both the core cases of ergative/absolutive and the peripheral cases which can be used to mark the undergoer. As discussed in chapter 3, Van Valin & LaPolla (1997:29) draw a distinction between direct core arguments and oblique core arguments. As seen here, P/Y marks these by case marking rather than prepositions as in English.

In P/Y noun phrases can be compounded, and the case marking can occur on the individual noun phrases or the compound. The enclitic pronouns are suffixed to the first constituent, which may be a compound noun phrase. Although verbs are central in the Western Desert language and sentences can be composed of verbs only (Douglas, 1958:21) the bound pronominals on the verb in a verb only sentence are not necessarily head marking arguments as described by Pavey (2010:79-81). In such a situation the clitics attach to the only structure in the sentence.

Pavey (2010:315-316) discusses basic constituent order, depending on two independent noun phrases and verb in a basic, unmarked sentence: declarative, active, predicate focus and noun phrases. From the study, P/Y appears to be head final, with the predicate after the undergoer, and thus SOV. The use of non-core cases means that some constructs that would be thought to be semantically transitive with an actor and undergoer are syntactically intransitive, leading to absolutive case on the sole argument. This is described as the antipassive (Blake, 1987:57ff).

## **5 Serial and multi verb constructs in P/Y - nexus juncture relations.**

This section will investigate multiple verb constructs in P/Y. We will start with a description of the verbal system for simple clauses and follow with a look at the nature of more complex structures. The type of verbs that can be involved will be examined including the possibility of 'light verbs' (Blake, 1987:119) and semantic bleaching. An attempt will be made to characterise multi verb constructs as nexus junctures; we will look at what level and type are shown. We will also investigate whether any of these fulfil the criteria for serial verb constructions.

## 5.1 Verbs in P/Y

In P/Y tense, aspect and mood are generally indicated by suffixes on the verb stem. Goddard (1993:9) has these examples. There is no marking on the verb for person or number. Thus the role of the PSA in controlling verb agreement does not apply here. The PSA in ergative languages is the nominal in absolutive case.

- (54) Papa-ngku tjitji patja-ni  
Dog-ERG child-ABS bite-PRES  
'The dog is biting a child.'

- (55) Papa-ngku tjitji patja-nu  
Dog-ERG child-ABS bite-PAST  
'The dog bit a child.'

There are four different types of verb or conjugations in P/Y (Goddard, 1993:10-11). Bowe (1990:28) suggests these arose diachronically from reanalyses of the final consonants. These are summed up in table 4 based on Ninti Ngapartji (2009: lesson 7). The classes are often referred to as zero, *la*, *wa* and *ra* class based on the imperative form. Note that in each case there is a root and the particular form is constructed by appending the suffix.

**Table 5: Pitjantjatjara/Yankunytjatjara verb conjugations**

	(0)	(l)	(ng)	(n)
	('zero' class)	(la-class)	(wa-class)	(ra-class)
	'talk'	'bite'	'hit'	'put'
Imperative	<i>wangka-Ø</i>	<i>patja-la</i>	<i>pu-wa</i>	<i>tju-ra</i>
Past	<i>wangka-ngu</i>	<i>patja-<u>nu</u></i>	<i>pu-ngu</i>	<i>tju-nu</i>
Imperative (continuous)	<i>wangka-ma</i>	<i>patja-nma</i>	<i>pu-ngama</i>	<i>tju-nama</i>
Present	<i>wangka-nyi</i>	<i>patja-<u>ni</u></i>	<i>pu-nganyi</i>	<i>tju-nanyi</i>
Past (continuous)	<i>wangka-ngi</i>	<i>patja-<u>ningi</u></i>	<i>pu-ngangi</i>	<i>tju-nangi</i>
Future	<i>wangka-ku</i>	<i>patja-lku</i>	<i>pu-ngkuku</i>	<i>tju-nkuku</i>
Characteristic	<i>wangka-pai</i>	<i>patja-lpai</i>	<i>pu-ngkupai</i>	<i>tju-nkupai</i>
Serial	<i>wangka-ra</i>	<i>patja-<u>ra</u></i>	<i>pu-ngkula</i>	<i>tju-nkula</i>
Nominal form	<i>wangka-nytja</i>	<i>patja-ntja</i>	<i>pu-ngkunyntja</i>	<i>tju-nkunyntja</i>

In the next sections we look at multi verb sentences. P/Y has systems of clause linking, switch reference and dependent verb forms that express intention and purpose. We will look at these structures to look for evidence of juncture level and nexus type, and then look at the ubiquitous serialisation of verbs. Key to an understanding of multi verb constructions is an analysis of how arguments are shared out, and the scope of operators.

## 5.2 P/Y clausal juncture

In some Western Desert dialects there are separate coordinating conjunctions for same subject clauses and different subject clauses. Such syntactic constraints on coordination are

not the norm in Australian languages (Blake, 1987:137). P/Y shows these alternatives. Clauses can be joined (Goddard, 1993:25-26) by *munu* or *ka*. These are coordinating conjunctions for the same or different subjects respectively (ibid., Bowe, 1990:96ff) and reflect switch reference.

*Munu* suggests the same subject:

- (56) Wati-ngku papa      pu-ngu    munu    mira-ngu  
 Man-ERG dog-ABS    hit-PAST    and    cried.out-PAST  
 'The man hit the dog and he cried out.'

*Ka* implies a different subject:

- (57) Wati-ngku papa      pu-ngu    ka    mira-ngu  
 Man-ERG dog-ABS    hit-PAST    and    cried.out-PAST  
 'The man hit the dog and it cried out.'

This feature is unique to certain Western Desert dialects (Blake, 1987:147). As well as showing a different subject, *ka* can also be used in showing contrast, or a surprising development. Pavey (2010:229) says switch reference is an example of clausal cosubordination. In the P/Y examples however the operators have scope over their own clause and only share an argument so are more likely examples of coordination.

Arguments don't need to be shared. This example from Goddard (1996:84) shows clausal coordination, linking with *munu*. Each clause has its own subject and inflected verb without reference to the other, so there is no subordination or cosubordination.

- (58) Kuwari nyanga-la    a-nanyi    munu-la    ngururpa    ma-ngari-nyi  
 Now    this-1plNOM travel-PRES and-1plNOM on.the.way away-camp-PRES  
 'Let's head off today and we'll camp overnight on the way (there)'

*Ka* and *munu* can also introduce sentences: note in this example from Goddard (1996:58) what might be core subordination in English is an adverbial phrase rather than subordinate clause as it contains no verbs:

- (59) Ka tjana    mapalku    kunkunari-pai,    tjukurpa wiyantja kuwaripangka  
 And 3plNOM immediately fall.asleep-HABIT story    finish    before  
 'And they (children) slip off to sleep quickly, before the story's finished'

### 5.3 Dependent verb forms

P/Y has a system of dependent verb forms; these are summarised (Bowe, 1990:169) in table 5. Bowe (1990:71) suggests that these are subordinate forms to the main clause as they are embedded and not adjoined. Evidence for this includes the fact that the form can be moved within the main clause; an example is found in (61).

**Table 6: Dependent verb forms**

	(0)	(l)	(ng)	(n)
	('zero' class)	(la-class)	(wa-class)	(ra-class)
	'talk'	'bite'	'hit'	'put'
Purposive DS	<i>wangka-ntjaku</i>	<i>patja-ntjaku</i>	<i>pu-ngkuntjaku</i>	<i>tju-nkuntjaku</i>
Purposive SS	<i>wangka-ntjikitja</i>	<i>patja-ntjikitja</i>	<i>pu-ngkunttjikitja</i>	<i>tju-nkunttjikitja</i>
Anterior DS	<i>wangka-nyangka</i> (P) <i>nyina-nytja-la</i> (Y)	<i>patja-nyangka</i>	<i>pu-ngkunyangka</i>	<i>tju-nkunyangka</i>
Anterior SS	<i>wangka-ntjatjanu</i>	<i>patja-ntjatjanu</i>	<i>pu-ngkuntjatjanu</i>	<i>tju-nkuntjatjanu</i>
Anterior (Merged)	<i>wangka-ra</i>	<i>patja-ra</i>	<i>pu-ngkula</i>	<i>tju-nkula</i>
Negative	<i>wangka-wiya</i>	<i>patja-wiya</i>	<i>pu-ngkuwiya</i>	<i>tju-nkuwiya</i>

Switch reference features here as well. The Anterior Merged is of interest as it is the same as the serial form. We will look at the other dependent forms first, looking at Anterior Merged in the serial verb section. Wilkins (1988) discusses purposive clauses in the Australian language Mparntwe Arrernte and says they too are embedded not adjoined; furthermore that they can be arguments of the core. Referents are tracked by zero anaphora.

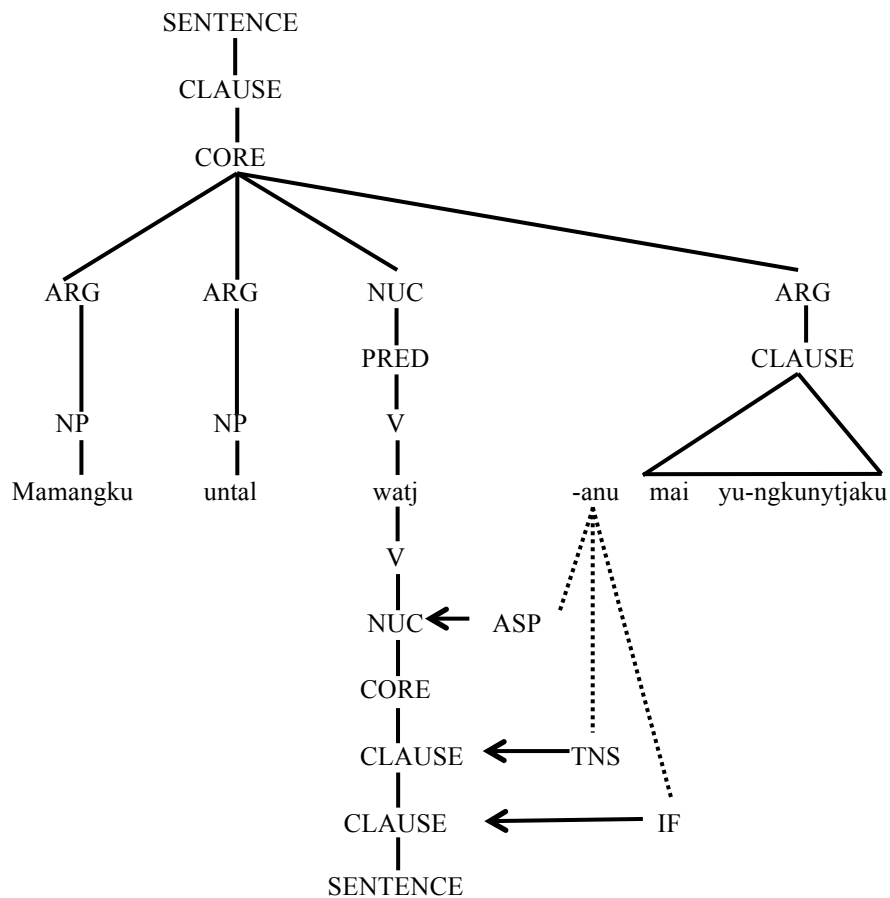
### 5.3.1 Purposive Different Subject (DS)

This is formed by the nominalised verb and *-ku* (purposive/possessive case ending). In this example from Goddard (1996:228) the PURP DS *ngkuntjaku* marking shows this to be a subordinate clause, modifying the core. The argument *untal* 'daughter' is shared, that it is the subject of the subordinate clause is indicated by the DS switch.

- (60) Mama-ngku untal                      watja-nu,    mai yu-ngkuntjaku  
 Father-ERG daughter-ABS tell-PAST, food give-PURP DS  
 'The father told the daughter to give food.'

Bowe (1990:71) suggests the dependent forms are embedded not adjoined because they can occur surrounded by the elements of the main clause:

- (61) Trevor-lu    Mary-nya a-nkuntjaku watja-nu  
 Trevor-ERG Mary-ABS go-PURP DS say-PAST  
 'Trevor told Mary to go.'



**Figure 32: Purposive DS**

### 5.3.2 Purposive Same Subject (SS)

This is formed by nominalisation and the suffix *-kitja*. The following is from Goddard (1993:31).

- (62) Ngayulu nyinakati-ngu,                      wangka-nyttji-kitja  
 1sgNOM sit.down-PAST                      talk-NOML-*kitja*  
 ‘I sat down to talk.’

We can see the logical structure is similar to that of the PURP DS structure:

**do’(1sg,[sat’(1sg)]) PURP talk’ (1sg)**

### 5.3.3 Anterior Different Subject (DS)

This is also referred to as the circumstantial clause, conveying ‘when’, ‘where’, ‘why’ (Goddard, 1993:29). Ninti Ngapartji (2009: lesson 13) gives it a connotation of ‘during, while’, but not ‘after having’ because it is DS. The subject of the main clause is different to that of the subordinate clause. There is a difference between the dialects in how this is constructed.

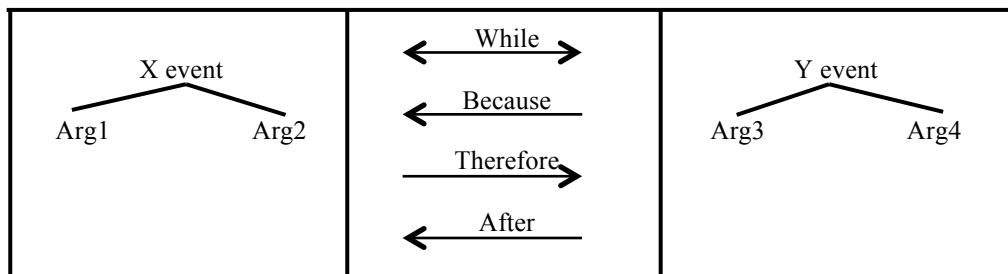
Yankunyjtajara uses nominalisation and the name locative:

- (63) Wati-ngku malu pau-ni, tjitji nyina-nytja-la  
 Man-ERG kangaroo-ABS roast-PRES child-ABS sit-NOML-LOC  
 ‘A man is roasting the kangaroo, while the child sits (there)’

Pitjantjatjara uses *-nya* and the ordinary locative. Goddard (1993:30) claims that this was originally *-nytja-ngka*, in other words nominalisation and locative.

- (64) Wati-ngku malu pau-ni, tjitji nyina-nya-ngka  
 Man-ERG kangaroo-ABS roast-PRES child-ABS sit-*nya*-LOC  
 ‘A man is roasting the kangaroo, while the child sits (there)’

A schematic of the relations between circumstantial clauses and main clauses is pictured in figure 20. The two clauses may be related by causality or by the simultaneity of events. The arguments between X and Y events may or may not be shared.



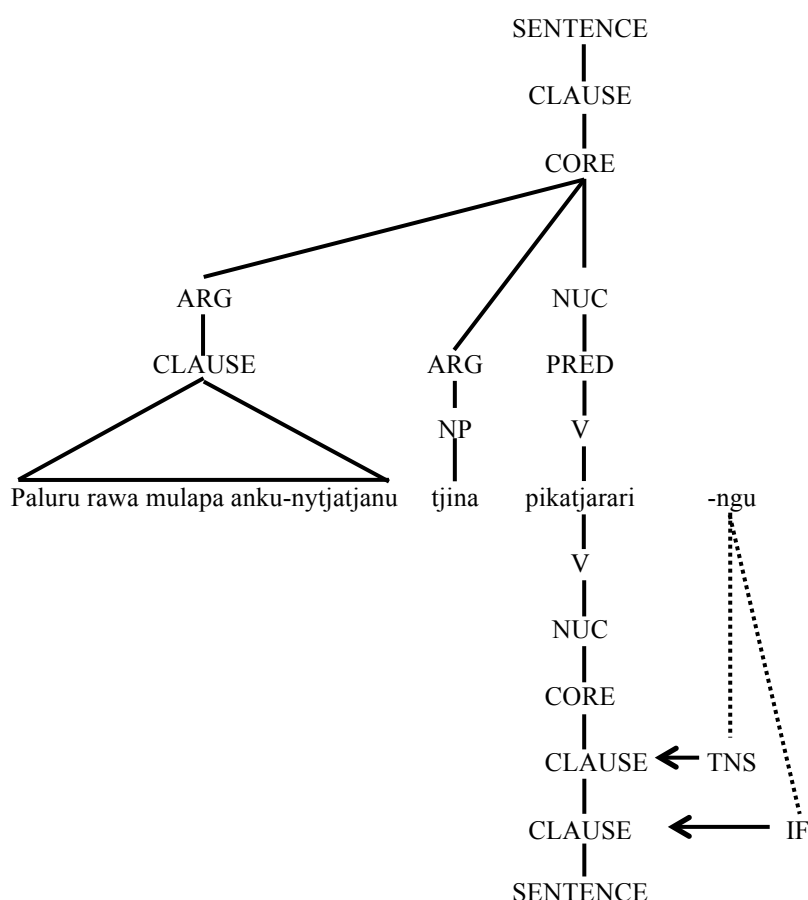
**Figure 33: Circumstantial clause**

#### 5.3.4 Anterior Same Subject (SS)

This is formed by the nominalised verb and suffixing *-tjanu*. The connotation is ‘after’, ‘having’, ‘after having’ (Ninti Ngapartji, 2009: lesson 13).

- (65) Paluru rawa mulapa anku-nytjatjanu tjina pikatjarari-ngu  
 3sgNOM for.a.long.time real walk-ANT.SS foot-ABS get.sick-PAST  
 ‘After walking for some time his feet became sore’

The projections are shown in figure 21. In this example the subordinate clause precedes the main one.



**Figure 34: Anterior SS**

#### 5.4 Serial verb constructions

Serial verb constructions (SVC) are characteristic of some Asian, African and Austronesian languages and not typical of Indo-European. There are none in Europe or north or central Asia, and few in North America or Australia (Dixon, 2006:338).

Aikhenvald (2006:1) defines SVCs as a series of verbs acting as a single predicate, with no coordination, subordination or dependency. They may also share core and other arguments. Each component must be able to occur on its own, but they may have different transitivity values. Aikhenvald (2006:55) also states that prototypical SVCs share all arguments. Less tightly knit SVCs may lack argument sharing.

Payne (2006:288ff) draws a continuum from serial verbs with tight grammatical integration to looser coordination. Serial verb constructions have two or more verb roots that are not compounded and occur in the same clause. The second verb has no independent expression of subject or independent tense or aspect marking; the intonation is that of a single clause. Furthermore Payne (2006:290) states that serial verbs are a major diachronic source for auxiliaries, for instance ‘go’ indicating future tense. As the example in English ‘go eating’, the second, matrix verb describes the event and the first indicates the event is about to start. With two matrix verbs, one may become more auxiliary or half auxiliary and lead to two

functions coexisting. SVCs with core or nuclear level junctures can occur in different languages (Pavey, 2010:236).

The fusional or synthetic characteristics of a language can have an impact on the use of SVCs too. Isolating languages tend to have SVCs with independent components that may be discontinuous. Heavily polysynthetic ones have grammatically meaningful affixes on the verb rather than SVCs (Aikhenvald, 2006:53). As we have seen in chapter 5 P/Y is somewhat synthetic in using suffixes productively.

We will look at the serial form in P/Y, and discuss whether it fulfils the criteria for SVCs in Aikhenvald (2006:1ff) and Dixon (2006:339ff).

### 5.5 Serial verb form in P/Y

Goddard (1993:26-27) states that serial constructions are very common in P/Y, describing a series of actions, one after the other or simultaneously. This uses a form on the first verb known as the serial participle. Other authors use different terms to refer to the same form. Bowe (1990:89) calls it the anterior merged, while Eckert & Hudson (1988:307-309) refer to it as the ‘secondary’ form. In all cases the construction is of one or more verbs with the serial ending, and a finite verb that is typically clause final. We will look at the constructions these verbs are members of and see if they fulfil the criteria to be considered SVCs. In the examples below the verb stems are in bold and marked in the line below.

These first two examples are from Goddard (1993:26). We see that serial participles occur in imperative and statements; the mood of the sentence is determined by the last, finite verb. In (66) *waru* divides the two verbs. Implicit in (67) is that the subject *paluru* is shared.

- (66) Ya-nkula      waru                  ura-la  
v.....v  
Go-SERIAL firewood-ABS get-IMP  
'go and get firewood'
- (67) Paluru      nyina-ra      pata-ni  
               v                                v  
3sgNOM sit-SERIAL stay-PRES  
'He's sitting/staying waiting'

Goddard (1983:99) divides serial verb constructions into loose and tight. Loose ones have verbs that may have their own arguments and modifiers; tight ones cannot be separated and may form a complex predicate that shares arguments and modifiers. Tight serialisation can be further divided into periphrastic and non periphrastic. These examples distinguish tight and loose serialisation in Yankunytjatjara (Goddard, 1983:103), starting with the tight:

- (68) Paluru    nyiiinyii                  ya-nkula         ura-nu  
                                                             v                                  v  
 3sgNOM zebra:finch-Abs go-SERIAL get-PAST  
 ‘She went and got zebra finch (droppings)’.



As they are considered part of one nucleus, the logical structure is:

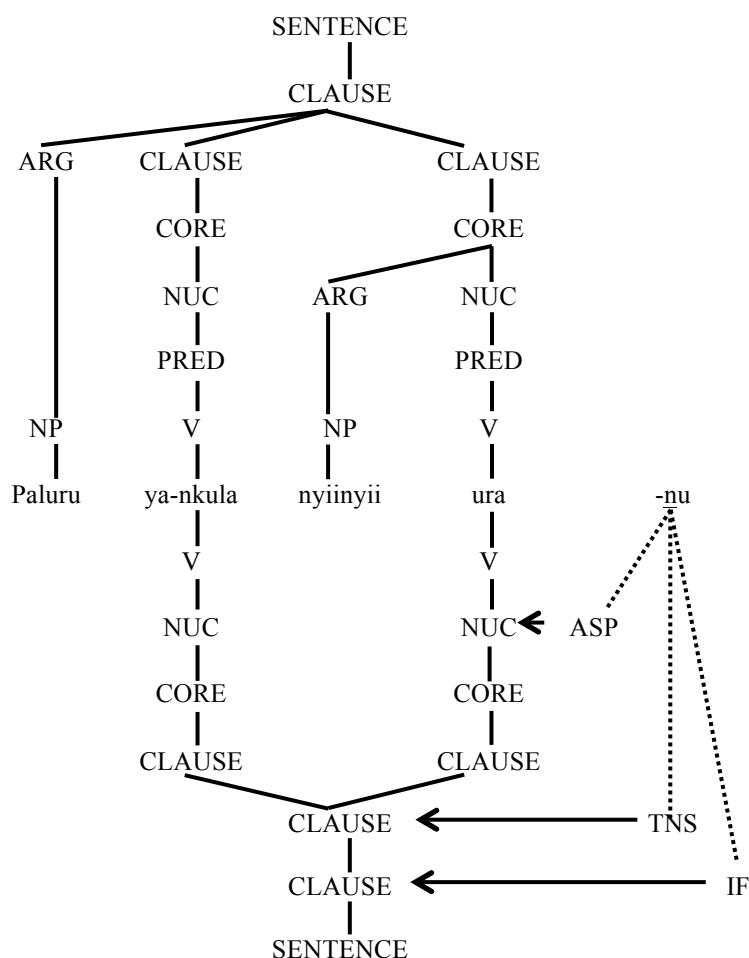
The constituent structure shows the arguments are shared; the tense and IF operators from the finite verb govern the entire clause, while the progressive aspect marks both nuclei:



(70) Paluru ya-nkula, nyiinyii ura-nu  
v v  
3sgNOM go-SERIAL zebra:finch-ABS get-PAST  
'Having gone, she got zebra finch'

The logical structure suggests she goes and then she gets zebra finch droppings:

**do'**(3sg, [**go'**(3sg)]) & **do'**(3sg, [**get'**(3sg, zebra.finch)])



**Figure 36: Clausal cosubordination with serial verb**

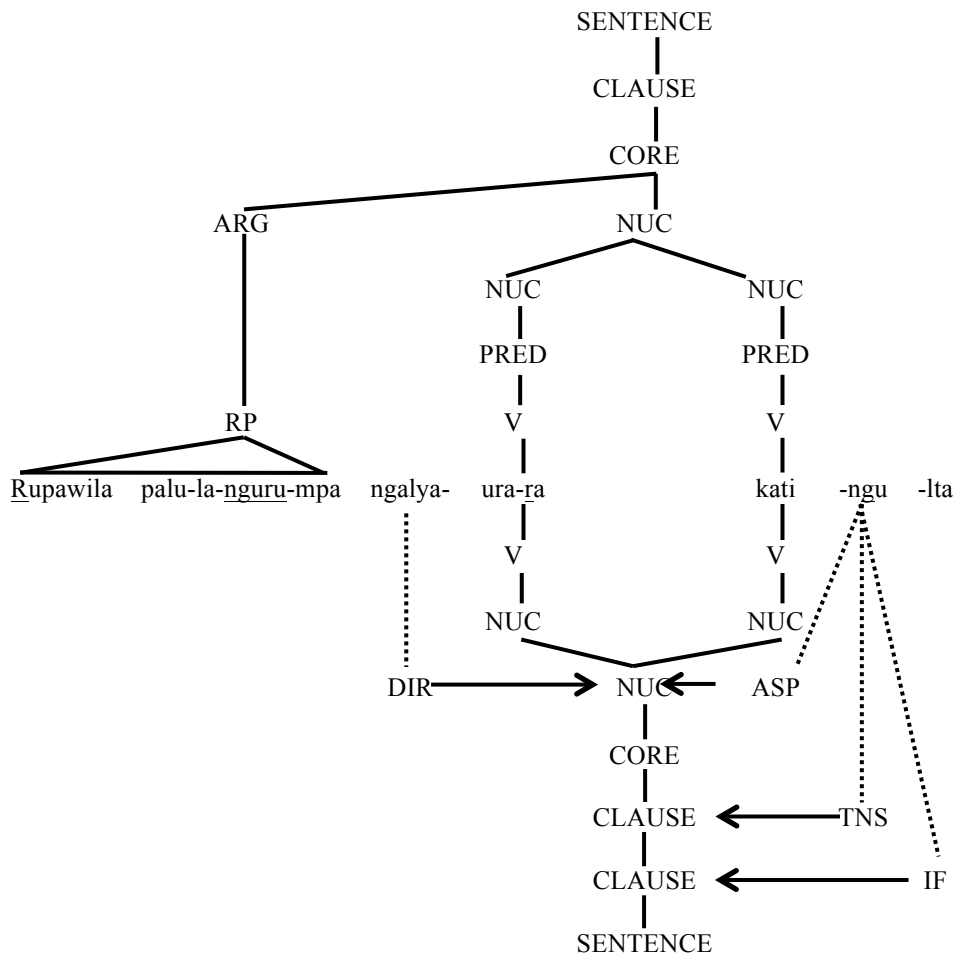
In figure 23 we see that perfective aspect only has scope over *ura* ‘get’. The shared operators are at clausal level indicating clausal cosubordination. The argument *nyiinyii* now only belongs to the second verb. This is looser as the two verbs are split by an intervening argument.

The serial form *ya-nkula* is the same in both the imperative and statement sentences shown in examples (66), (68) and (70): the mood and tense of the cluster are governed by the finite verb. Blake (1987:129-130) notes that in Yankunytjatjara, verbs keep their lexical meanings and do not modify each other. These verbal clusters therefore indicate a series or simultaneous set of related actions. Subjects or objects can be shared, as befits serial verbs (Aikhenvald, 2006:3).

Non periphrastic tight serialisations (Goddard, 1983:100) are nuclear level junctures. Goddard (1983:104) cites the fact that directionals attach to the verb complex. In this

example *ngalya* ‘this way’ governs both nuclei. As directionals are nuclear operators they provide evidence that the nexus is cosubordinate.

- (71) Rupawila palu-la-nguru-mpa ngalya-ura-ra kati-ngu-lta  
 v v  
 Robb’s Well DEF-LOC-ABL-INTEREST this.way-get-SERIAL bring-PAST-  
 AND.THEN  
 ‘From Robb’s Well (he) came this way, gathering up (the escaped birds)...’



**Figure 37: Non-periphrastic tight serialisation**

Periphrastic tight serialisation has a serial verb and finite verb, but the finite verb has become lightened to act as an aspectual modifier although syntactically is still in nuclear juncture. The serial verb then determines the case of the subject, whether it is transitive or intransitive. Goddard (1983:104) has this periphrastic example. *Waninyi* appears to be bleached and serves to give aspect to ‘sit’:

- (72) Nyina-ra wani-nyi  
 v v  
 Sit-SERIAL throw-PRES  
 ‘sitting around the place’

(73) Minyma tju<sub>ta</sub> nyina-ra wani-nyi  
 v v  
 Woman many-ABS sit-ANT (MERG) cast.aside.PRES  
 ‘Many women are sitting around all over the place.’



On the other hand the normally intransitive *nyina* ‘sit’ forms compounds that may be transitive:

- Goddard (1983:105) shows how the customary can develop from the periphrastic:

- (75) Wati-ngku kali atu-ra nyina-nyi  
 Man-ERG boomerang.ABS chop-SERIAL sit-PRES  
 'The man makes boomerangs.'

Goddard (1983:105) also has a category he calls ‘semi periphrastic’, as the serial verb determines the case of the subject but the finite verb still has some of its own meaning:

- (76) Wanyu-na                  kala-ra                  arka-la  
                                              v                                              v  
JUST.LET-1sgNOM light-SERIAL try-IMP  
'Just let me try lighting it.'

Aikhenvald (2006:20) states that while the verbs in an SVC have no marker of syntactic dependency, there may be marking to identify it as an SVC, for example on all but the last verb. These are not considered markings of dependency, but indicate membership of the SVC. In the case of the tight serialisations in P/Y the serial suffix appears to fulfil this function.

Eckert & Hudson (1988:223) describe this use of the serial form in terms of a verb phrase, which describes one action and is pronounced together with no pause:

- (77) Tjitji tjuṭa a-nkula wiya-ri-ngu  
Child many go-SERIAL NEG-INCH-PAST  
'The children have gone out of sight.'

Loose serialisation is cosubordinate nexus at the peripheral or clause level; there may be separate arguments, but the same tense is signalled by the main verb. Since tense is a clausal operator, this indicates cosubordination. The serial participle gives no indication of tense or aspect per se. However a sequence can be implied, as in this example from Goddard (1983:101):

- (78) Munu-li            Mimila-la       ngari-ra,     mungawinki maa-yana-nyi,  
                                        v                                      v  
And-1duNOM   Mimili-LOC lie-SERIAL morning       away-go-PRES,  
Intalka-ku-lta  
Indulkana-PURP-AND.THEN  
'And having slept at Mimili, in the morning we'll go off to Indulkana.'

Eckert & Hudson (1988:220) call these ‘secondary verbs’ that form a sequence before a main verb. They are common in stories, allowing the narrative to flow:



A distinct pause changes this for some speakers. This suggests that this may not be a SVC as one of the criteria is a single intonation across the verbs.

- (84) Minyma, mai mantji-ra, ngalya-pitja-ngu  
                 v                                    v  
 Woman food get-SERIAL back-go-PAST  
 ‘The woman, having got some food, came back.’

## 5.6 Causation

At the nuclear level, sentences with two nuclei are often used to express causative events (Pavey, 2010:221-222). For example if there are two predicates, one could be causal (V<sub>cause</sub>) and the other the effect (V<sub>effect</sub>). Cause and effect when expressed by two serialised verbs can combine to form one meaning. The second verb can describe the consequence or outcome of the event described by the first verb (Pavey, 2010:243). This is the case in French, for example (Robert, 1978:698):

- (85) Je suis venu travaill-er  
1sgNOM be.PRES come.PFV work-INDIC  
'I have come to work'

The logical structure shows purpose:

- (86) **do'**(1sg,[**come'**(1sg)]) PURP **get'** (1sg,work)

This is achieved in P/Y via dependent purposive subordinate clauses, with the same subject, for example Bowe (1990:75):

- (87) Trevor-nya paka-nu a-nkuntjikitja  
Trevor-ABS get.up-PAST go-PURP SS  
'Trevor got up to go.'

Again, PURP is shown in the logical structure:

- (88) **do'**(Trevor,[**get-up'**(Trevor)]) PURP **go'** (Trevor)

Alternatively some verbs can be used to show direct causation. This example is from French (Tallerman, 2005:206):

- (89) Jean a lu ce livre  
John read-PAST this book  
'John read this book'

The causative uses *faire* ‘to make’ and the infinitive:

- (90) Nous avons fait lire ce livre à Jean  
We have-PRES make.PAST.PART read.INDIC this book to John  
'We made John read this book'

Verbs such as *faire* in their capacity as [Vcause] are semantically bleached, in that their original meaning is lost and they are present only to indicate causation (Song, 1996:81).

Causative SVCs usually have the verb of causation preceding the main verb (Aikhenvald, 2006:16). In this *faire* appears quite typical.

Causation is another type of SVC in Chinese (Sun, 2006:205-206). Verbs that can exist on their own such as *qǐng/ràng/gěi/jiào* ‘invite/allow/give/call’ can be used as causative markers in an SVC. The NP between the two verbs is the undergoer of the first and the doer of the second; this is known as a pivotal construction.

- (91) Wǒ zuótiān qǐng/ràng/gěi/jiào le tā kàn diàn yǐng  
 1sg yesterday invite/let/give/call PFV 3sg look electric shadow  
 ‘I invited/let/allowed/made him (to) watch a film yesterday.’

P/Y makes use of the serial participle in this example, where there is an obligation to give (Goddard, 1996, 194).

- (92) Paluru tungunpu-ngkula ngatji-nu, ka-na yu-ngu  
 3sgNOM press-SERIAL demand-PAST and-1sgNOM give-PAST  
 ‘He pressed me to give it, so I did.’

In language generally, where events described by two predicates are closely interconnected, there is a tendency to have a more tightly connected syntactic structure (Pavey, 2010:245). In this example from P/Y (Goddard, 1996:238), the elements of [Vcause] and [Veffect] are independent lexical verbs, adjacent and contiguous, therefore COMPACT as in Song (1996:33). *witura* ‘insist’ and *iyani* ‘send’ combine to mean ‘get to go somewhere’. The first verb gets the serial participle, and they share arguments.

- (93) Ka minyma-ngku panya witu-ra iya-nu kungkawara  
 And woman-ERG that insist-SERIAL send-PAST girl-ABS  
 panya wati-ngka kuka mantji-ntjaku  
 that man-DAT meat-ABS get-PURP DS  
 ‘The older woman had the girl go get the meat from the man’

In this example the sense of ‘make’ is implied; a second verb is not required (Goddard, 1996:238).

- (94) Waru tju-nkula, mina-ku witu-nu minyma tjuṭa.  
 Fire set-SERIAL, water-PURP tell-PAST woman PL  
 ‘Set a fire, then got the women (to go) for water.’

This example using *paini* ‘forbid’ (Goddard, 1996:117) has two verbs, but they are not tightly bound as *patu* ‘far’ intervenes; the first verb is not serial, and the second verb is a dependent subclause:

- (95) Kami-lu-nanya pai-nu patu inka-nytjaku.  
 Grandmother-ERG-1plACC forbid-PAST far play-PURP DS  
 ‘Grandmother’s forbidden us to play far.’



## 5.7 Discussion

Verbs in P/Y use suffixing to demonstrate tense, mood and aspect. The verbs do not take on person or number agreement; person and number is shown by stand alone or enclitic pronouns and nominals. These represent the verb arguments.

Multi verb constructs are used frequently, but dependent forms appear to be most typical. In the purposive and anterior subclauses we have a pattern of nominalising the verb, then adding dative or locative for different subject subclauses; or *-kitja* or *-tjanu* for same subject subclauses. We see with the same subject (SS) forms, that they take ergative marking if the main verb is transitive. The other two dependent forms, anterior merged and negative, differ from this pattern. As the SS forms share the same argument, they fulfil one of the criteria for an SVC. Negative uses the suffix *-wiya* which can occur with other affixes. These dependent forms are embedded and thus subordinate core junctures in P/Y. This differs from the case in English where these would be core coordination or subordination.

The anterior merged/serial verb participle occurs both as a dependent clause level verb and at nuclear level, where it represents a verb complex. The main verb, if there is one, takes the finite form. However as seen in some cases there is not a ‘main verb’ but the two (or more) nuclei form one action or series of actions. The debate is to what extent these are serial verb constructions as defined by Aikhenvald (2006:1ff).

The neighbouring Western Desert dialect Ngaanyatjara can have two or more juxtaposed verbs, with finite inflection indicating a complex (Blake, 1987:131-132). Note that aspect can be different but tense must be the same.

- (96)   ...pula       kutitya-ngu               parraputa-ranytya  
                           v                                               v  
           Ant.hill go-PAST:PFV           playfully.spear-PAST:IMPF  
           ‘... and went and were playfully spearing ant-hills’

Glass (1983:9) has this Ngaanyatjara example with three verbs in the past perfect. She states that the verbs in the cluster must be from one tense or mood but aspect can differ.

- (97)   Katurri-ngu               =latju               mapitja-ngu               Winpuly-tja tju-nu  
           v                                               v                                               v  
           Get.up-PAST.PFV   they               catch-PAST.PFV   Winpuly-at   put-PAST.PFV  
           ‘We got up went and put our things at Winpuly’

Such juxtaposition of similarly inflected verbs does not appear to be a feature of P/Y. Instead it uses the serial participle, and a finite verb. Pavey (2010:229) discusses converbs in some European languages which have markings on the non-finite verb to indicate membership of a serial construction. This appears similar to the loose serialisation discussed here. Blake (1987:118) suggests that the serial marked verbs are backgrounded to the main verb, but are necessary adjuncts. He compares the serial form with subordinate clauses in English such as, ‘Seeing such waste, I became angry’ (Blake, 1987:126).

Pavey (2010:234) states that some SVCs are cases of nuclear subordination. The second verb is lexical and subordinate, peripheral to the main nucleus. The study here shows that in cases where a serial verb construction is found, the nexus seems to be cosubordinate, as aspect is shared and governed by the finite clause. In contrast, Bowe (1990:74ff) describes the purposive and anterior circumstantial as being examples of subordination.

Aikhenvald (2006:1ff) and Dixon (2006:339ff) have several criteria for SVCs. These are that a sequence of verbs behaves like a single predicate with no overt marking for coordination or dependency. They should represent a single event, be monoclausal intonationally and have one tense and aspect. However some variations exist; they do not have to be contiguous and marking can be on one or every component. There are also symmetric and asymmetric SVCs where in the latter one of the constituents is from a restricted class. Aikhenvald (2006:20) also states that there can be a morpheme marking on all but the last verb to indicate membership of an SVC.

We see that the serial verbs in P/Y fulfil some of these criteria. The finite verb marks the tense and aspect of the whole construct and the serial participle in effect shows membership of a series of actions to different degrees of tightness. As we have discussed, the tight serialisation has periphrastic constructions where one verb appears just to show aspect. This is similar to the asymmetric SVCs where a verb from a restricted class is used, often one of motion or posture. Aikhenvald (2006:58-59) acknowledges terminological issues with SVCs; she quotes Goddard (1988) as referring to chained clausal structures as serial verbs. As there are some variations in the strict criteria, a particular serial verb construction in P/Y may be classed as an SVC depending on the particular form in question.

SVCs have similarities with other multiverb constructions such as monoclausal converbs and clause chaining as well as clause coordinated structures. So they are part of a continuum of multiverb structures (Aikhenvald, 2006:56). Other languages show similar phenomena. Taleghani (2010) shows how the progressive tense in Persian is formed periphrastically using 'have'; and that this is a SVC rather than an aspectual complex predicate where the main verb would be in stem form. The verb complex describes a single conceptual event and the verbs are not separated by complementisers or conjunctions.

P/Y also has periphrastic aspectual constructions too as noted, with *waninyi* serving to give aspect to the serial verb in the same complex (Goddard, 1983:104). This periphrastic construction in P/Y is the reverse of the case in some Formosan languages as reported by Yeh & Huang (2009). These languages can have three or more verbs in SVCs; some of the verbs may be adverbial or modifying of the final action verb. Guaraní has a continuum of degree in predicate chains (Velázquez-Castillo, 2004); there is a single macro event and modifying of co-verbs. The tight non periphrastic constructions in P/Y show a single event ('go get'), while the periphrastic ones have a finite verb providing tense and aspect to the serial verbs; there is no modifying of the verbs themselves.

## 6 Concluding discussion and significance

The objective of this paper was to look at the phenomenon of serial verb constructions in two dialects of the Western Desert language in Australia, Pitjantjatjara and Yankunytjatjara. Serial verb constructions themselves have not been thought to feature heavily in Australian languages though Dixon (2006:344) uses some of the SVC criteria to see if they occur in Dyirbal. As languages showing ergativity and agglutination Australian languages have features that differ from many European ones; so this work used RRG as a way of studying the case and inflectional systems and the system of affixation and cliticisation generally, allowing us to see what is going on in multi verb constructions.

We found that nominal case marking occurs on the noun phrase rather than the individual nominal, and serves to identify phrases as core or peripheral arguments. The nominals show ergative-absolutive contrast while the pronominals have a nominative-accusative system. Pronominals have dual number in addition to singular and plural. In this they are typical of Australian languages. Case marking is used for marking grammatical relations rather than the use of adpositions. There is also a system of pronominal clitics that have a strict order of affixation.

RRG is crucial to the analysis as with the constituent and operator projections we could determine the argument structure and scope of operators. The lexical decomposition allowed us to break down predicates and their arguments to their logical structure and semantic representation. In this way we could look at serial verbs to see if they shared arguments and aspect, and thus whether they represented nuclear junctures or single actions or a chain of clausal events. Can serial and multi verb constructs in P/Y be characterised as nexus juncture relations? By looking at grammatical markings on simple verbs, we can see their scope in multi verb and serial verb constructions and thus the types of juncture and nexus involved. We can characterise switch reference at clause and core level, dependent subordinate core level clauses and serial verbs at the clause and nucleus level.

Multiple verb sentences display switch reference in dependent verb forms and clausal linkage. A feature of both dialects is the very common use of serialised verbs. These can indicate a series of actions or a compound verb. The study of nexus juncture relations of the multi verb constructions shows there is tight and loose serialisation present and the tight serialisation has many of the characteristics for serial verb constructions. We have found that in serial verb constructions the finite verb marks the tense and aspect of the phrase, and the together with the serialised members show a sequence of actions. The subject is shared, though object and location may be separate for loose serialisation. Tight serialisation may be periphrastic where the finite verb has been lightened to act as an aspectual marker. The serial marked verbs are thus the lexical matrix verbs and determine the transitivity of the verb complex and the actions. This is significant because we can see that P/Y serial verbs exist in a continuum with the same system of suffixes whether showing nuclear or clausal cosubordination. In this they are perhaps not prototypical SVCs.

Causation in some languages is indicated by SVCs. P/Y is shown to use lexical causative verbs, suffixes as well as multiple clause constructs. There is a dependent clause with a

different subject that indicates indirect causation, in other words that the subject of the dependent clause has agency. Sun (2006:200-206) describes serial verbs in Chinese and draws a distinction between flexible order parallel constructions and inflexible order sequential constructions. In both types of construction aspectual markers cover all verbs in the SVC. In some cases initial verbs may turn into grammatical markers. This mirrors the periphrastic tight serialisation in P/Y.

This study points to some interesting areas of future research. Intonation is used in describing the contours of phrases. Further work might look at information structure over multi verb constructions and this would include how they are conceived intonationally in P/Y. As Aikhenvald (2006:1) states, one of the criteria for SVC is that intonationally they are like monoverbal clauses. A study of how the serial chains are spoken would aid in determining whether they are nuclear or clause level junctures. The focus projection could add to the work on arguments and how they are shared; whether the focussed argument belongs to one of the verbs or the entire complex. Word order is relatively free in P/Y so while the cases mark the macroroles and other parts of the clause, intonation and topicalisation could be used to draw attention to different parts of the sentence.

## 7 Abbreviations

ABL Ablative	FUT Future	PAST Past
ABS Absolutive	GEN Genitive	PFV Perfective
ACC Accusative	HABIT Habitual	PL Plural
ALL Allative	IMP Imperative	POS Possessive
ANT Anterior	IMPF Imperfective	PRES Present
AVERS Aversive	INCH Inchoative	PURP Purposive
CAUS Causative	INDIC Indicative	REP Reported
CONT Continuous	INSTR Instrumental	SERIAL Serial participle
DAT Dative	LOC Locative	SS Same Subject
DEF Definite	MERG Merged	TRANS Transverse
DEM Demonstrative	NEG Negative	TURN Turning point
DS Different Subject	NOM Nominative	VOC Vocative
ERG Ergative	PART Participle	

### Pronouns

1, 2, 3 first, second and third person	
sg	singular
du	dual
pl	plural

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# How data-ink maximization can motivate learners

## – Persuasion in data visualization

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### ABSTRACT

*This paper discusses both the macro- and the micro-level of persuasion in data visualizations in persuasive tools for language learning. The hypothesis of this paper is that persuasive data visualizations decrease reading time and increase reading accuracy of graph charts. Based on Tufte's (1983) data-ink maximization principle the report introduces a framework for persuasive data visualizations on the persuasive micro level which employs Few's (2013) conception of de-emphasizing non-data and emphasizing data-ink. This way persuasive data visualizations for a performance optimizing tool called Learning Journey Online (cf. Gottschalk and Winther-Nielsen 2013) is presented.*

### 1 Introduction

“Make more from your brain” – this slogan resembles the well-known heading of the Nike running App<sup>4</sup> and it promises optimization of brain resources. How can one make more of one's learning and consequently of one's brain? Can these be changed by a web interface keeping track of our learning progress? And what makes such an interface persuasive? This report deals with the latter question from a specific perspective: It asks how the visualization of learning data can be persuasive. What is needed for a data visualization to be persuasive and what helps users to easily understand such a visualization?

Over the past three years six partner institutions from four countries in Europe have been working on the development of Persuasive Learning Objects and Technologies (PLOT) in a Lifelong Learning Project which is called EuroPLOT ([www.eplot.eu](http://www.eplot.eu)). EuroPLOT has been funded by the Education, Audiovisual and Culture Executive Agency (EACEA) of the European Commission from 2010 – 2013. Within the project PLOTLearner has been developed as new learning technology (cf. Winther-Nielsen ms, 1). One part of PLOTLearner is Learning Journey Online which attempts to measure learning progress in students by using IRT within the persuasive architecture of PLOTLearner. The guiding hypothesis which Learning Journey Online is based on is that gathering data from learning statistics through computational surveillance and data mining algorithms and their visualization can support persuasive teaching in systems for computer-assisted language learning.

Based on this hypothesis I present a framework for persuasive data visualizations in a computational surveillance tool that can predict the learning progress of a learner and enables teachers to keep track of their students' learning progress. The term surveillance is essentially defined by Fogg as “observe others' behavior” (2003: 46), but the concept has been

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<sup>4</sup> [http://nikeplus.nike.com/plus/products/gps\\_app/](http://nikeplus.nike.com/plus/products/gps_app/)

developed further in Gottschalk and Winther-Nielsen (2013) as a persuasive principle which enables a feedback-loop to apply within CALL systems.

Currently PLOTLearner is being repurposed as an online application developed by Claus Tøndering under the name of Bible Learner Online (<http://bibleol.3bmoodle.dk/>; Winther-Nielsen 2013a: 22f). This online application will automatically upload data on learner performance to Learning Journey Online at regular intervals. In Learning Journey Online these data can then be used, stored in log files, as input for modeling learning statistics. Teachers, students, and peers can then use these continuously-uploaded and complete learning statistics to plot an individual's learning progress in a class and enhance the learning process on the basis of complete statistical evidence. With the new system I follow the ultimate goal of emulating the presence of an artificial tutor as a learning supervisor in an interactive, virtual environment. The plan is to expand Learning Journey Online to a full-fledged intelligent tutoring system in language learning; the architecture of such a system is described in Gottschalk (2012).

The present report and study are rooted in the experimentation of a course taught for the EuroPLOT project by Nicolai Winther-Nielsen at Fjellhaug International University College Denmark in Copenhagen and is based on a paper written by Gottschalk and Winther-Nielsen (2013) which has introduced Learning Journey Online at the International Workshop on EuroPLOT Persuasive Technology for Learning, Education and Teaching 2013 [IWEPLET 2013] which was held in Paphos, Cyprus, from 16.-17 September 2013. Learning Journey Online (<http://statdb.3bmoodle.dk/>)<sup>5</sup> grew out of a study by Gottschalk (2013) which analyses the importance of feedback in language learning. The study gives evidence that students desire feedback and support in their learning progress. Consequently Learning Journey Online provides the student, on the one hand, with feedback on his or her learning and, on the other hand, still opens the field for self-directed learning. In this report I complement the findings in Gottschalk and Winther-Nielsen (2013) with details of how persuasive data visualization within Learning Journey Online can look like to develop a full-fledged performance optimization system which gives teachers and learners the possibility to keep track of the students' learning progress.

The remainder of this paper is organized as follows: In section 2 I give an introduction to Tufte's (1983) and Few's (2013) world of data visualizations. Section 3 reviews of a number of empirical studies on Tufte's data-ink ratio on which Few's work as well as my approach are based. I discuss in detail how a persuasive approach for data visualization needs to look like. Section 4 presents a concrete design approach to persuasive data visualization in Learning Journey Online which is in use in section 5.

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<sup>5</sup> The system of Learning Journey Online can be accessed by using a guest account (login name guest, password start123) until February 2014. In case one desires to log onto the system later is asked to send a request to [gottschalk.judith@gmail.com](mailto:gottschalk.judith@gmail.com)



## 2 The world of Tufte and Few: An introduction

Tufte (1983) has developed a framework for data visualization which is the result of extensive research. He has introduced a metric to measure the efficiency with which a data visualization presents its data (cf. Blasio and Bisantz 2002: p. 89): The key factors for them are the data ink ratio, chartjunk, data density and the lie factor (cf. Tufte 1983).

The concept of the data ink ratio applies when quantitative information is displayed in printed form. Some of the ink in such a visualization presents data and some presents visual content that is not data (cf. Few 2013: p. 96). Tufte defines the data-ink ratio as follows:

“A large share of ink on a graphic should present data-information, the ink changing as the data change. Data-ink is the non-erasable core of a graphic, the non-redundant ink arranged in response to a variation in the numbers represented.” (Tufte 1983: p. 93)

From this concept Tufte develops the design principle which he puts this way:

“Maximize the data-ink ratio, within reason. Every bit of ink on a graphic requires a reason. And nearly always that reason should be that the ink presents new information.” (Tufte 1983: p. 96)

Both Tufte (1983) and Few (2013) agree that the following list of non-data can be reduced from data visualizations: The third dimension of depth on pie charts or bar charts, Lightning effects that make pies or charts look three dimensional, Ornaments on titles, labels, backgrounds and graphs, Grid line in graphs (cf. Few 2013). Tufte uses the term chartjunk to refer to effects like grid lines, ornaments, decoration etc. For him these are non-informative visual elements which do not support the core purpose of display. Here it even coins the way in which chartjunk obscures the visual data. Tufte says: The interior decoration of graphics generates a lot of ink that does not tell the viewer anything new; it is often chartjunk (Tufte 1983: p. 107).

Within my attempt to develop a persuasive visualization in Learning Journey Online I follow the guiding principles developed by Tufte (1983) and described in Few (2013). I reduce the non-data content in the visualizations as much as possible. This is done to proceed with the enhancement of the data content with as much clarity and meaning as possible (cf. Few 2013: 87). In this my approach follows the procedure described in Few (2013):

1. Reduce the non-data pixels
  - a) Eliminate all unnecessary non-data pixels
  - b) De-emphasize and regularize the non-data pixels that remain.
2. Enhance the data pixels
  - a) Eliminate all unnecessary data pixels.
  - b) Highlight the most important data pixels that remain.

(cf. Few 2013: p. 98)

Few's conception of data enhancement which he complements with the de-emphasizing of non-data is in contrast to Tufte (1983) who completely deletes non-data ink.

### **3 Review of Tufte's data-ink ratio and Few's data enhancement principle**

While Tufte's argumentation for the data-ink ratio is compelling he does not give empirical evidence confirming that the maximization of the data-ink ratio leads to better task performance (cf. Blasio and Bisantz 2002: p. 91). Nevertheless an extensive body of research exists on the question whether there is empirical evidence for better performance of visualizations using Tufte style. Carswell et al. (1991) have shown that three-dimensional effects on bar charts, pie charts or line charts make the accuracy with which these graphs are read decrease. Visualizations which use 3D-effects also lower the performance on tasks which involve the magnitude estimations and trend classifications of these types of graph (cf. Blasio and Bisantz 2002: p. 91).

A considerable amount of research was conducted on whether background images have an effect on preference, performance and recall of data visualization. Sorensen (1993) is one example but also Gillian and Richman (1994) and Gillian and Sorensen (2009) have investigated these effects. In Tufte (1983) and Few (2013) background images are regarded as chartjunk per se and both conclude that using background images is counterfactual to the principle of data-ink maximization. Gillan and Richman (1994) generally have shown that pictorial backgrounds increased response time and decreased accuracy. Additionally they have shown that specific kinds of pictorial backgrounds have more effect on specific types of charts (line chart vs. bar chart). The type of background also influences the performance in response time and accuracy on reading data visualizations. Gillan and Sorensen (2009) have based their work on the findings in Gillan and Richman (1994) and have investigated graphs which have no background, a pictorial background with circles or with rectangles and found that accuracy in reading the graphs was highest for the difference task when the features in the indicators and the background of a graph have differed (cf. Gillan and Sorensen 2009: p. 1096).

Another aspect discussed in Gillan and Richman (1994) is the effect of x- and y-axis in data visualizations and how they affect reading accuracy and response time of graphs. Both ticks and axis serve as redundant data-ink in Tufte (1983) because they carry redundant information as the data they provide is also contained in the positions of the numerical labels. Based on a literature review Gillan and Richman (1994) doubt this because it has been pointed out in Sanders and McCormick (1987) that tick marks might be beneficial to graph readers. In another study which Gillan and Richman cite, Whitehurst, (1982), who gives empirical evidence based on performance times for using ticks and axis, too.

While Few (2013) in his framework for dashboard design agrees with Tufte that all kind of background should be regarded as non-data pixels as he coins it, he does not agree with Tufte on the point that grid lines and axis should be regarded as chartjunk. Instead he argues to de-emphasize and regularize non-data ink that remain in a chart (cf. Few 2013: p. 102). De-emphasizing axis and grid lines is, according to Few, a process which follows the reduction of non-data and is thought to be used when lines, borders and grid support the structure, organization and legibility a visualization. Here Few is in line with Gillan and Richman's study on the effectiveness of axis in data visualization.

#### 4 Data-ink maximization: An approach towards persuasive data visualizations

In persuasive technology computers act as persuaders to help people change their attitudes or actions (cf. Gottschalk and Winther-Nielsen 2013; Fogg 2003). When applied to data visualizations this principle must be interpreted on two levels: A persuasive macro level and a persuasive micro level. On the persuasive macro level the data visualization is put into context with the other persuasive elements of the technology it occurs with while on the micro level the persuasion itself is enriched with aspects that make the visualization persuasive. In the development of persuasive data visualizations I follow two principles which utilize Tufte's and Few's principle of data-ink ratio maximization and data-ink enhancement respectively:

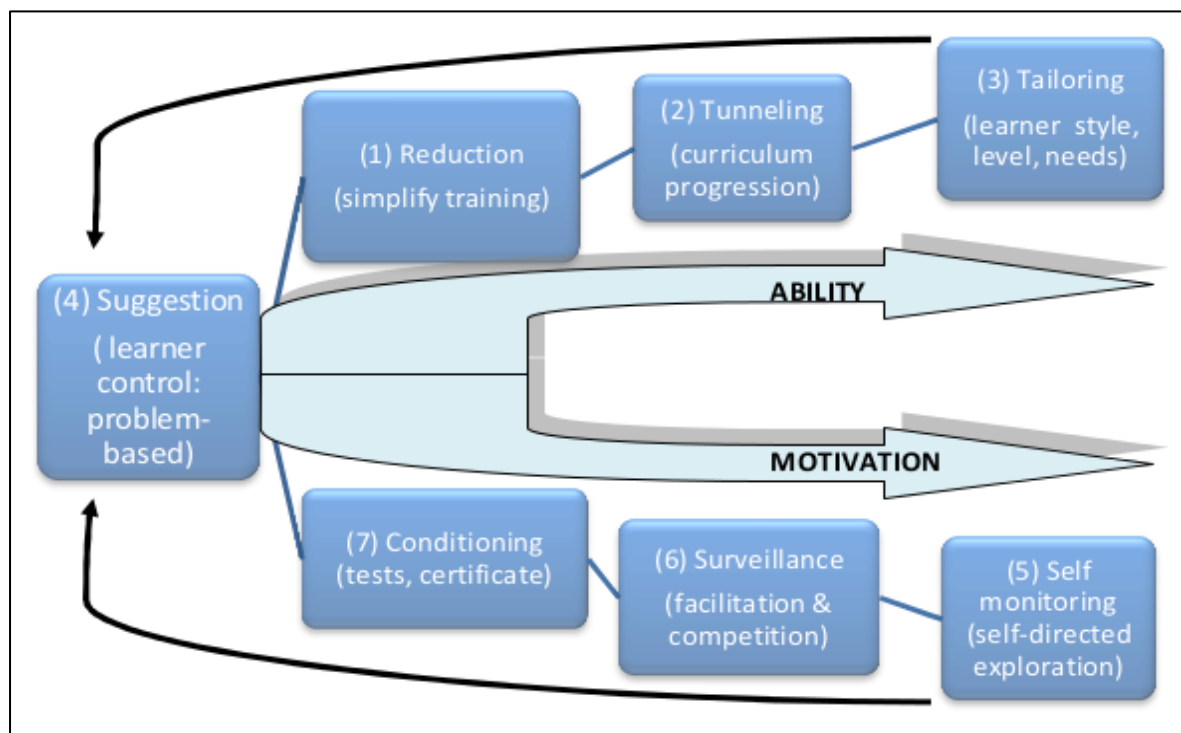
(1)

- a. A visualization is persuasive on the **micro** level if it follows the principle of data ink maximization to decrease reading time of a visualization and increase reading accuracy.
- b. A visualization is persuasive on the **macro** level if it utilizes persuasive principles like tailoring and surveillance to the degree that it does not interfere with the principle of data ink maximization.

The persuasive principle in (1a) boils down to the concept of usability: If a data visualization is easy to read and understand it can be regarded as persuasive. This simple principle is derived from Oinas-Kukkonen and Harjumaa (2008: pp. 166) who, present seven postulates for the evaluation of persuasiveness within ICT systems. One of these is the following: "Persuasive systems should aim at being both useful and easy to use" Oinas-Kukkonen and Harjumaa (2008: p. 168). Ease-of-use includes a number of aspects like convenience, ease of access, error-freeness, high information quality, a positive user experience, attractiveness and user loyalty. To make it short: if a system is useless or difficult to use it is unlikely that it could be persuasive (cf. Oinas-Kukkonen and Harjumaa 2008: p. 168). I will exemplify on a practical basis how the principle in (1a) is used to make Learning Journey Online persuasive on the micro level.

The predominant principle of persuasion that inspired Learning Journey Online on the macro level is surveillance and it is set out by Fogg (2003). The surveillance approach chosen in Learning Journey Online is uncovered monitoring. Gottschalk (2012) exemplifies that feedback is what most users of a software for CALL like PLOTLearner desire. Surveillance is a way to provide learners with feedback via detailed learning statistics. This is possible because it supports teachers to give their students such feedback and also gives learners the possibility to keep track of their learning progress (cf. Gottschalk and Winther-Nielsen 2013). Learning Journey Online also uses the persuasive principle of tailoring. The detailed feedback provided by learning statistics makes it possible for the learners to adjust their learning process according to their statistics. By choice of the student the teacher receives a detailed learning profile of the student so that he can adjust his teaching according to the statistics and needs of the student (cf. Gottschalk and Winther-Nielsen 2013).

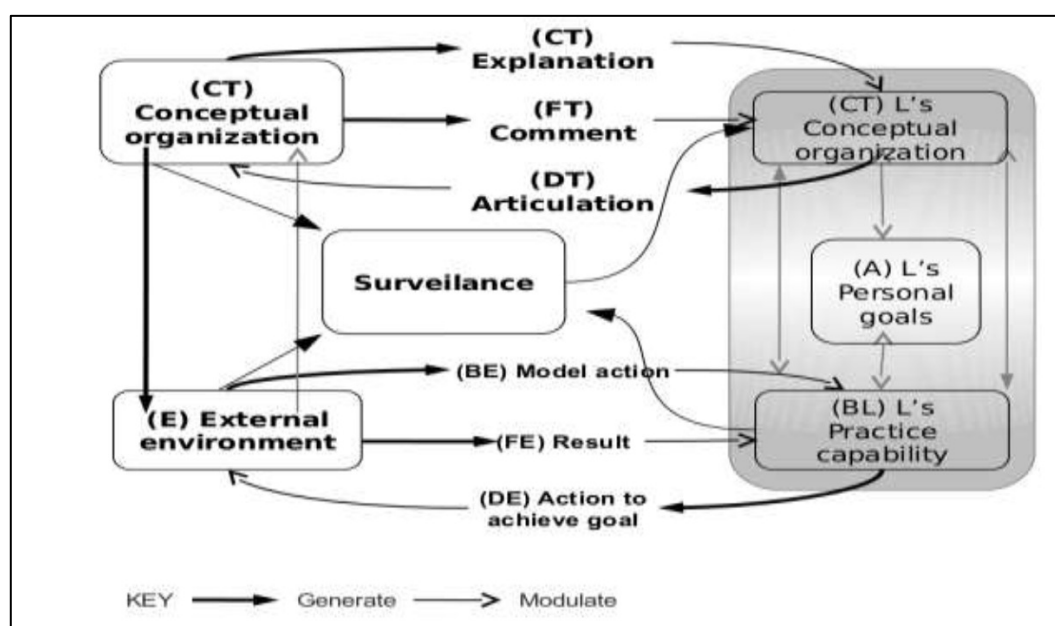
Winther-Nielsen (ms a: 7) and Gottschalk and Winther-Nielsen (2013) describe persuasion on the macro level in PLOTLearner as being based on three levels in the development of ability and motivation through computer-assisted language learning. These levels are reduction, tunneling and tailoring. The most persuasive mechanism to increase the ability of a learner is tailoring. In such a persuasive technology the training is adjusted to the learners' knowledge level, age, learning style, progression, goals and other highly individual parameters which are related to vocational needs (cf. Gottschalk and Winther-Nielsen 2013). The persuasive architecture which Winther-Nielsen follows for the development of PLOTLearner and which is also employed within Learning Journey Online is exemplified in figure 1 below



**Figure 1: Persuasive architecture (Winther-Nielsen ms a: )**

The persuasive data visualizations in Learning Journey Online support tailoring by giving detailed feedback based on learning statistics will make it possible to adjust the whole learning process according to the statistics results and the specific needs of the student. The other branch of Winther-Nielsen's architecture is *motivation* with similar functions and set up in a parallel track to focus on increasingly persuasive feedback. The data visualizations in Learning Journey Online are persuasive because they enable the learner to self-monitor their learning progress and to be intrinsically motivated to change their learning habits. The ultimate system for language learning described in Gottschalk (2012) and envisioned by Winther-Nielsen uses artificial intelligence and natural language processing to record the individual's processes and outcomes and measure performance on language learning tasks. Mainly it is the addition of a further feedback element to the learning circle which makes the system persuasive on the macrolevel. In Learning Journey Online the robust theory of design for learning introduced in Laurillard (2012) has been used as pedagogical approach (cf.

Gottschalk and Winther-Nielsen 2013). It is this elements within the architecture of Learning Journey Online which makes it persuasive on the macro level. Gottschalk (2013) points out in some detail that what most users of persuasive tool for language learning like PLOTLearner and Learning Journey Online desire feedback. As has been shown in the empirical study by Gottschalk (2013) what most learners desire is to have their learning progress visualized for themselves. In the environment of PLOTLearner learners act self-directetly and therefore it is very important for them to keep track of their learning progress (cf. Gottschalk 2013). I use Laurillard's model of conversational theory to visualize the processes involved in learning from en external environment (cf. Winther-Nielsen *ms a*) and to add a feedback-loop to Learning Journey Online. A sketch of this approach is given in figure 2 below:



**Figure 2: Surveillance added to the model of Laurillard (2012: 60)**

In the approach developed by Laurillard (2012: 60) learners use their personal goals and the current organization of learning spaces for the selection of a desired practice which generates learning actions on the external environment (cf. Gottschalk and Winther-Nielsen 2013). Learners use actions modelled by the teacher or even results of their own actions to modulate and build practice and capability. It is also possible to learn through direct communication. In this case exlanations and comments from the teacher or the learning environment enable the learner in her development of a conceptual organization of the learning environment. In figure 2 this is indicated by the elements (CT) and (FT) (cf. Gottschalk and Winther-Nielsen 2013). Specifically the feedback-loop, which is created by adding the learning circle to Learning Journey Online, creates persuasive data visualization on the macro level. What gets obvious at this stage is that the persuasiveness of visualization on the macro level is a means to transport information and, in this way, to contribute to the general persuasive architecture of an ICT system.

## 5 Persuasive data visualizations in action

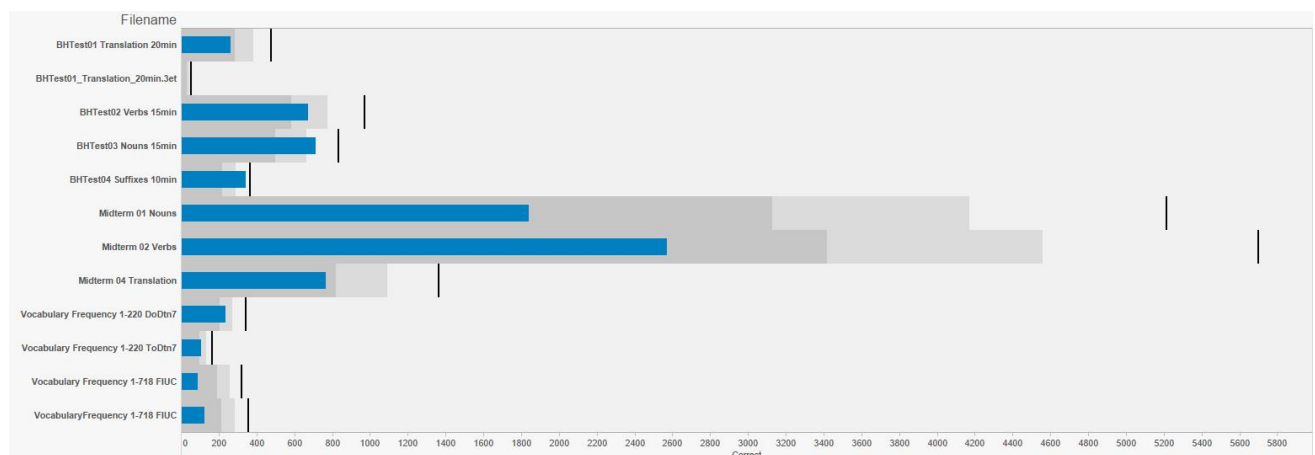
Learning Journey Online uses a number of different parameters to measure the learning performance of a student: The parameters ability, logarithmic likelihood and difficulty have

their origin in the formal framework of Item Response Theory [IRT] (cf. Gottschalk and Winther-Nielsen 2013). Especially the parameter proficiency, a persuasive label I am using for the concept of automatization, is rooted within psycholinguistic research on second and foreign language acquisition (cf. DeKeyser and Criado 2012). Gottschalk and Winther-Nielsen (2013) describe in length how ability, logarithmic likelihood and difficulty are calculated within IRT statistics. The bullet chart in figure 2 shows how many right answers a student gave for every completed section compared to the overall sum of all answers. The line graph visualizes how proficiency, has developed over time. (cf. figure 3).

Since learners can solve a great number of exercises to the different grammatical aspects of Biblical Hebrew a visualization is needed which allows several of graphs in conjunction. A bullet chart is specifically designed to serve this need (cf. Few 2013: p.151). While especially Tufte (1983) mentions that color of graphs should be considered as chartjunk Few (2013) explains that hues other than gray can be used in visualizations if they do not disturb the reader. In my visualization of the bullet chart I follow this advice.

The main reason for this is persuasion on the micro level: The use of the color blue should give the user a positive impression without disturbing her too much from the data. Contrary to Tufte's approach to the maximization of the data ink ration the bullet chart and all other charts have at least an x-axis with ticks. This is motivated by the principle in (3a) which refers to persuasion on the micro level: All means to decrease the reading time of a graph and to decrease the reading accuracy are considered as persuasive. Following Few's conception of de-emphasizing non-data ink the axis and ticks are however in light gray to emphasize the data in the visualizations. Although the original concept of the graphs for Learning Journey Online included using an image of Mount Sinai to give learners the impression of being on a journey, I decided against using pictorial images in my data visualizations.

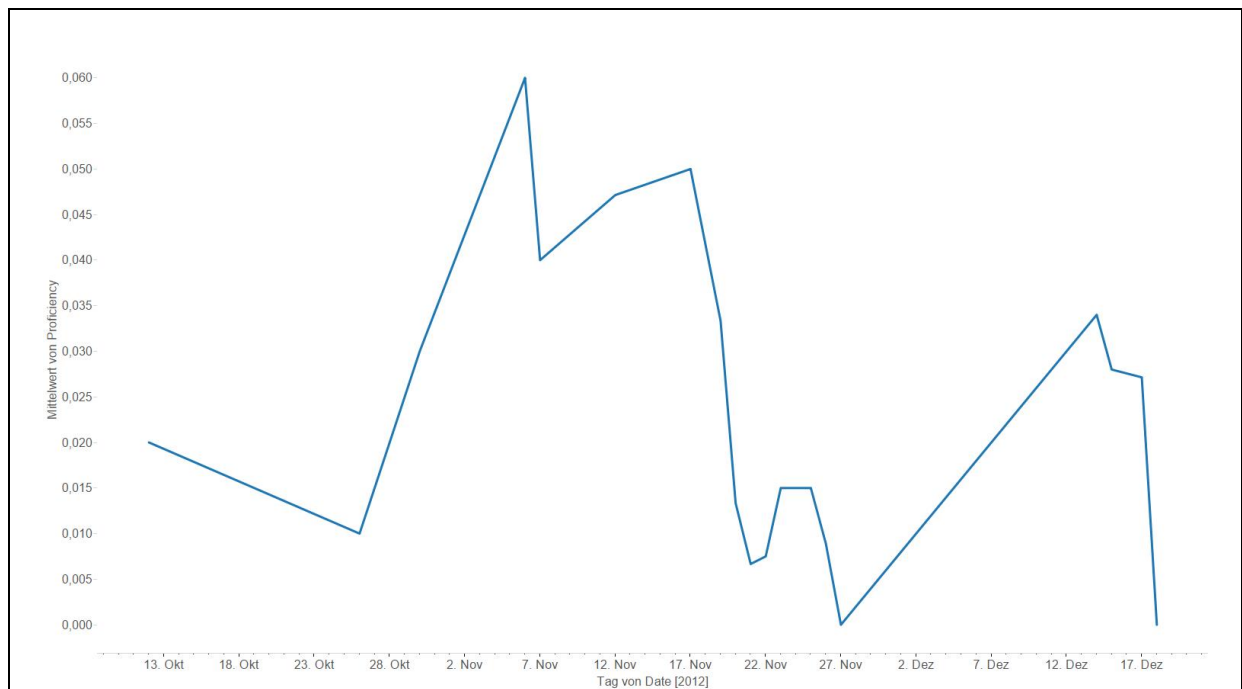
As pointed out in Gillan and Richman (1994) the use of pictorial images does increase the reading time in specific circumstances. While a pictorial background in some situations might support fast reading and reading accuracy (cf. Gillan and Sorensen 2009) it was difficult to decide whether a picture of Mount Sinai might support the two persuasive measures. My overall conclusion was that the picture would not support persuasion on the micro level.



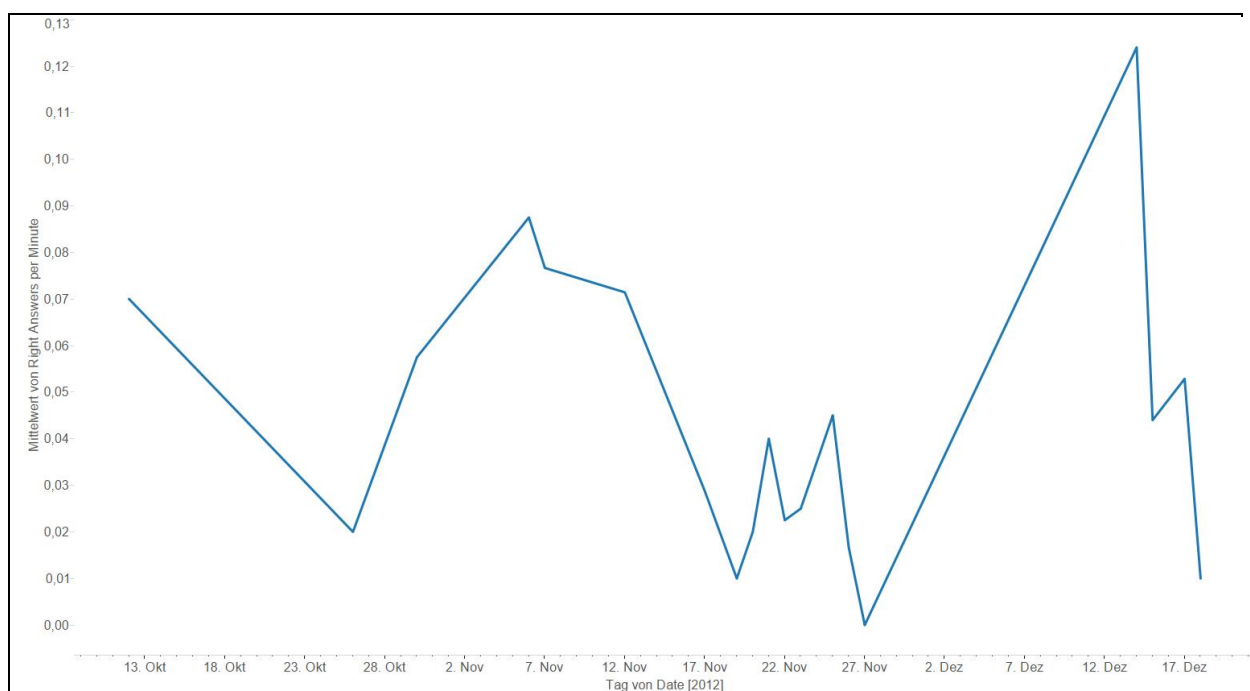
**Figure 2 Persuasive Bullet Chart**

To nevertheless support the impression of a 'journey' the parameters, accuracy, difficulty and right answers per minute are visualized as line diagrams. The line graph in figure 3 visualize

the continuity with which learners have learned; with the peaks and valleys the line graphs display they give the impression of a journey even without the image in question. In a final version of Learning Journey Online also the statistical IRT model will be visualized as line chart. At the time of writing this was not possible, due to a lack of data. A specifically persuasive data visualization is given in figure 4. It displays the development of how many right answers a student has given within a minute.



**Figure 3 Persuasive Line Chart Proficiency**



**Figure 4 Line chart for right answers per minute**

While in earlier approaches to data visualizations in Learning Journey Online and PLOTLearner the measure of how fast learner was able to solve a grammatical exercise, I meanwhile use the measure of right answers per minute in Learning Journey Online. The reason for this have to do with the motivational character of this measure: Although the speed with which a student has solved an exercises gives inside of how well he already mastered the acquisition of a new language (cf. DeKeyser and Criado 2012) this measurement is not persuasive when displayed on a graph. The reason is that a graph with many valleys would in this case display good learning progress while usually low values, especially when displayed in a graph are regarded as bad. Another aspect is that the visualization of processing speed would be the only one having a decreasing direction on the graph; this would make the understanding of the data visualizations specifically difficult. Therefore I have chosen the measure right answers per minute within Learning Journey online.

## 6 Conclusions

The core of the architecture of the new persuasive performance optimizing system, Learning Journey Online, is surveillance combined with tailoring. These two persuasive mechanisms act on the macro level of persuasion and they are complemented with thorough data visualizations which act on the persuasive micro level. In these visualization s the principle of data-ink maximization developed by Tufte (1983) and the principle of data-ink emphasizing and the de-emphasizing of non-data ink presented in Few (2013) are employed. With its persuasive data visualizations the system employs a feedback-loop persuading users to change their learning behavior.

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