

ITB Journal

Issue Number 23, December 2012



Contents

Headedness in Māori Reflexivity: A Role and Reference Grammar Analysis4

Aoife Finn
Trinity College Dublin

The Persuasive Tutor: a BDI Teaching Agent with Role and Reference Grammar
Language Interface – Sustainable design of a conversational agent for language
learning.....31

Judith Gottschalk
Aalborg University, Denmark

The academic journal of the Institute of Technology Blanchardstown
<http://www.itb.ie/ResearchatITB/itbjournal.html>



<http://www.itb.ie/ResearchatITB/itbjournal.html>

Views expressed in articles are the writers only and do not necessarily represent those of the ITB Journal Editorial Board.

ITB Journal reserves the right to edit manuscripts, as it deems necessary.

All articles are copyright © individual authors 2012.

Papers for submission to the next ITB Journal should be sent to the editor at the address below. Alternatively, papers can be submitted in MS-Word format via email to brian.nolan@itb.ie

*Dr. Brian Nolan
Editor
ITB Journal
Institute of Technology Blanchardstown
Blanchardstown Road North
Blanchardstown
Dublin 15
IRELAND*

Editorial

I am delighted to introduce the **23th edition of the ITB Journal**, the academic journal of the Institute of Technology Blanchardstown.

The first paper, by Aoife Finn, examines the reflexive construction in the Polynesian language Māori. It provides a brief introduction to elements of Māori grammar and gives special attention to the Māori reflexive construction that sometimes uses a so-called support form to express reflexivity. The account is situated within a functional model of grammar called Role and Reference Grammar (RRG), a model that can characterise both the form and function of language. It is demonstrated that RRG provides a robust framework for analysing reflexive constructions. The article accounts for the occurrence of a reflexive support form in Māori reflexive constructions

The second paper, an article by Judith Gottschalk, is also situated within Role and Reference Grammar but within a very different piece of research and educational context. This paper investigates how an intelligent teaching agent, using the RRG model as a linguistic engine, can support language learning. Based on a user-centred empirical design study, the architecture of a highly persuasive tool for language learning is developed as an extension of the EU project PLOTLearner (<http://europlot.blogspot.dk/2012/07/try-plotlearner-2.html>) The EuroPLOT project aims at developing a framework and tools for persuasive learning objects. Both the EACEA Lifelong Learning Programme and the European Commission fund the EuroPLOT project. While also based on Grounded Theory, the author shows that feedback and support is of greatest importance in self-directed computer assisted language learning. It is also shown how this overall approach to language learning can be situated into traditional conversation-based learning theories. The paper demonstrates the potential for a computationally adequate model of the RRG-linking algorithm, extended into a computational processing model, to account for communication between a learner and the software by employing conceptual graphs to represent mental states in the language-aware software agent. The important role of speech acts is emphasised.

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

Dr. Brian Nolan
Editor
ITB Journal
Institute of Technology Blanchardstown
Blanchardstown Road North
Blanchardstown
Dublin 15
IRELAND
email: brian.nolan@itb.ie

Headedness in Māori Reflexivity: A Role and Reference Grammar Analysis

Aoife Finn

aoifenifhinn@hotmail.com

finnao@tcd.ie

<http://tcd.academia.edu/AoifeFinn>

Trinity College Dublin

Abstract

This article will provide an introduction to the Māori language. Particular attention is paid to Māori reflexive construction, which sometimes uses a so-called support form to express reflexivity. It will familiarise the reader with Role and Reference Grammar (RRG), a functionally motivated approach to a grammatical model which accounts for both the form and function of language. RRG provides a robust framework for analysing reflexive constructions. Finally, having considered this framework, the article will account for the occurrence of a reflexive support form in reflexive constructions.

1 Linguistic Description of Māori

This section will acquaint the reader with the Māori language. It will begin with an examination of the typical structure of the phrase. This will encompass word order, active and passive voice constructions and their marking. In preparation for the chief topics of reflexivity and reciprocity, the complex topics of pronouns and possession will be covered.

The order of occurrence in a typical unmarked Māori phrase is verb-subject-object. Māori is a head-first language, in most circumstances a head will always precede a modifier. Harlow (2007, p101) elaborates on this with “full NP possessors follow the possessum, relative clauses follow their antecedents... if two or more lexical items occur in sequence within a phrase, then the leftmost is the head of the lexical phrase and the others modify the item immediately to their left”.

Example 1(1) taken from Harlow (p26) is a prototypical Māori active clause.

(1) Ka	hoko	te	matua	i	ngā	tīkiti	ACTIVE
PRES .IPFV	buy	DEF.SG	parent	ACC	DEF.PL	ticket	VOICE
“The parent buys the tickets”							

Example (1) allows us to see that the canonical Māori active voice is composed of the following.

- The verb heads the phrase. Verbs receive no numerical or gender marking. Accordingly, it is not marked by any adpositions or clitics et al. Harlow (2007, p155) tells us that “number is routinely indicated in the nominal phrase by the determiner”. Tense, aspect and mood may be marked periphrastically with particles contiguous to the verb.
- The traditional subject follows the verb. It is deemed nominative by both its non-overt morphological marking and its immediate post-verbal position.
- The direct object is marked by an accusative particle. In this case ‘i’ marks the object ngā tīkiti. Alternatively ‘ki’ may mark the direct object, indicating a different thematic role.

Harlow (p26) also provides the clause in the passive voice, shown in example (2).

(2) Ka	hoko-na	ngā	tīkiti	e	te	matua	PASSIVE
PRS.IPFV	buy-PASS	DEF.PL	ticket	OBL	DET.SG	parent	VOICE
“The tickets are bought by the parent”							

The Māori passive voice has a derived passive verbal form. The direct object is now in the traditional position of the subject (preverbal in English, immediately postverbal in Māori), the former subject is now an oblique argument marked by a preposition. The canonical Māori passive is composed of the following.

- The verb now has a passive suffix. Harlow (2007, p115) informs us that the suffix “referred to in literature on PN¹ languages as –Cia, has seventeen allomorphs”.
- The direct object is now in the immediate post verbal position, it is no longer marked with an accusative particle. Accordingly, it is now deemed to be the nominative argument.
- The former subject is now clause final and is preceded by ‘e’, an agentive marker. This downgrades the subject to an oblique argument. Bauer (1993, p404) reminds us that the “e-marking is normal whether or not the subject of the active is agentive”.

1.2 Personal Pronouns in Māori

On account of the form of the Māori reflexive and reciprocal constructions, this section will pay particular attention will be given to the Māori personal pronouns in this section. Number in Māori personal pronouns is trichotomous, distinguishing between singular forms, dual forms and plural forms for three or more people. Another striking feature is the inclusive and exclusive distinction that is applied to the first person dual and plural. An inclusive pronoun means that the speaker is including the listener, that is to say that the listener’s inclusion is implicit in the pronoun itself. By contrast, an exclusive pronoun indicates that the speaker is referring to participants that do not include the listener. Personal pronouns are neither marked for gender nor social status distinctions. By and large, personal pronouns in Māori only refer to humans.

Table 1 lists the personal pronouns and provides an English gloss that may more plainly clarify these distinctions. The translations also show that personal pronouns are not case-marked.

1.3 Possession in Māori

Before progressing specifically onto possessive pronouns this section will look at the general concept of possession in Māori since many reflexive and reciprocals involve possessive-reflexive constructions. Bauer (1993, p197) explains that Māori does not have distinct verbs of possession such as ‘belong to’, ‘own’ or ‘have’ as in English. Thus, when wishing to convey possession in Māori there are a number of considerations to be made. Bauer recounts (p197-198) that Māori distinguishes between location and ownership. Ownership is not taken for granted if the possessum is with, or in the custody of, the possessor, instead it is thought of as being location and is marked as such. This locative relationship is marked for tense

¹ PN denotes Polynesian

as can be seen in examples (3). Examples (3) through (5) taken from Bauer (1993, p208).

Table 1: Māori Personal Pronouns

Personal Pronouns			
	Singular	Dual	Plural
1st Person Inclusive	au/ahau <i>I / me</i>	tāua <i>we / us two</i>	tātou <i>we all / all of us</i>
1st Person Exclusive		māua <i>We / us two <u>but</u> not you</i>	mātou <i>we all / all of us <u>but</u> not you</i>
2nd Person	koe <i>you</i>	kōrua <i>You two</i>	koutou <i>You all</i>
3rd Person	ia <i>she / he her / him</i>	rāua <i>They two / the two of them</i>	rātou <i>They all / all of them</i>

- (3) Kei a Hone te kī PRESENT LOCATION
 POSS.PRES ART John DET.SG key
 “John has the key”
- (4) I a Hone te kī PAST LOCATION
 POSS.PST ART John DET.SG key
 “John had the key”
- (5) Hei a Hone te kī FUTURE LOCATION
 POSS.FUT ART John DET.SG key
 “John will have the key”

Ownership in Māori has its own considerations. Māori has two possessive prepositions namely <ā> or <ō>. These prepositions can stand alone or combine with other particles to express a variety of senses. Initially, there is the choice as to whether the possession will be indicated by the possessive prepositions <ā> or <ō>. Once this <ā/ō> marking has been determined, it must be decided if the possessum is a specific or non-specific referent. More explicitly, further classification is determined by the specificity of the possessum. Specific ownership itself is divided into two categories. If the specific ownership will occur at some time in the future then it is ‘intended’ and is marked by <m> followed by the appropriate possessive preposition <ā/ō>. If the specific ownership has occurred in the past, or is ongoing, then it is deemed actual possession and <n> comes before the appropriate possessive preposition. Examples of specific ownership taken from Bauer (1993, p198) can be seen in examples (6) and (7).

- | | | | | | |
|-----------------------------|----------|---------|----------|------|--------------------|
| (6) Mō | Hone | ēnei | hū | | SPECIFIC |
| intended.POSS | John | DEM | shoe | | INTENDED OWNERSHIP |
| "These shoes are for John" | | | | | |
| | | | | | |
| (7) Nā | Hone | te | pukapuka | nā | SPECIFIC |
| actual.POSS | John | DET.SG | book | DEIC | ACTUAL OWNERSHIP |
| "That book belongs to John" | | | | | |
| | | | | | |
| (8) He | hōiho | tō | Tohe | | NON-SPECIFIC |
| PRED | horse | SG.POSS | Tohe | | SINGULAR OWNERSHIP |
| "Tohe has a horse" | | | | | |
| | | | | | |
| (9) He | pukapuka | ā | Pou | | NON-SPECIFIC |
| PRED | book | PL.POSS | Pou | | PLURAL OWNERSHIP |
| "Pou has some books" | | | | | |

Likewise, non-specific ownership is split into two categories. If the possessum is singular then <t> comes before the possessive preposition, a plural possessum is indicated by the absence of <t>. These categories can be seen in examples (8) and (9). These steps involved in clarifying the type of possession are shown diagrammatically in Figure 1 as inspired by Bauer (1993, p198).

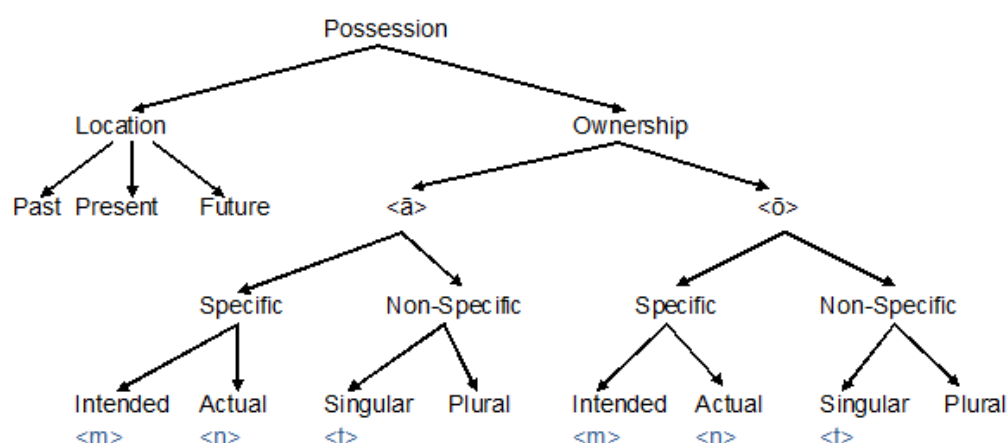


Figure 1: Overview of Possession Categories

The rationale for choosing <ā> or <ō> to convey possession is extremely complex. The <ā/ō> preposition alternation that Harlow (2007, p23) terms “the double possessive system” has been repeatedly commented on in literature. There seems to be much discussion and very little concord about exactly why some possessed items take either the <ā> or the <ō> form. Harlow (p168) states that “encoded in the choice of a-forms or o-forms is rather the relationship between the possessor and the possessum... there is general agreement that notions of ‘dominance’ and ‘control’ play a crucial role”.

Inherent thematic relations mean that some noun phrases usually fall into one category. As example (10) from Harlow (2001, p159) shows, family relationships usually are marked with <ā>. Nonetheless, there is no definitive list of <ā> or <ō> category noun phrases. The expression of different senses leads to noun phrases that can potentially take either <ā> or <ō>. The choice depends on the relationship

being described. Such a situation can be seen in examples (10) and (12), again from Harlow (p158). In example (10) category <ō> denotes that the relationship is between the possessor and the possessed. In example (12) category <ā> indicates that the relationship between is between creator and creation.

(10)	Te DET "Mary's niece/nephew"	irāmutu niece/nephew	a POSS	Mere Mary	FAMILIAL RELATIONSHIP
(11)	Nō-ku actual.ōcategory-1SG "Those are my clothes" ie "I bought/wear them"		ēnā DEM	kākahu clothes	POSSESSION
(12)	Nā-ku actual.ācategory-1SG "Those are my clothes" ie "I made/designed them"		ēnā DEM	kākahu clothes	CREATION

We will not attempt to shed light on such a complex issue here, except to say that there seems to be some semantic factors at play, most authors concur that the <ā> marking is typical when the possessor plays a dominant role over the possessum.

1.4 Possessive Pronouns in Māori

Leading on from the general discussion on possession, this section deals exclusively with possessive pronouns. These occur in the possessive-reflexive constructions. Table 2 shows the three classes of possessive pronouns, namely class ā, marked with <ā>, class ō marked with <ō>, and finally the neutral possessive pronouns. The class ā and class ō possessive pronouns are comprised latterly of the personal pronouns, as previously seen in Table 1. Preceding this, the possessive pronouns have a possessive preposition, either <ā> or <ō>. If the possessum is plural then the preposition is not preceded by <t>.

Like the personal pronouns, the possessive pronouns make distinctions based on singularity, duality, plurality and inclusivity. It should be noted that the neutral possessive pronouns are restricted to use with a singular possessor and so are not used for dual or plural possessors. Like the class <ā> and class <ō> possessive pronouns, their use depends on the word class of possessum, Bauer (1993, p376) remarks that "the conditions for the use of these neutral forms are not at all clear". It is not within the scope of this study to explore the issues around <ā>, <ō> or neutral choices further but to only to recognise the possessive pronouns when they occur in the reflexive construction.

As previously mentioned, personal pronouns in Māori normally only refer to humans. Contrastively, Bauer (p375) tells us that the possessive pronouns "are fairly readily extended to animals and inanimates". Surprisingly, Bauer (p155) then goes on to say that personal pronouns used in a reflexive construction can allude to non-humans. It would seem then that, in reflexive constructions, the broader scope of reference of the possessive pronouns extends to personal pronouns.

Table 2: Māori Possessive Pronouns

Possessive Pronouns							
	Class ā			Class ō			Neutral Class
	Singular	Dual	Plural	Singular	Dual	Plural	Singular
1 st Person Inclusive	t-ā-ku <i>my</i>	t-ā tāua <i>our (just the two of us)</i>	t-ā tātou <i>our (all of us)</i>	t-ō-ku <i>my</i>	t-ō tāua <i>our (just the two of us)</i>	t-ō tātou <i>our (all of us)</i>	t-a-ku <i>my</i>
1 st Person Exclusive		t-ā māua <i>our (just the two of us <u>but</u> not you)</i>	t-ā mātou <i>our (all of us <u>but</u> not you)</i>		t-ō māua <i>(just the two of us <u>but</u> not you)</i>	t-ō mātou <i>our (all of us <u>but</u> not you)</i>	
2 nd Person	t-ā-u <i>your</i>	t-ā kōrua <i>your (the two of you)</i>	t-ā koutou <i>your (all of you)</i>	t-ō-u <i>your</i>	t-ō kōrua <i>your (the two of you)</i>	t-ō koutou <i>your (all of you)</i>	t-ō <i>your</i>
3 rd Person	t-ā-na <i>her/his</i>	t-ā rāua <i>their (the two of them)</i>	t-ā rātou <i>their (all of them)</i>	t-ō-na <i>her/his</i>	t-ō rāua <i>their (the two of them)</i>	t-ō rātou <i>their (all of them)</i>	t-a-na <i>her/his</i>
All the forms above indicate a single possessum, a plural possessum may be indicated by the absence of the initial “t”							

2 An introduction to Māori Reflexivity

2.1 The form of the Māori Reflexive

Maori has no special reflexive or verbal forms. Rather reflexivity is expressed by the addition of a personal pronoun or possessive pronoun. Additionally, what Bauer (1993, p165) calls a “support form” may accompany the pronouns. The support forms are ‘anō’ or ‘anake’, they mean ‘again’ and ‘only’ respectively. The combination of the pronoun and support form is elucidated diagrammatically in Figure 2.

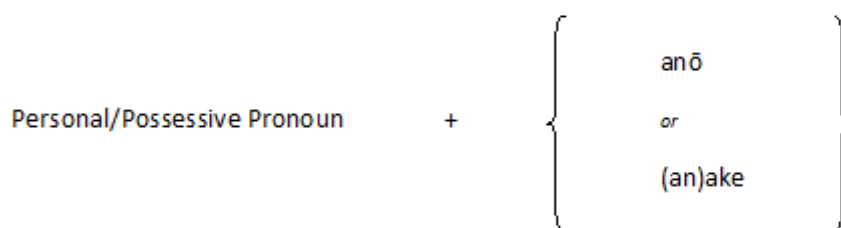


Figure 2: The support form ‘anake’ may optionally be expressed as ‘ake’.

As can be seen in Figure 2, the support form 'anake' may optionally be expressed as 'ake'. Bauer (1993, p165) maintains that 'ake' is a clipped form of 'anake', meaning 'only'. Whilst Harlow (2001, p36) states that it is the unrelated word 'ake' meaning 'upwards'. The precise meaning is not especially relevant here, but both forms may occur in cited texts and examples. Harlow (p36) points out that the reflexive can occur with or without the reinforcing particle. According to Harlow, the reinforcing particle can be used to demarcate ambiguity between a reflexive and non-reflexive reading. Examples (13) and (14) illustrating this are taken from Harlow (2001, p36).

(13)	Kei te	horoi	a	Mere	i	a	ia		AMBIGUOUS
	PROG.PRES	wash	ART	Mary	ACC	ART	3SG		READING
	“Mary is washing herself”								
	<i>or</i>								
	“Mary is washing her/him”								
(14)	Kei te	horoi	a	Mere	i	a	ia	anō	REFLEXIVE
	PROG.PRES	wash	ART	Mary	ACC	ART	3SG	REFL.again	READING
	“Mary is washing herself”								

Bauer (1993, p168) clarifies that ordinarily the reflexive is anaphoric; being that the antecedent precedes the reflexive. Bauer (p166) tells us that the reflexive form “occurs in the same sentence position as non-reflexive items with that function”. More plainly put, for example, if the antecedent is the subject and the reflexive is the direct object, *ceteris paribus* the reflexive construction will appear in the usual position of the direct object. Bauer (p165) explains that if the pronoun is possessive it cannot be immediately followed by the support, this in contrast to (14) above where the support form immediately follows the pronoun. As can be seen in example (15), it follows that the word order will adjust to accommodate these requirements.

(15) Kei te horoi a Mere i ōna kākahu anake
 PROG.PRES wash ART Mary ACC POSS.3SG clothes REFL.only
 “Mary is washing her own clothes”

Example (15) is a possessive-reflexive construction. A great deal of Māori reflexive data includes possessive-reflexive constructions. Possessive-reflexives may initially seem curious to an English speaker. With reference to Givón (1990, p639), Nolan (2012, p85) states that possessive reflexives “occur within a specific semantic context where the ‘the subject is the possessor of the object’”. Nolan (p85) goes on to explain that “in this type of construction, the subject and object are not co-referential”. This is in direct contrast to clauses such as (14) where the subject and the object have the same referent. In fact, it is the act of possession that is co-referenced, by way of the possessive pronoun indicating the participants. The

antecedent is the possessor, the possessive pronoun is the anaphor. Co-reference occurs between the antecedent and the possessive pronoun, which refer to the same participant. The possessive pronoun marks the antecedent's tenure of the possessed argument. As pointed out by Nolan (p85), these reflexives are not in fact valency decreasing since the number of arguments remain the same syntactically and semantically.

Upon initial examination, it seemed that the presence of a support form was quite arbitrary. Bauer (p165) stated that a support form was more likely to accompany "functions less semantically central to the verb". In addition, Bauer (p156) explains that non-human antecedents are far more likely to trigger the occurrence of a reinforcing particle. There seemed to be a multitude of factors affecting whether a support form is necessary. As shall be shown, the occurrence of a support form is chiefly dependent on the headedness of both the antecedent and the anaphor.

3 An Overview of Role and Reference Grammar

Van Valin and LaPolla (1997, p13) explain how Role and Reference Grammar, hereafter RRG, differs from other grammatical models. The principal distinction that sets RRG apart is that it posits that "grammatical structure can only be understood with reference to its semantic and communicative functions". RRG manages to take into account both the form and the function of language. This is achieved by way of the 'linking algorithm', shown in Figure 3. Van Valin (2008, p3) tells us that the linking algorithm "maps from semantics to syntax and from syntax to semantics" and insightfully points out that "this is an idealization of what a speaker does (semantics to syntax) and what a hearer does (syntax to semantics)".

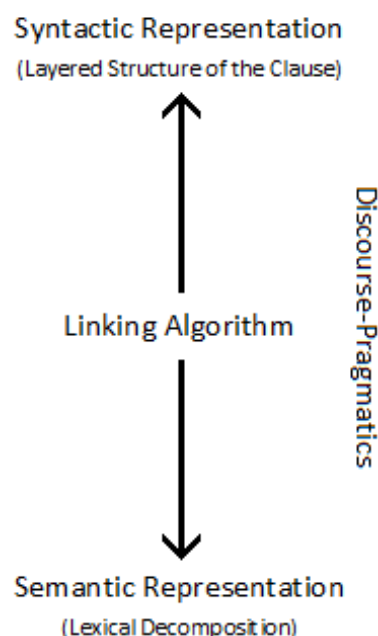


Figure 3: The 'linking algorithm'

3.1 Semantic Representation in Role and Reference Grammar

The semantic representation is provided by “lexical decomposition”. Van Valin and LaPolla (1997, p90) tell us that this involves “paraphrasing verbs in terms of primitive elements in a well-defined semantic meta-language”. Van Valin and LaPolla (1997, p91) go on to explain how this meta-language is based on Vendler’s (1957) four original Aktionsart distinctions. The metalanguage representation of the classes is known as the ‘logical structure’ of the predicate, hereafter abbreviated to the LS. The predicate is shown in **bold** font followed by an apostrophe, whilst the argument(s) of the predicate are shown in regular font encased in brackets. More detail about the predicate classes and their representations in RRG can be found in Van Valin and LaPolla (1997, p82-196).

Pavey (2010, p118) tells us that RRG condenses “the number of semantic roles down to two general groups of semantic roles, two macroroles termed actor and undergoer”. These two macroroles absorb all the traditional thematic relations and bifurcate them into more agentive-like actor and the more patient-like undergoer. The actor and the undergoer tend, marked choices aside, to be found as particular arguments of the predicate. This can be seen in the Actor-Undergoer Hierarchy in Figure 4 as reproduced from Van Valin (2008, p13).

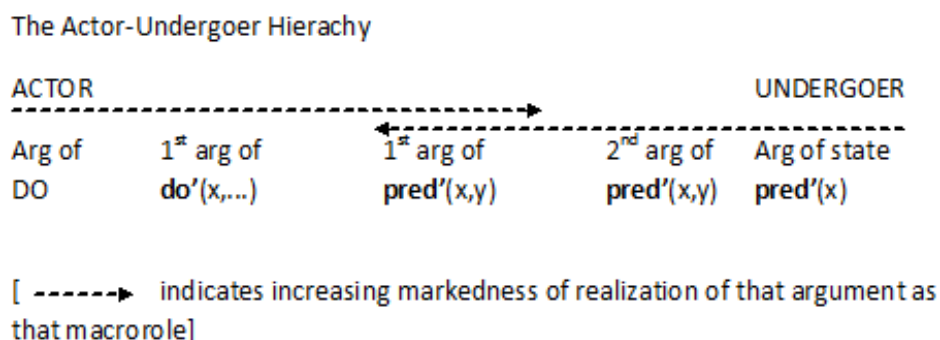


Figure 4 The Actor-Undergoer Hierarchy

3.2 Syntactic Representation in RRG

The syntactic representation of the clause is provided by the layered structure of the clause, abbreviated to the LSC. The composition of the LSC is made clear in Figure 5 which is inspired by Van Valin and LaPolla (1997, p26). It is worth remembering (p28) that since “the nucleus, core, periphery and clause are syntactic units that are motivated by... semantic contrasts”, their components can often be roughly analogous to one another. This is shown in Figure 6 which was inspired by Pavey (2010, p9).

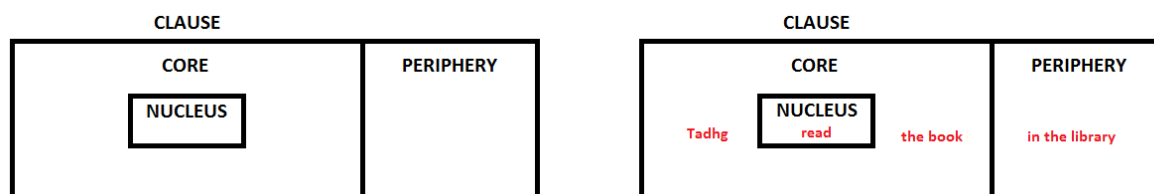


Figure 5: Layered Structure of the Clause

Syntactic Unit		Semantic Unit	
Clause	Nucleus	≈	Predicate
	Core	≈	Predicate + Arguments
	Periphery	≈	Non – Arguments

Figure 6: Analogous Syntactic and Semantic Units

In RRG, the LSC is illustrated with a combination of two ‘projections’, these two projections are what Van Valin and LaPolla (1997, p46) terms “an explicit syntactic representation of clause layers and their operators”.

The constituent projection is a tree diagram. This diagram captures the syntactic layers of the clause, namely the nucleus, the core, the periphery and their constituents. These constituents, to be precise, are the predicate, it’s arguments and it’s non-arguments respectively. The constituent projection of a clause is shown in Figure 7.

“Tadhg read the book in the library”

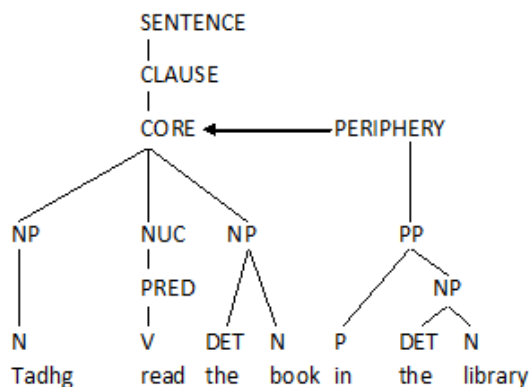


Figure 7: Sample Constituent Projection

The ‘operator projection’ is the other projection that can be illustrated by the LCS. Operators do not explicitly predicate or refer. Rather, they add extra depth to our knowledge about the constituents. Some examples of familiar operators include tense, negation and aspect. The operator projection itself is shown in Figure 8 and a sample operator constituent of a clause is shown in Figure 9.

The Operator Projection in the LSC

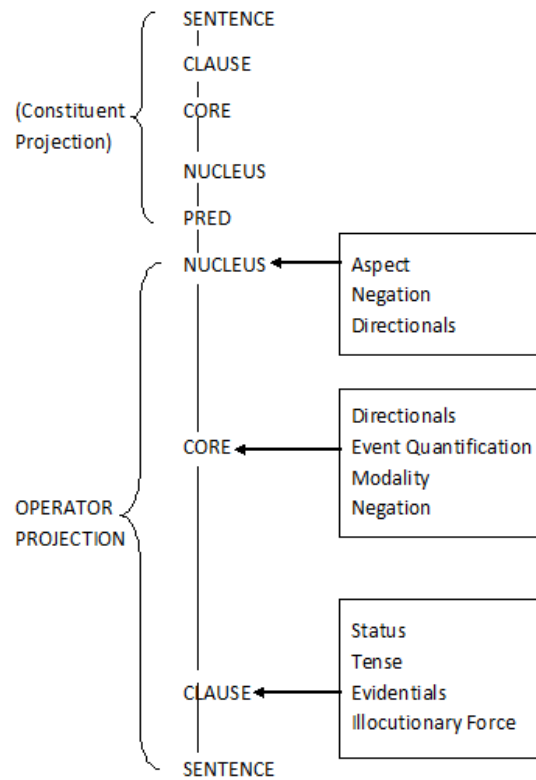


Figure 8: Operator Projection

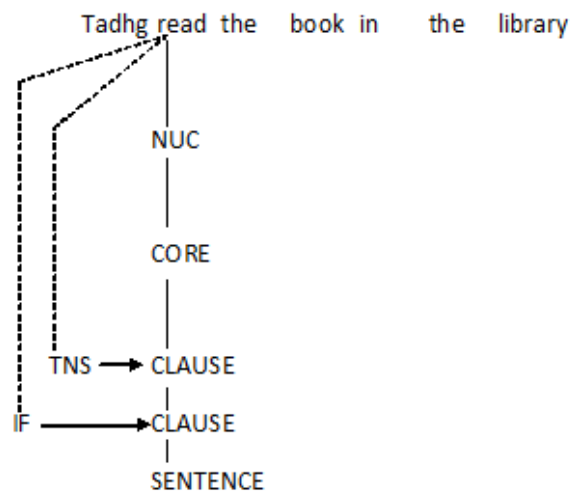


Figure 9: Sample Operator Projection

3.3 The Privileged Syntactic Argument

RRG does not make use of traditional grammatical names. The notion of subject varies greatly both within a language and cross-linguistically. Therefore it is particularly unusable since it can be dependent on numerous presumptions. Instead, RRG posits that the predating element has a “Privileged Syntactic Argument”, or from this point onward, the PSA. The PSA is what ‘controls’ the predicate, Pavey (2010, p143) explains how this argument is “privileged because it has special functions that the other arguments do not have”. The PSA may be an actor or an undergoer. The choice is determined by with Van Valin’s (2001, p213) “Privileged Argument Selection Principles” and “Privileged Syntactic Argument selection hierarchy”. Both of which can be seen in Figure 10. More simply put, the left-most argument is the least-marked choice of PSA in Nominative-Accusative constructions whilst the right-most argument is the least-marked choice in Ergative-Accusative constructions. This is directly related to the AUH in Figure 11, in which the left-most choices are more agent-like, whilst the right-most choices are more patient-like.

“Privileged Syntactic Argument Selection Principles
 a. syntactically accusative constructions: highest ranking macrorole is default choice
 b. syntactically ergative constructions: lowest ranking macrorole is default choice”

“Privileged syntactic argument selection hierarchy:
 Arg of DO > 1st arg of do’ > 1st arg of pred’ (x,y) > 2nd arg of pred’ (x,y) > pred’ (x)”

Figure 10: PSA Selection Principles and Hierarchy

4 Reflexivity in Role and Reference Grammar

The Māori reflexive is what Van Valin and LaPolla (1997, p396) term a co-reference reflexive. In co-reference reflexives the antecedent and the reflexive pronoun are separate syntactic arguments. The reflexive pronoun refers to the antecedent. RRG posits a set of conditions governing reflexivity. The first condition dictates which arguments may be the antecedent or reflexive pronoun. Nolan (2012, p72) cites the following condition in Figure 11 taken from Van Valin (2005, p162).

Role hierarchy condition on reflexivization

The reflexive pronoun must not be higher on the privileged syntactic argument (PSA) hierarchy, as applied to the selection of privileged syntactic arguments in the language than its antecedent.

Figure 11: Role hierarchy condition on reflexivization

In this context ‘higher’ means left-most. Figure 11 is stating that the controlling antecedent must have a more actor-like semantic role than the reflexive pronoun, the controlled. Van Valin and LaPolla (1997, p399) explain that ergativity or accusativity is inconsequential for the Role Hierarchy Condition. They say that “actors are always the antecedents for undergoers, never the other way around”. This is not surprising since case-marking is syntactic denotation for semantic categories. Semantic

categories are universal and in the mind of the speaker, and they do not change regardless of how a language is case-marked. It is important to remember that the PSA selection criteria vary, so the idiosyncrasies of the selection process of the individual language must be considered. Van Valin and LaPolla (1997, p397) expand on this by stating that, because of PSA selection restrictions, “in some languages only a macrorole argument may function as the antecedent of a reflexive, whereas in other languages a non-macrorole direct core argument can be the antecedent”.

Logical structure superiority (LS-superiority)

A constituent P in logical structure is LS-superior to a constituent Q if there is a constituent R in logical structure such that:

1. Q is a constituent of R; and
2. P and R are primary arguments of the same logical structure.

Superiority condition on reflexivization

A bound variable may not be LS superior to its binder

Figure 12: Reflexivity constraints

Van Valin (1997, p400) also sets out the above conditions involving logical structure superiority in Figure 12. The LS-superiority simply states that, within a phrase, any head argument is superior to any dependent argument. In the superiority condition on reflexivization, the antecedent is the binder argument, whilst the reflexive is the bound argument. Considered jointly, the two constraints simply state that a dependent argument cannot be the antecedent for a reflexive head argument. The head of the noun phrase is indicated in the logical structure by being underlined, as in example (16).

(16) Noun Phrase	Logical Structure	
Tadhg's mother	have.as.kin' (Tadhg,mother)	MOTHER IS THE HEAD NOUN as is <u>underlined</u>

The final constraint laid down by Van Valin (1997, p405) is shown in

Figure 13 below. It establishes the scope of reflexivization. Essentially a reflexive form is obligatory when co-reference occurs between two semantic arguments. Semantic co-arguments are syntactically realised arguments of the same logical structure. Syntactic co-arguments are arguments in the same simple clause, yet they are not part of the same logical structure, that is they are not semantic co-arguments.

Domain of obligatory reflexivization (DOR) constraint

One of two co-referring semantic co-arguments within a simple clause must be realized as a reflexive, while one of two co-referring syntactic arguments (which are not semantic co-arguments) within a simple clause may be realised as a reflexive.

Figure 13: Domain of obligatory reflexivization constraint

This can be illustrated more clearly with the examples shown in (17). When co-reference occurs between two syntactic arguments a reflexive form is optional. Nolan (2012, p71) defines a simple sentence as “constructions with a single nucleus within the core of a single clause”.

(17) Clause	Logical Structure	
Conall loves himself	love' (Conall,himself))	<i>CONALL AND HIMSELF</i> ARE ARGUMENTS OF THE SAME LS <i>semantic co-arguments</i>
Brendan saw the cat beside him	see' (Brendan,cat) \wedge be-near' (him,cat)	<i>BRENDAN and HIM</i> ARE NOT ARGUMENTS OF THE SAME LS <i>syntactic co-arguments</i>

5 Headedness within Māori reflexive constructions.

This section will begin with a look at a simple transitive clause taken from Bauer 1993, p168). The clause is shown in (18) with the linking algorithm shown in Figure 14.

(18) Kei te	horoi	a	Mere	i	a	ia	anō/anake
TNS	wash	ART	Mary	ACC	ART	3SG	again/only
“Mary washed herself”							
(19) I	hoatu	a	Mere	i	te kete	mā-na	ake
PST	give	ART	Mary	ACC	the kit	DAT-3SG	only
“Mary gave herself the kit”							

The constraints on reflexivization mentioned in the previous section will prove crucial in analysing this and succeeding constructions. The linking in Figure 14 illustrates that the antecedent “Mere” is the first argument of an activity predicate. At its highest position on the PSA Hierarchy, the reflexive pronoun “ia” is the first argument of the two place predicate **wash'**. The antecedent is therefore superior to the reflexive pronoun on the PSA Hierarchy and the Role Hierarchy Condition on reflexivization is satisfied. The Superiority Condition on Reflexivization states that a bound variable may not be superior to its binder. Here both the binding antecedent ‘Mere’ and the bound reflexive pronoun ‘ia’ are primary arguments of the LS. This presents an interesting situation where the constraint is not strictly complied with but is not quite violated. This is seen repeatedly in Māori. Under Van Valin’s (1997, p406) terms ‘Mary’ and ‘ia’ are semantic co-arguments in that they “are arguments of the same logical structure and are realized as syntactic arguments”. The Domain of Obligatory Reflexivization constraint states that in an LS with semantic co-arguments a reflexive form must be realised. In Māori the definitive reflexive form includes one of the three support forms. Undeniably, there is a support form in this simple clause. Yet as shall be seen this principally linked to the Superiority Condition on Reflexivization. When

the antecedent is a sole primary argument that is referenced by a sole primary reflexive argument, a support form is obligatory. This occurs again in ditransitive constructions such as (19), taken from Bauer (1993, p168). The linking algorithm can be seen in Figure 15.

"Mary_i washed herself_i"

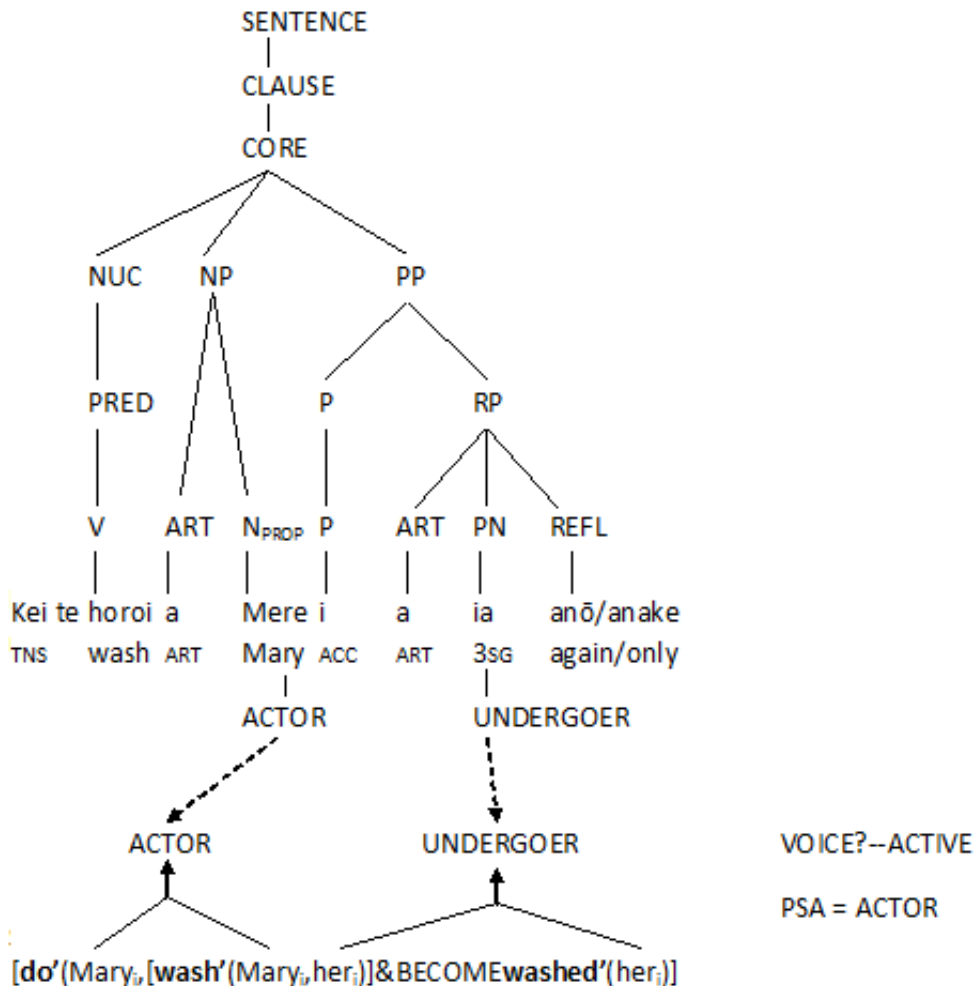


Figure 14: Transitive clause, sole primary antecedent, sole primary reflexive

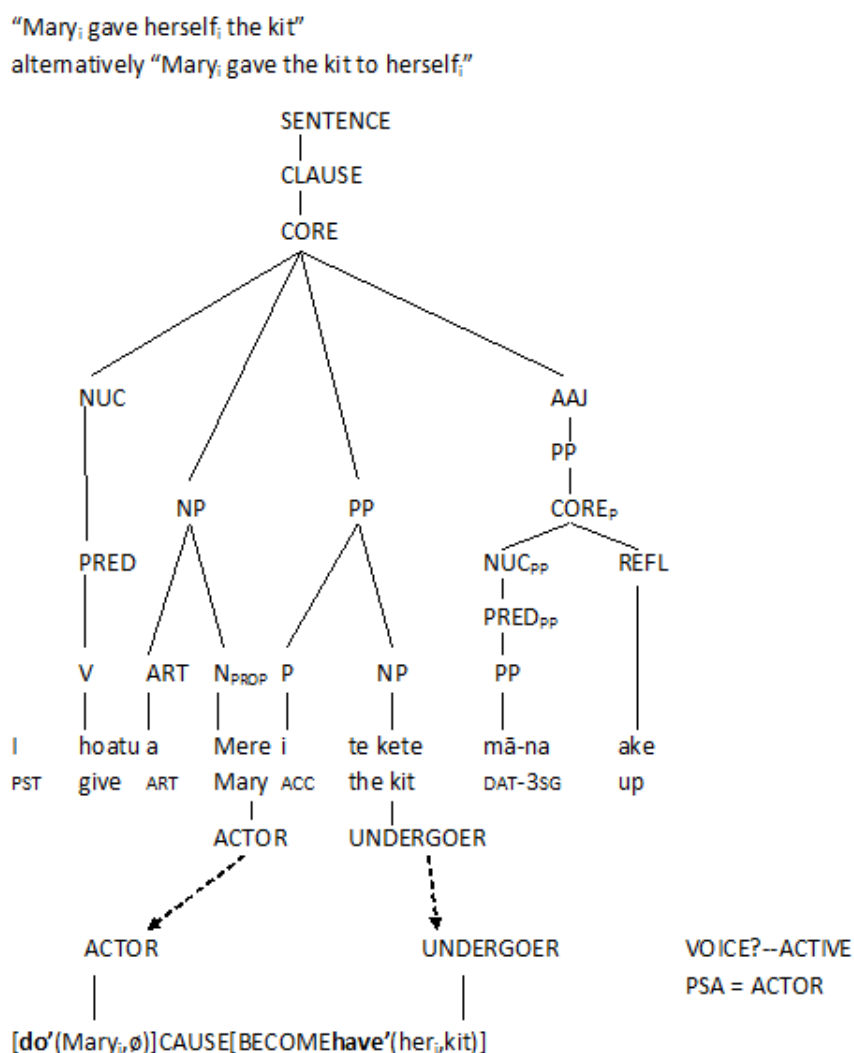


Figure 15: Ditransitive clause, sole primary antecedent, sole primary reflexive

Example (20), from Bauer (1993, p169), provides the next example of a transitive clause. It seems to have a similar form to the previous examples and at first seems unremarkable.

- (20) E patu ana te hoa o Hone i a ia anake
PROG beat PROG the friend P John ACC ART 3SG only
"John's friend is hitting himself"

The linking algorithm is provided in Figure 16. The antecedent is the second argument of the **have'** predicate noun phrase. The complete NP in which the antecedent is contained is the argument of a **do'** predicate. The reflexive pronoun is the second argument of the **hit'** predicate. The antecedent is then unequivocally higher on the PSA Hierarchy than the reflexive pronoun. Ergo, the role hierarchy condition on reflexivization is satisfied. The antecedent 'friend' is the primary constituent, or head noun, of the noun phrase [**have'**(John, friend)]. The complete noun phrase, hereafter NP, includes both a primary and a dependent constituent. The reflexive pronoun is also a primary argument. The antecedent and the reflexive pronoun are again equal according to the Superiority Condition on Reflexivization. Again, the antecedent and

the reflexive are semantic co-arguments and a support form 'anake' is present. Although it is tempting to presume that the Domain of Obligatory Reflexivization constraint is responsible for the presence of the support form in (20). The next example ought to encourage caution about making such an assumption. Bauer (p169) also presents the previous clause without a support form as seen in (21) below, with linking shown in Figure 17: .

- (21) E patu ana te hoa o Hone i a ia
 PROG beat PROG the friend P John ACC ART 3SG
 "John's friend is hitting him"

The antecedent is now 'John', the dependent constituent of the NP [**have'**(John, friend)]. The reflexive pronoun is still the second argument of the **hit'** predicate. The antecedent and the reflexive pronoun are no longer semantic co-arguments so a support form is not obligatory. Furthermore, they are not syntactic arguments, 'John' being an argument of a complete noun phrase, this leave ought to leave the status of the support form doubtful. However, the PSA Hierarchy and the SCR together disambiguate any uncertainty. This is an acceptable and grammatical clause yet the bound reflexive is a primary argument. It is therefore LS-superior to the dependent antecedent argument and in violation of the superiority condition of reflexivization, hereafter SCR. Notice that in both Figure 16 and Figure 17: the complete NP [**have'**(John, friend)] is higher on the PSA hierarchy than the reflexive pronoun, the second argument of a **hit'** predicate. If the complete NP, within which the antecedent is contained, is higher on the PSA Hierarchy then the condition is deemed satisfied.

In Māori reflexivization, if the role hierarchy condition is satisfied then the presence or absence of a support form can override the SCR and the speaker can chose an entirely grammatical antecedent. In this and other examples the antecedent can, under the correct circumstances, be chosen from a primary or dependent constituent of a noun phrase. It follows that, under agreeable conditions, a support form implies 'headedness' of an antecedent. More clearly, a support form denotes that a primary reflexive antecedes another primary constituent whether it has an accompanying dependent or not. The underlying criterion is that the antecedent is higher on the PSA Hierachy. Even if there is no dependent constituent, as in Figure 14, two co-referencing primary arguments require a support form.

"John_i's friend is hitting him_i."

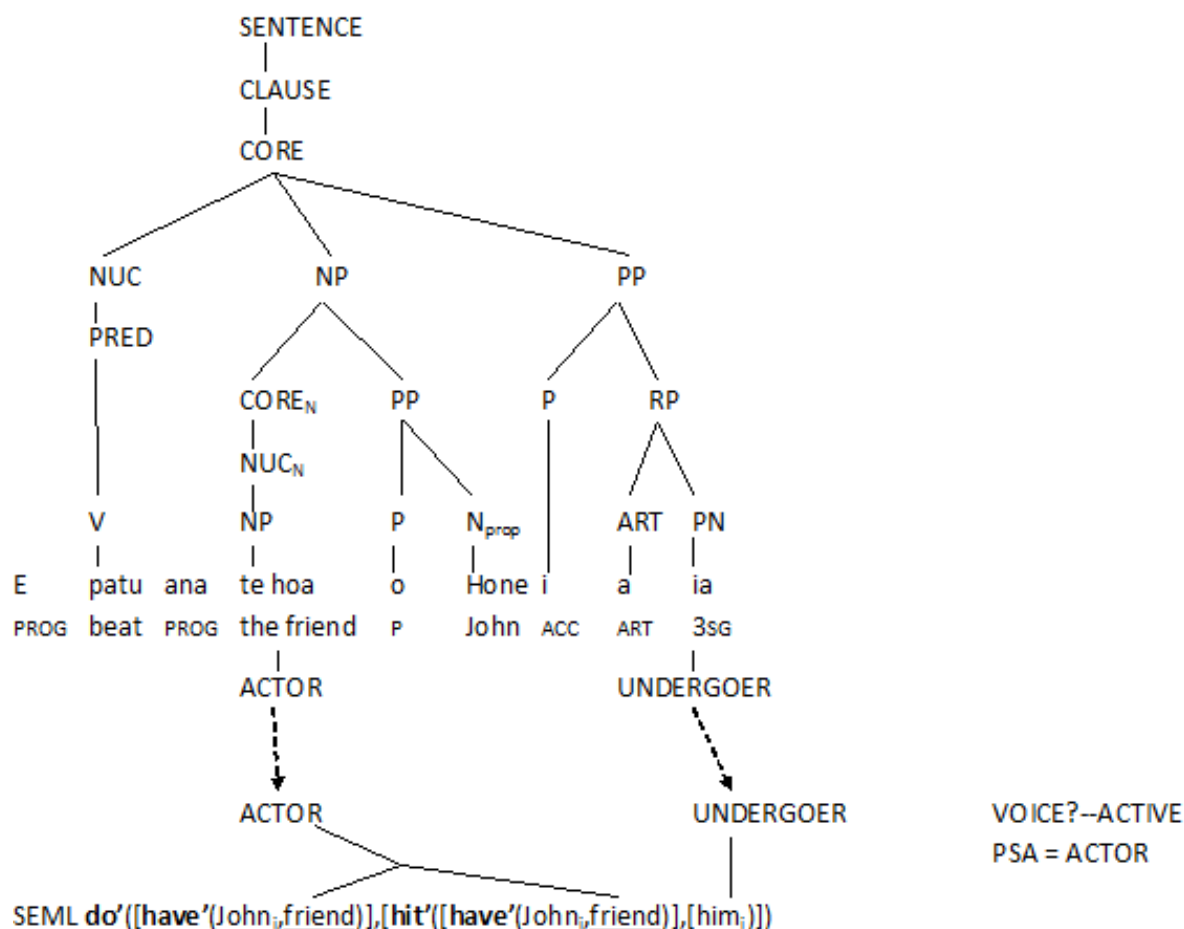


Figure 17: Dependent antecedent within an NP, primary reflexive without support form

Having seen above how a clause with primary reflexive argument behaves, this begs the question as to what takes place when the reflexive pronoun is a dependent constituent. Much of the data provided by Bauer (1993) includes possessive-reflexives. However, Van Valin (1997, p393) does not include possessive-reflexives in his analysis. Pollard and Sag (1992) argue that they “operate rather differently from argument reflexives”. Nonetheless, to be comprehensive during this investigation sentences with possessives were analysed as guided by the RRG approach. As shall be seen, all things being equal, all dependents in Māori behave similarly whether they are a possessive or not.

The following two examples used to demonstrate this are from Bauer (1993, p170). Examples (22) and (23) are standard transitive constructions. Their linkings are shown in Figure 18: and Figure 19 respectively.

- (22) E horoi ana ngā hoa o Hone i tana motokā
 PROG wash PROG the friends P John ACC 3SG.POSS car
 “Johns’ friends are cleaning his car”
- (23) E horoi ana te hoa o Hone i tana motokā (anake)
 PROG wash PROG the friend P John ACC 3SG.POSS car (only)
 “John’s friend is cleaning (only) his car”

In Figure 18: the antecedent ‘John’ and the reflexive possessive pronoun ‘tana’ are both first place arguments in a **have**’ predicate, the complete antecedent NP is the argument of a **do**’ predicate. The role hierarchy condition is satisfied. As regards the SCR, the antecedent and reflexive constituents are both dependent constituents contained within NPs. This is another example of equality testing but not quite violating a constraint. The antecedent and the reflexive are not semantic co-arguments, the semantic co-arguments of the LS of ‘horoi/wash’ are “friends/hoa’ and ‘car/motokā’. Both the antecedent and the reflexives are arguments within an NP and so are not syntactic co-arguments either. Unsurprisingly, a reflexive form is then neither obligatory nor optional. In summation, in Figure 18: the dependent reflexive co-references the dependent antecedent. Preliminarily, it seems that a dependent reflexive antecedes a dependent antecedent.

However, examining a very similar construction such as Figure 19 shows that such a presumption would be mistaken. Recall that number in Māori nouns is marked on the determiner. In this clause the primary constituent of the antecedent NP is now singular. As can be seen in the linking in Figure 19 it is now the antecedent of the possessive pronoun. Even the addition of a support form cannot alter the antecedent, and would only serve as the verbal modifier ‘only’. It can be stated that, where both the antecedent and the reflexive contain a dependent and a primary constituent, a dependent reflexive must agree with the primary constituent of the antecedent where numerical agreement allows. Only if the primary constituent of the antecedent does not agree in number with the dependent reflexive pronoun may it antecede the dependent antecedent constituent. These constructions highlight an important, so far unmentioned, axiom. Namely, that a potential antecedent must agree in number with the reflexive.

"Johns_i' friends are cleaning his_i car"

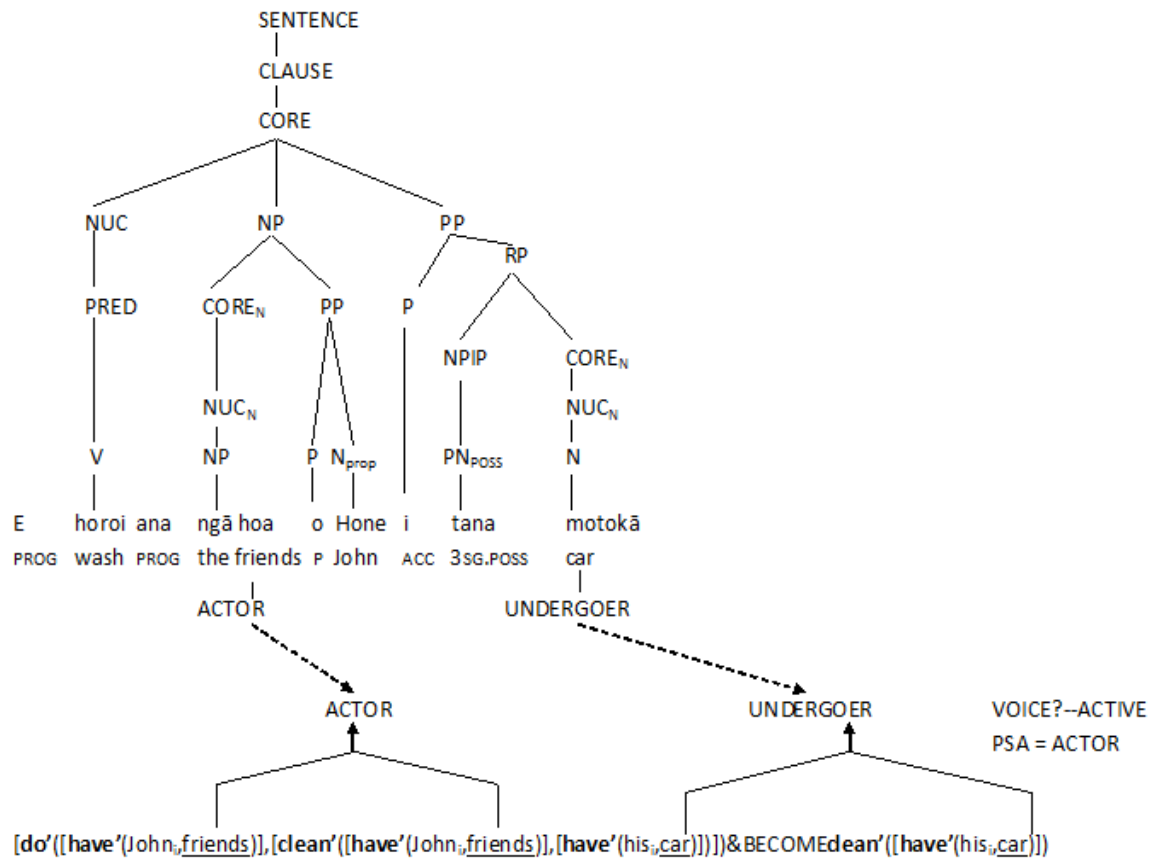


Figure 18: Dependent antecedent within an NP, dependent reflexive without support form

"John's friend_i is cleaning (only) his_i car"

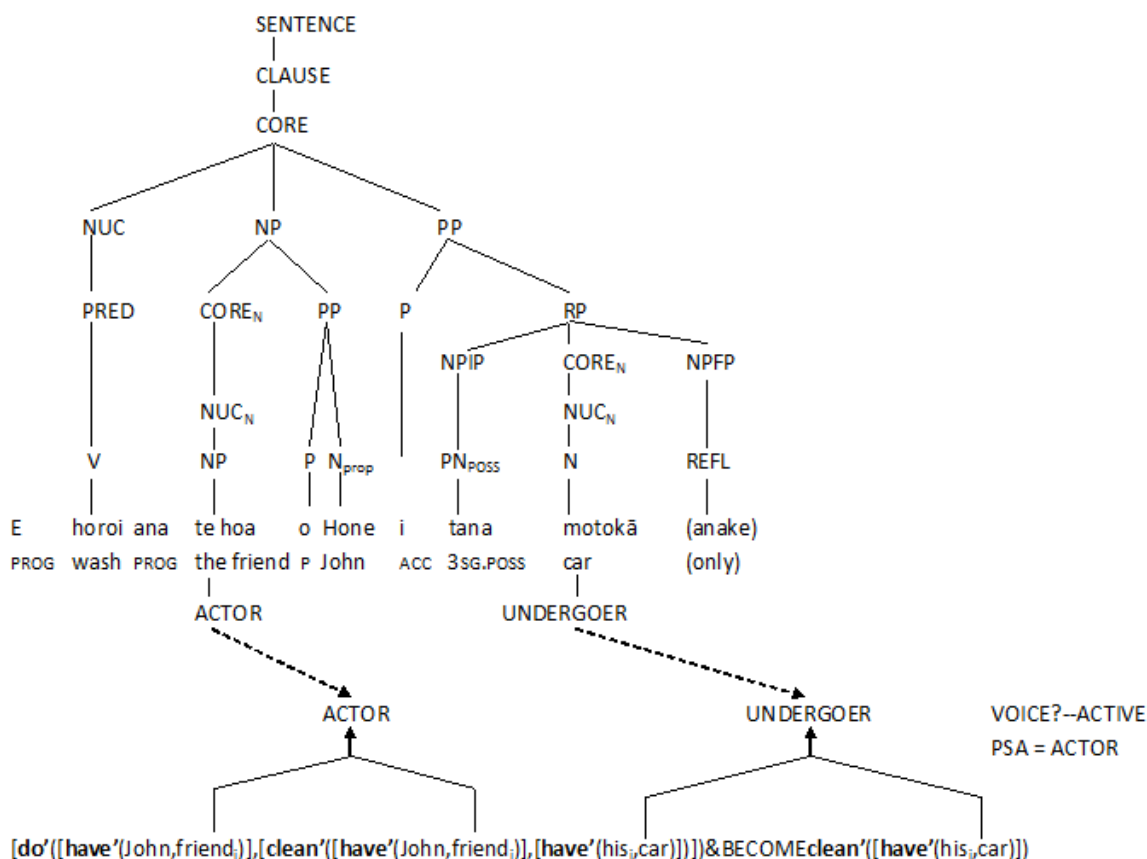


Figure 19: Primary antecedent within an NP, dependent reflexive without support form

Having examined (22) and (23) above, it is worth considering example (24), taken from Bauer (p168). The linking for (24) is shown in Figure 20. The role hierarchy condition is satisfied since the antecedent 'Mary' is the higher than the reflexive possessive pronoun 'ōna'. The binder 'Mary' is the sole primary constituent and the bound reflexive possessive pronoun 'ōna' is a dependent constituent so the SCR is met unequivocally. The antecedent and the reflexive are neither semantic nor syntactic co-arguments. Yet again, if added, a support form would not serve as such but would act as a determiner modifying the noun. More precisely, it would modify the noun serving to intensify the sense of possession by the antecedent. Although optional, a support form is preferred in this clause.

- (24) Kei te horoi a Mere i ōna kākahu (anake)
 TNS wash ART Mary ACC 3SG.POSS clothes (only)
 "Mary is washing her (own) clothes"
- (25) E whakāri atu ana ahau i a Hone ki tōna pāpā
 PROG show PROG 1SG ACC ART John ACC 3SG.POSS father
 "I showed John to his father"

It is useful to compare (24) with example (25) from Bauer (p172). The linking for (25) is shown in Figure 21. Here, the antecedent is also the sole primary constituent

“Hone”, the reflexive possessive pronoun is a dependent constituent. The antecedent is second argument of **see**’ and is lower on the hierarchy than the reflexive possessive pronoun which is the first argument of **have.as.kin**’. However as with Figure 16, if the complete noun phrase containing the antecedent [**have.as.kin**’(his_i, father)] is higher on the hierarchy, then the condition is deemed satisfied and the phrase is grammatical. Once more the antecedent and the reflexive are neither semantic nor syntactic co-arguments. In this sentence there is no support form, although Bauer deems it optional. Initially the presence of the support form in these constructions seemed entirely arbitrary. But this analysis found that in these constructions the optional support form was favoured if the antecedent was also the actor.

Having examined the data above, it is more clearly summarised in Table 3 below. Table 3 summarises the overall pattern for Māori reflexives and correctly predicts when a support form will occur. It also anticipates the consequences of the inclusion or exclusion of a support form.

"Mary_i is washing her_i (own) clothes"

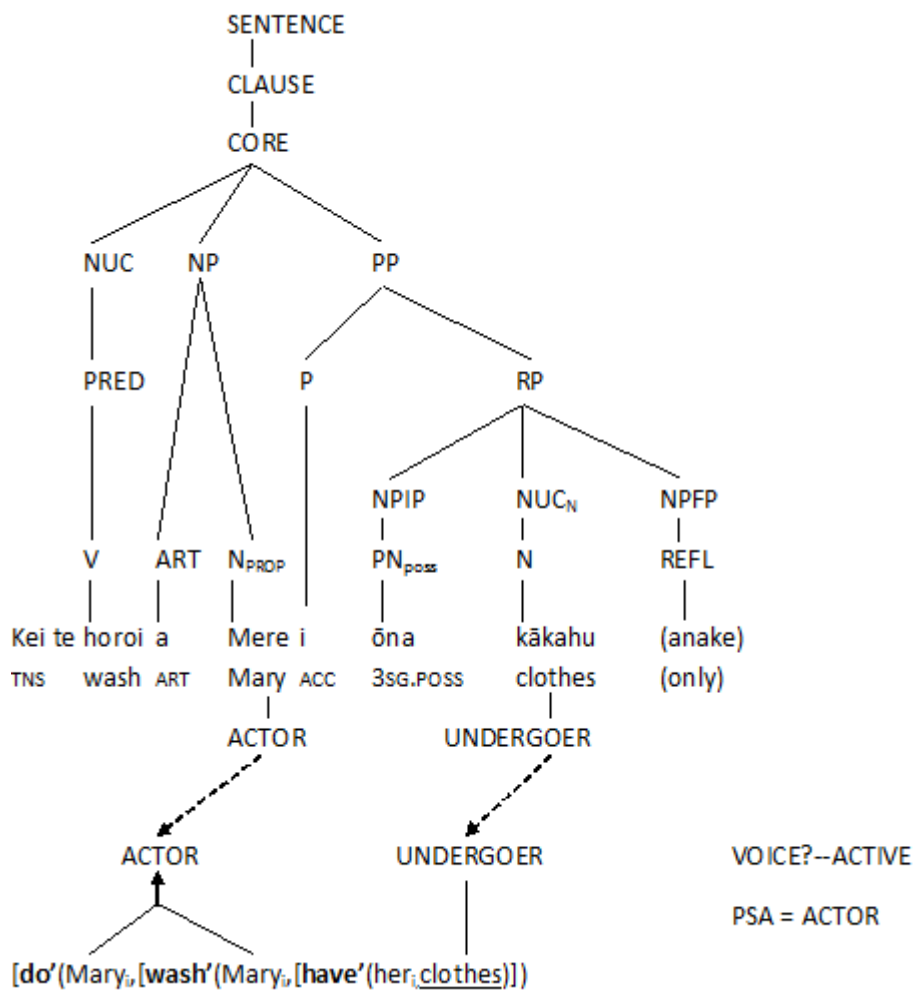


Figure 20: Primary antecedent, dependent reflexive within an NP, support form preferred

Table 3² Criteria for the inclusion or exclusion of a support form

Antecedent	Reflexive	Support Form
Sole primary constituent	Sole primary constituent	Obligatory <i>Kei te horoi a Mere i a ia anō/anakewash wash</i> <i>Mary 3SG again/only</i> <i>"Mary is washing herself"</i>
Sole primary constituent	Dependent of a primary constituent	Optional Preferred if antecedent is an actor <i>Kei te horoi a Mere i ōna kākahu (anake)</i> <i>wash Mary 3SG.POSS clothes (only)</i> <i>"Mary is washing her own clothes"</i> <i>E whakāri atu ana ahau i a Hone ki tōna pāpā</i> <i>show 1SG John 3SG.POSS father</i> <i>"I am showing John to his own father"</i>
Dependent and Primary constituents	Dependent of a primary constituent	None. The reflexive must antecede the primary if it agrees numerically. <i>E horoi ana te hoa o Hone i tana motokā</i> <i>wash John's friend 3SG.POSS car</i> <i>"John's friend is washing his own car"</i> <i>E horoi ana ngā hoa o Hone i tana motokā</i> <i>wash Johns' friends 3SG.POSS car</i> <i>"Johns friends are washing his car"</i>
Dependent and Primary constituents	Sole primary constituent	With support the reflexive antecedes the other primary constituent <i>I hoatu te tama o Hone i te kai mā-na anake</i> <i>give John's son the food DAT-3SG only</i> <i>"John's son gave himself food"</i> Without support the reflexive antecedes the dependent constituent <i>I hoatu te tama o Hone i te kai mā-na</i> <i>give John's son the food DAT-3SG</i> <i>"John's son gave him food"</i>

6 Conclusion

This article illustrated the importance of headedness in anaphora in Māori. Compliance with the Role Hierarchy Condition on reflexivization was deemed obligatory. Be that as it may, there are instances where an antecedent, within an NP, appeared not to comply with the condition. It was found that if the complete noun phrase was higher on the PSA Hierarchy then the condition was deemed satisfied. In judging the Role Hierarchy Condition satisfied, it allows a primary or dependent antecedent to be chosen from within an NP under the correct circumstances. In Māori, the Superiority Condition on Reflexivization is of lesser importance than the Role Hierarchy Condition. This provided an explanation for the occurrence of support forms in reflexive constructions. It followed that the headedness of the antecedent and reflexive is crucial in predicting the occurrence of a support form.

² Some glossing has been omitted in the table for clarity; a full gloss is given in the linking algorithms seen above.

7 List of Abbreviations used

1	first person
3	third person
ACC	accusative
ART	article
DEF	definite
DEIC	deictic
DEM	demonstrative
FUT	future
IPFV	imperfective
OBL	oblique
P	preposition
PASS	passive
PL	plural
POSS	possessive
PRED	predicative
PRES	present
PROG	progressive
PST	past
REFL	reflexive
SG	singular
TNS	tense

8 References

- Bauer, W., W. Parker, et al. (1993). *Māori*. London, Routledge.
- Givón, T. (1990) *Syntax: A functional-typological introduction. Volume II*. John Benjamins, Amsterdam.
- Harlow, R. (2001). *A Māori Reference Grammar*. Pearson Education New Zealand, Auckland.
- Harlow, R. (2007). *Māori A Linguistic Introduction*. Cambridge University Press, London.
- Nolan, B. (2012) *The Structure of Irish: A functional account*. Sheffield, Equinox Publishing Company
- Pavey, E. L. (2010). *The structure of language : an introduction to grammatical analysis*. Cambridge, Cambridge University Press.
- Pollard, C. and I.A. Sag. (1992) *Anaphors in English and the scope of binding theory*. in *Linguistic Inquiry* 23.2:261-304
- Van Valin, R. D. (2001). *An introduction to Syntax*. Cambridge, Cambridge University Press.
- Van Valin, R. D. (2005). *Exploring the syntax-semantics interface*. Cambridge, Cambridge University Press.
- Van Valin, R.D. (2008). *An overview of Role and Reference Grammar* retrieved 4th June 2012 from http://linguistics.buffalo.edu/people/faculty/vanvalin/rrg/RRG_overview.pdf
- Van Valin, R. D. and R. J. LaPolla (1997). *Syntax : structure, meaning, and function*. Cambridge, Cambridge University Press.
- Vendler, Z. (1957). *Linguistics in philosophy*, pp. xi. 203. Cornell University Press: Ithaca.
- The Māori Language Commission*,
retrieved 28th March 2012 from <http://www.tetaurawhiri.govt.nz/english/faq/lang.shtml>
- The Māori Dictionary*,
retrieved 11th August 2012 from <http://www.Māoridictionary.co.nz/index.cfm>

The Persuasive Tutor: a BDI Teaching Agent with Role and Reference Grammar Language Interface – Sustainable design of a conversational agent for language learning

Judith Gottschalk
Aalborg University
gottschalk.judith@gmail.com

Abstract³

This paper investigates how an intelligent teaching agent with Role and Reference Grammar [RRG] (cf. Van Valin 2005) as linguistic engine can support language learning. Based on a user-centred empirical design study the architecture of a highly persuasive tool for language learning as an extension of PLOTLearner (<http://europlot.blogspot.dk/2012/07/try-plotlearner-2.html>) is developed. Based on grounded theory it is shown that feedback and support is of greatest importance even in self-directed computer assisted language learning. It is also shown how this overall approach to language learning can be situated into traditional conversation based learning theories (cf. Laurillard 2009). It is shown that a computationally adequate model of the RRG-linking algorithm, extended into a computational processing model, can account for communication between a learner and the software by employing conceptual graphs to represent mental states in the software agent and the important role of speech acts is emphasized in this context.

1. Introduction

The problems I am working on in this paper are 1) Does a conversational agent for language learning support language learners in their desire to learn a language and how should such an agent look like and 2) How should an architecture for an intelligent teaching agent look like which uses RRG as linguistic engine? Since in this design study I use grounded theory for the analysis of my empirical data no hypothesis is stated. The hypothesis is generated from user-input within a user centred design approach.

Based on qualitative research in terms of a focus group interview and a questionnaire a design study resulting in the architecture for an intelligent teaching agent using RRG (cf. Van Valin and LaPolla 1997; Van Valin 2005) as its linguistic engine is presented. I will introduce the architecture of a highly persuasive learning technology that emulates the presence an artificial tutor as learning supervisor for a learner in a virtual and interactive world. This way artificial intelligence will enable persuasive learner-controlled tutoring for collaborative learning in the community of enquiry. The intelligent teaching agent has a natural language interface using the functional linguistic framework of RRG for both language production and comprehension. This computationally adequate linguistic theory guides the interaction of the learner with the intelligent teaching agent, and this human-computer interaction is structured like an instant messaging system. I will base my work on a user-centred design approach.

3 I would like to thank my family for supporting me during my studies in Denmark. Kim Hülsewede receives my thanks for language correction. Without the support of Erich Herber it would not have been possible to conduct the empirical study, as well as my focus group from Fjellhaug International University College Denmark he deserves my greatest thanks. I would like to thank Hagen Langer for many discussions on intelligent teaching agents. Brian Nolan receives my thanks for many inspiring discussions, his emotional support during the last months and for publishing my paper. Finally I would like to thank my Nicolai Winther-Nielsen for his wonderful supervision, scientific and personal support during the last months. I enjoyed our discussions and am looking forward to many more interesting projects with you.

I am developing the design for persuasive learning in a technology called the PLOTLearner that is being developed in the EU project EuroPLOT (www.eplot.eu). PLOTLearner is a learning environment for database-supported language learning which making it possible to learn Biblical Hebrew with the ancient language of the Hebrew Bible, which is stored in an Emdros database. The learning environment generates database-informed grammatical exercises. PLOTLearner turns the Hebrew Bible into a pedagogical tutor. Through interactive and pedagogical expose to the Hebrew texts, the learner is gradually guided into learning Hebrew and studying the culture (cf. Winther-Nielsen 2012: 1).

In the course of the development of the BDI teaching agent, I will use a lexicalist approach to RRG, which is crucially informed by an architecture of the mental lexicon as developed in Gottschalk (2010, 2012). I will use an extension of the RRG-linking algorithm based on Gottschalk's (2012) approach to a computationally adequate model of RRG. My version of a computational adequate RRG uses conceptual graphs [CGs] for the representation of the semantic structure of sentences that are processed by the teaching agent.

This paper is organized as follows in section 2 the concept of my user-centred design is laid out and presented within a taxonomical framework for classifying design approaches based on Keinonen (2009). Qualitative data gathering and a focus group interview is the topic of section 3 in which I describe in detail my empirical data gathering and data analysis. In section 4 the basic theory of RRG is introduced. The concept of intelligent software agents is introduced in section 5 and section six contains the architecture of an RRG-driven teaching agent and the different phases within the workflow of this architecture is described. A conclusion is contained in section 7.

2. Design approach

Human-centred design is an area of research which has received much attention during the last couple of years (cf. Keinonen 2009). User-centred design is defined by generative research. In this approach, design generatively evolves during a design approach that is informed by user interaction (cf. Sanders 2005: 2). Keinonen (2009) has introduced a design contribution square that makes it possible to taxonomically classify the degree to which users are involved in such a generative design approach. This is illustrated in figure 1. In inactiveness, behaviour is not influenced by design. It is not easy to be documented and communication is usually unambiguous. If the design behaviour is reactive, it is also possible that communication is unambiguous; however, an effective and replicable design process can be found. Participants in design studies respond to new stimuli. This is true for designers as well as for users or co-creators. In a proactive design approach, all participants react to new stimuli; however they also reframe problems and agendas of design. Also, participants utilize non-task related expertise (cf. Keinonen 2009: 145).

In cases where well-structured methods or rules are employed for guiding the design interaction, designers and users are in a reactive mode. This method has dominated human-centred design. It is called traditional user-centred design. In this design

approach, design is conducted on behalf of the user; however a user constantly informs it. Keinonen (2009: 146) describes this design approach as follows:

For instance, a usability test [47] aiming at evaluating the quality of a prototype or product – rather than improving it – with its predefined task scenarios, measurements and participant roles is an example of an interaction with agenda that ties both users and designers. The interaction can lead to increased understanding about known challenges like the quality of design in the interactive prototype, but is unlikely to reveal anything completely unexpected. Collaborative design sessions aiming at new solutions following predefined rules and problem frames belong also to this category. Even though many human centered design scholars would probably argue for changing these situations towards a more proactive direction, there are reasons to accept the participants' relative passivity. First, evaluation processes benefit from following rigid agendas for comparable results. Second, problems with collaboration and communication may be time consuming to solve, and thus agendas structuring design and focusing attention to relevant problems bring practical efficiency benefits. Consequently, the method development challenge for *DreUre* type of HCD is to develop interaction agendas that are able to structure, focus and standardize collaborative procedures in a way that still accommodates many of the relevant aspects of design (Keinonen 2009: 146f).

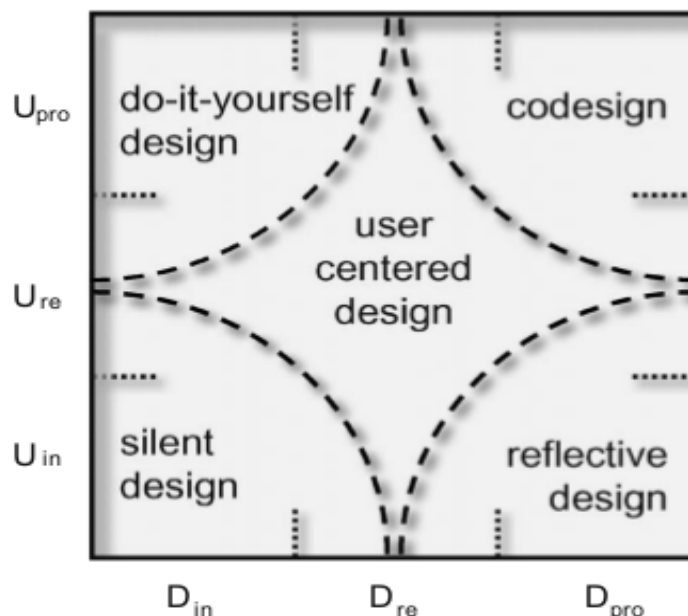


Figure 1: Human centred design approaches positioned on Design Contribution Square

(U_{pro}: proactive user contribution, U_{re}: reactive user contribution, U_{in}: inactive user contributions, D_{pro}: proactive designer contribution, D_{re}: reactive designer contribution, D_{in}: inactive designer contribution) (Keinonen 2009: 146)

The present design study had to face the problem that I, as designer, am situated in Düsseldorf, Germany, while my users are situated in Copenhagen, Denmark. Given this specific situation, cut backs in the designer's involvement as well the involvement of users had to be made. My design study was mainly informed by traditional research methods, like focus group interviews and questionnaires (cf. Hanington 2003: 13). These methods provided an efficient means to reach my users in Copenhagen.

The design study followed structured methods or rules in that I chose qualitative data gathering as basis for the development of a first prototype of the persuasive tutor. In

a first step, the concept for the persuasive tutor was developed on the basis of brainstorming and mind maps, which I used for the creation of an idea for the improvement of the PLOTLearner in its current state. The design question that guided this first step was in how far natural language processing can be used in order to improve language learning within the PLOTLearner. Based on this initial step in the design study, I have roughly sketched a first idea of an RRG-driven intelligent software agent and then I have interviewed my focus group in Copenhagen. This focus group interview was supported by a qualitative questionnaire, in which the users had the possibility to express their opinion about a persuasive tutor in more detail. Based on this user input, it was possible to have a clear picture of what the users expect from such a persuasive tutor and it was possible to revise my design approach.

This design approach was interactive in the sense that two data gathering methods were chosen, and that the design was generated from user input. In that sense, a generative research approach was conducted. The communication with the user was unambiguous in any situation, as well as the users' responses. Since the design approach followed a clear schema, with focus groups interviews after a prototype was developed, as well as the use of an initial questionnaire, the approach was replicable. This is also true for the behaviour of the users in that they constantly participated in these design steps. With new prototypes and accordingly new focus group interviews, I responded to the new stimuli of the user, who also responded to the new stimuli in terms of a new prototype in focus group interviews. Given this design approach my design study can, based on Keinonen's (2009) taxonomy, be classified as user-centred design.

In the next section I will introduce my qualitative data gathering process and my analysis based on grounded theory will be roughly sketched.

3. Empirical data gathering, data processing and coding

The reactive interaction with the focus group in Copenhagen was conducted in two steps. It consisted of a focus group interview and a qualitative questionnaire. I chose grounded theory to evaluate the user responses to both my qualitative data gathering in terms of the questionnaire and the focus group interview. Grounded theory is an approach to analysing qualitative data and to developing a scientific theory from the systematic analysis and interpretation of empirical data (cf. Rogers et al. 2011: 297). This approach was first developed by Glaser and Strauss (1967). The approach chosen in grounded theory is to develop a theory that fits to the data collected. A grounded scientific theory is developed by alternating data collection and the analysis of this data (cf. Rogers et al. 2011: 297). In a first step data is collected via qualitative questionnaires or focus group interviews and then categories within the data are identified. In a second step, further data collection is conducted and interactively analysed. This interaction takes place until a proper theory is developed (cf. Rogers et al. 2011: 297). This way, new insights to a specific topic are gathered.

Following Rogers et al. (2011: 297) the following coding steps are executed in order to develop the theory: 1) open coding, which is the process which leads to the first categories with properties and dimensions which are informed by the data 2) axial

coding, which is the process which leads to a systematic fleshing out of categories which are set into relation to their subcategories 3) selected coding, a step in which categories are organized around a central category which forms the theory's backbone (cf. Rogers et al. 2011: 297).

The focus group consisted of four informants. The informants are all currently enrolled in the bachelor program in theology at Fjellhaug International University College Denmark and are all male. They are between 20 and 25 years old and participate in a class on Biblical Hebrew with a weekly workload of 24 hours. The learning format chosen is corpus-driven self-directed persuasive language learning. The teacher functions as facilitator. The learners are taught the text of the Hebrew Bible. The teacher gives feedback to the learners in oral discussions in class as well as in e-mails as response to learning statistics the learners send to him on a regular basis. Sending the learning statistics to the teacher is voluntary, as he keeps the promise of letting the learners do their class work self-directed and independently. This has the result that he does not always get the statistics from the learners. In class, the students watch learning videos and use learning sheets with corresponding information on the Hebrew grammar. To support their grammatical drills, the learners use PLOTLearner.

The in the focus group interview I asked the following: *Imagine PLOTLearner had an interactive help function that starts to communicate with you once it recognizes that you get stuck in your exercises. Please give some opinion on this.* They were asked to argue for their specific opinion and to discuss this question controversially. Only little guidance from the interviewer was provided. In the second step of my data gathering process, I conducted an online survey, in which I used a qualitative questionnaire in order to ask the learners more detailed questions about the envisioned teaching agent.

In a first step of the data analysis, a line-by-line analysis based on the answers given in the focus group interview and the questionnaire was conducted. I identified diverse categories derived from the data. In the course of this coding step, I identified key words in the data and brought them into a larger context, which summarizes the answers of the informants. Two examples for the open coding tables are given in tables 1 and 2 below. All other tables are to be found in appendix A.

Table 1: Open Coding

<i>Imagine the learning software could give you advice via text messages when you get stuck with an exercise. Would you like that? Give reasons!</i>	
Answer	Sample codes generated and notes
It would be a great help, especially if there are links to more knowledge.	1. Desire for <u>support</u> 2. <u>Knowledge building</u> through links to more knowledge
Absolutely, that will be great, because it removes unnecessary waste of time and frustration in the learning process	1. Reduction of frustration through timely and efficient support. 2. <u>Encouragement</u> through reduction of frustration
It would be helpful. To solve learning problems immediately is good.	1. <u>Support</u> in learning through immediate feedback. 2. <u>Efficiency</u> through immediate feedback

Table 2: Open Coding

<i>Imagine you are supervised by the learning software via textual dialogues. What feedback would you like to have from the learning software? - Give examples!</i>	
Answer	Sample codes generated and notes
Suggestions to where I need to improve. Information about what my most common mistake is.	1. <u>Knowledge building</u> through suggestions for improvement. 2. Display of most common mistake for <u>efficient</u> learning.
Not answered	
Just short and specific grammatical advice.	1. <u>Knowledge building</u> through advice. 2. <u>Efficiency</u> through short and succinct advance

From the initial open coding, the following categories which play a role in the development of an persuasive intelligent tutoring system which extends PLOTLearner can be derived: Feedback, Support, Collaboration, Communication, Efficiency, Knowledge building, role change, competition and competition.

From the global categories, it is possible to derive axial coding in terms of a hierarchical model that describes the interactions of the different elements at play in the envisioned extension of PLOTLearner with an RRG-driven BDI teaching agent. This diagram is given in figure 2 below:

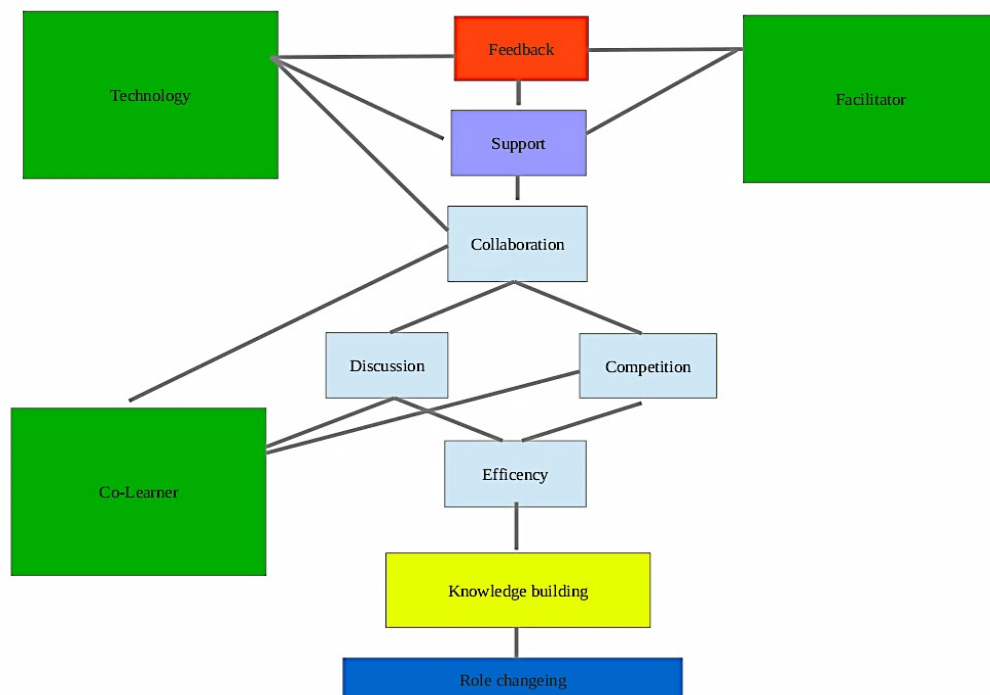


Figure 2: Axial coding and hierarchical model of empirical data

From the open coding, it was possible to identify the need for feedback as a core issue for successful learning and as a desire of the learners. An interview with the facilitator of the focus group in Copenhagen, Nicolai Winther-Nielsen, has shown that for the learners feedback in class is important for their learning process. As the open coding suggests, the feedback directly results in support with problems that occur in the learning process. Collaboration plays a part in learning with PLOTLearner. The reason for this is that the learners are self-directed learners in a university environment in which the facilitator is their main source for support and feedback.

However, as pointed out in the focus group interview, in a context in which the facilitator is unavailable and the envisioned teaching agent can not give the desired support and feedback, collaboration is desired. In these situations the learners can collaborate with other learners via discussions and competition. Collaboration should always be efficient. Efficiency plays a very important role in all kinds of interaction the learners could have. They have a desire to get short and succinct help with problems in their learning progress and, as pointed out by the learners in the focus group interview, this need also results in a degree of collaboration, supported by the fact that the learners would only like to collaborate with learners who have already mastered a problem, rather than mastering a problem with the learning object in collaboration with other learners.

These different steps lead, as shown in figure 2, to the aim of the self-directed learning process: Knowledge building. If the learning object is mastered, the learners also would like to change their roles. In this situation, the learners are willing to act as facilitators and to support other learners. This actually results in a learning circle, in which self-directed learning applies and which PLOTLearner supports with its extension by an intelligent tutoring system. These findings lead me to an overall theory, in which feedback is the backbone, supported by self-directed learning with PLOTLearner. In these situations, as in learning at home, the teaching agent supports the learners with short and succinct answers on specific problems with the learning object. The agent is used in situations where the facilitator is not available. This way, the important role of efficiency is underpinned. It also gives feedback on the learning process, which should help the learners' master the learning object. In situations where the teaching agent cannot give the desired support and feedback, it leaves room for collaboration with other learners who have already mastered the problem, and directs learners to such advanced co-learners. The teaching agent supports discussion and gives the possibility for competition on the learning object. A further function of this collaboration dimension of the teaching agent is to give the possibility for role changing to further support collaboration in PLOTLearner.

This theoretical approach is supported by theoretical findings developed in Laurillard (2009). In her approach to conversational learning theory, Laurillard (2009) uses an approach that is driven by social interaction between learners and the facilitator (cf. Conole et al. 2004: 20). In this model, the role of interpersonal relationships, which involve imitation and modelling, is emphasized (cf. Conole et al. 2004: 20). In this framework, language is used as a tool for learning as well as for the construction of knowledge. Following Laurillard, language in this framework has two functions: First it is a communicative or cultural tool, used for sharing and for jointly developing knowledge. However language is also a psychological tool, used for the organization

of individual thoughts for reasoning, planning and reviewing of the learner's actions (cf. Conole et al. 2004).

This pedagogical framework can clearly be found in PLOTLearner as a tool for self-directed learning in which the learner communicates with the learning object via quizzes; however it is also found in the learning context in which the focus group at Fjellhaug International University College Denmark learns Hebrew and uses PLOTLearner, as the direct contact between the facilitator in class supports the use of language as a communicative tool.

However, in her approach to conversational learning theory Laurillard (2009) also emphasizes the role of communication between learners in a collaborative context, in which the learning object is mastered in a communicative concept, in which the learners reflect about the learning object. In an approach to PLOTLearner which uses the fact that the learners would like to use communication and feedback from the learning software as well as their facilitator and their peers, Laurillard's (2009) pedagogical framework is of major importance.

Nevertheless, the learning conception realized by PLOTLearner is also bound to a second pedagogical framework, which can be subsumed under the heading 'Constructivism'. Constructivism focuses on processes that cause knowledge building in the learners and giving them the possibility to build their own mental structures when they interact with their environment (cf. Conole et al. 2004: 19). The pedagogical focus in this learning model is task-oriented and it favors hands-on, self-directed activities that are oriented towards design and discovery. This approach is useful for structured learning in things like simulated worlds and it supports the construction of conceptual structures through the engagement in self-directed tasks (cf. Conole et al. 2004: 19).

While the conversational framework as described by Laurillard (2009) would especially apply to the envisioned extension of PLOTLearner with the intelligent teaching agent in that it constantly gives feedback and support to the learners, constructivism is already realized in PLOTLearner through its self-directed learning approach, which is also realized in the learning environment at Fjellhaug International University College Denmark. This clearly shows that in a teaching approach in which a teaching agent is used, a well-established learning framework can be realized.

In the next section, I will present in some detail the computational linguistics approach to RRG as it is laid out in Gottschalk (2012) and which, although also developed to some detail, is still a work in progress.

4. Role and Reference Grammar

RRG is a monostratal functionalist theory. It uses a single syntactic description which is semantically motivated and does not assume abstract underlying levels of syntactic representations as they are used in Government and Binding Theory and Relational grammar (cf. Van Valin 1991: 154; cf. Van Valin 2005: 1). RRG employs a semantic representation based on Aktionsarten as they are developed by Vendler (1969) and Dowty (1979). For this correspondence, RRG uses a linking algorithm,

which directly links the semantic representation of the clause with its syntactic representation (cf. Van Valin 2005). Based on this, RRG is both a lexicalist and a functionalist theory (cf. Van Valin 1991: 154). Also, RRG uses a representation of information structure to account for the communicative function of the utterance (cf. Van Valin 2005: 1).

In what follows I will give a general overview of RRG, in which I will describe the basic theory of RRG as developed in Van Valin (2005) and Gottschalk (2012). The focus here is clearly on the computational adequate model of RRG as presented in Gottschalk (2012).

Word order regularities in RRG are described in terms of the layered structure of the clause [LSC], which displays clause structure. Phrases in the LSC are semantically motivated and contain components every human language has (cf. Van Valin 2005: 4). The underlying semantic units from which the syntactic units are projected in the LSC are summarized in table 3.

Table 3: Semantic units underlying the syntactic units of the LSC (Van Valin 2005: 5)

Semantic element(s)	Syntactic unit
Predicate	Nucleus
Argument in semantic representation of predicate	Core argument
Non-arguments	Periphery:
Predicate + Arguments	Core
Predicate + Arguments + Non-arguments	Clause (= Core + Periphery)

As pointed out in Van Valin (2005: 8), although the LSC is semantically motivated, all units are syntactic. Beside the semantic units given in table 3, RRG also assumes additional syntactic elements that can occur in single-clause sentences. The precore slot [PrCS] is one of these elements. It is the position in which question words occur in languages in which they do not occur *in situ*. Also, the PrCS is the place where fronted elements occur, as in the sentence: *Unjustice, Batman doesn't like* (cf. Van Valin 2005: 5).

Not all languages have a PrCS, but in languages that do have it Van Valin (2005: 8) proposes that it is pragmatically motivated. As shown in figure 3, the PrCS is inside the clause but it is not part of the core (cf. Diedrichsen 2008: 204).

As shown in figure 3, the question word *what* occurs in the PrCS. This is typical for languages like English, since here the question word does not occur *in situ* (cf. Van Valin 2005: 5). The verb *say* is the nucleus. The nucleus is the heart of both the semantic and the syntactic representation of the clause. The reference phrase *Batman* is a direct core argument while *to Alfred* is an oblique core argument. The reason for this is that it has an oblique case and is marked by a preposition. The PP *in Wayne Manor* and the adverb *yesterday* form the periphery which modifies the core (cf. Van Valin 2005: 7). Van Valin (2005: 13) explains that the LSC is stored in terms of syntactic templates in the syntactic inventory. With the help of the linking algorithm, parts of syntactic templates are matched to create a full LSC. As noted in Van Valin and LaPolla (1997: 69f), syntactic templates are formally equivalent to ID/LP-rules, which were found in unification grammar like GPSG. This fact will be of crucial importance for the development of an RRG-based parser.

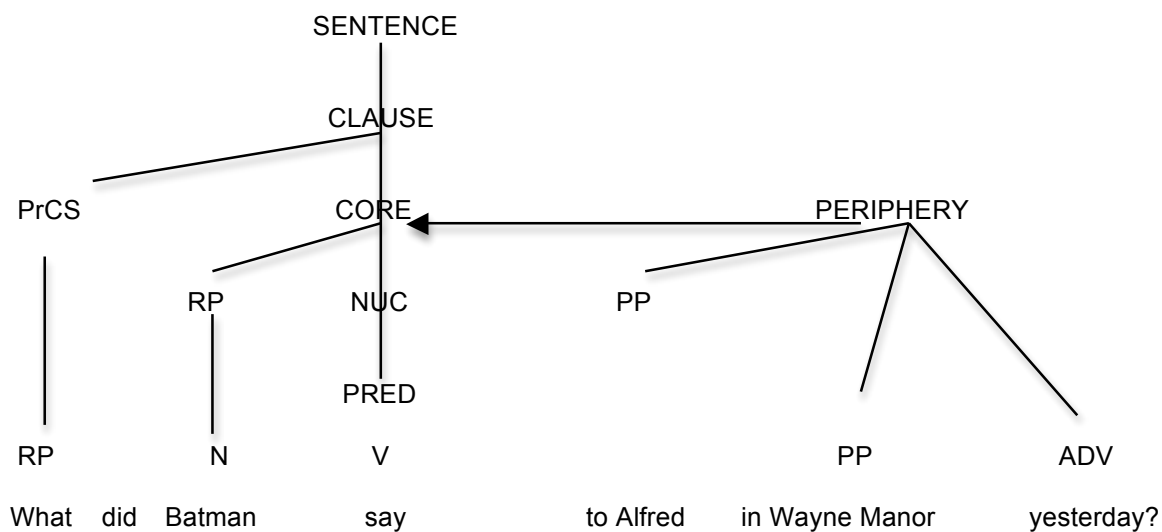


Figure 3: Layered structure of the clause

In RRG a semantic representation of clauses is used based on the Aktionsart classification adapted from Vendler (1969) (cf. Van Valin 2005: 31). In this classification, sentences are divided into states, achievements, accomplishments and activities (cf. Gottschalk 2010: 21). In order to construct logical structures from which the LSC is projected, RRG employs an extended representation of Dowty's (1979) semantic representations of Aktionsarten (cf. Van Valin 2005: 31). Besides the Aktionsarten used in Vendler's framework, RRG also uses a number of non-Vendlerian Aktionsarten. The added Aktionsarten are Semelfactives, Active Accomplishments and Process. Semelfactives have been added in Smith (1997). Gottschalk (2010) shows that the Aktionsart Process also exists. All Aktionsarten have a causative counterpart in RRG. With causatives the semantic differences are described in which a cause, for example a change in condition, can be identified (cf. Gottschalk 2010: 21). In RRG, Aktionsarten are defined by binary features (1).

(1) (Gottschalk 2010: 21)

State:	[+ static], [- dynamic], [- telic], [- punctual]
Activity:	[- static], [+ dynamic], [- telic], [- punctual]
Achievement:	[- static], [± dynamic], [+ telic], [+ punctual]
Semelfactive:	[- static], [± dynamic], [- telic], [+ punctual]
Process:	[- static], [- dynamic], [- telic], [- punctual]
Accomplishment:	[- static], [- dynamic], [+ telic], [- punctual]
Active Accomplishment:	[- static], [+ dynamic], [+ telic], [- punctual]

RRG uses several syntactic and semantic tests to determine the Aktionsart of a verb. The formal semantic representations of Aktionsarten in RRG are called logical structures [LSs]. An overview of them is given in (2).

Semantic roles play an important role in RRG. In Van Valin's (2005) approach to RRG the semantic macroroles actor and undergoer are used. However in Gottschalk (2012) it was shown that these semantic macroroles are epiphenomenal and therefore a number of lexical semantic relations was introduced, which are stored in inheritance networks in the mental lexicon. These lexical semantic relations are

stored within attribute value matrices in the mental lexicon and a unification-based inheritance process assigns them. This is described in length in Gottschalk (2012).

(2) (Gottschalk 2010: 22)

State	predicate' (x) or (x, y)
Activity	do' (x, [predicate' (x) or (x, y)])
Achievement	INGR predicate' (x) or (x, y) or INGR do' (x, [predicate' (x) or (x, y)])
Semelfactive	SEML predicate' (x) or (x, y) or SEML do' (x, [predicate' (x) or (x, y)])
Process	PROC predicate' (x) or (x, y)
Accomplishment	PROC predicate' (x, (y)) & INGR predicate' ((z), y)
Active Accomplishment	do' (x, [predicate' (x, (y))]) & INGR predicate' ((z), y)
Causative	α CAUSE β where α, β , are LSs of any type

In a new approach to the semantic representation of Aktionsarten in RRG, I will propose the use of CGs instead of the traditional semantic representation as proposed in Van Valin (2005). The reason for this is that, as shown in Petersen (2007), it is possible to automatically generate CGs from an input text. This is highly desirable for a computational approach to RRG.

The linking algorithm is bi-directional in the sense that it links the semantic representation with the syntactic representation and vice versa. This linking system makes it possible that, based on a procedural set of instructions, as in a programming language like C or C++, the semantic representation can be generated from the syntactic representation and vice versa.

From a computational linguistics perspective, RRG makes seriously strong claims about being a computational adequate linguistic theory in the sense of being executable on a computational device. One reason for this is in virtue of the application of a generalized linking system in terms of the linking algorithm as developed in Van Valin (2005: 136). In Gottschalk (2012) it was shown that RRG is not computational adequate in the sense of not being executable on a theoretical machine model like a random access machine. Therefore, the RRG linking algorithm was adjusted on a theoretical basis to develop a computationally tractable model of RRG. RRG's architecture which consists of a bidirectional linking algorithm triggers the idea that this algorithm could be used as the communicative basis for a talking computational device which finally led to research on intelligent software agents that could be used in a collaborative learning environment and the aim to develop a persuasive and intelligent tutoring system using RRG as its linguistic engine. In this paper it was shown that much reliance on the mental lexicon and on constructional schemas is necessary. The new version of the linking algorithm can be found in Gottschalk (2012) where it is discussed in detail.

5. BDI teaching agents

The theoretical foundation I use for the teaching agent is based on a model of human behaviour developed by philosophers to model human behaviour. The name of this model is the **belief, intention, desire** model and the philosophical basis of this model has been developed by Bratman (1987) (cf. Bordini, Hübner and Wooldridge 2007: 15).

In this conception of a BDI agent it is assumed that the computer has mental states. Beliefs in this context are defined as what the agent knows about the world (cf. Bordnini, Wooldridge and Hübner 2007: 15). In the case on the teaching environment what the agent knows about the world is the status of the learning progress of the agent according to which it acts. Desires are all the states of affairs that the agent possibly might like to accomplish. That the agent does have a desire does not mean however that the agent acts according to it. Rather a desire is a potential influencer for an action. One can also interpret a desire as an option (cf. Bordnini, Hübner and Wooldridge 2007: 16). Intentions play an important role in practical reasoning. What is most important with respect to intentions is that they lead to action (cf. Wooldridge 2002: 28). Once an intention is adopted the fact of having this intention constraints the future practical reasoning. While some particular intention is held, options will be entertained which are consistent with this intention (cf. Wooldridge 2002: 29). Intentions are closely related to beliefs about the future. This means if an agent has an intention it should believe in this intention. This means if an agent does not truly believe in its intention then it would make no sense to have this intention. Intentions have a number of different roles within practical reasoning. Intentions play a role in driving means-end reason; once an intention arises, the agent will attempt to achieve this intention. This involves the decision of how to achieve the intention and if the achievement of an intention fails another way of achieving it needs to be developed (cf. Wooldridge 2002: 29).

For the implementation of this approach a possible account is to use a control loop in which the agent looks at the world, in the case of PLOTLearner this is the learning environment, and deliberates to decide on which action it should achieve. In the case of the agent these are communicative and they are supported by speech acts. I will refer to this in this section 6. The agent uses means-ends reasoning to develop a plan to achieve this intention. The agent chooses a possible communicative strategy, in this case a speech act and based on this executes its plan, which in a conversational agent is a communication (cf. Bordnini, Hübner and Wooldridge 2007: 20).

Now that I have introduced the conception of a BDI agent I will focus on the architecture of an RRG driven agent in the next section and will show how the concepts of beliefs, intentions and desires can be realized within an RRG context.

6. Reference architecture for an intelligent teaching agent

The envisioned rough architecture of an extension of PLOTLearner and which contains an intelligent tutoring system is made up of two intelligent software agents. This is due to the fact that in this approach I have chosen a modular architecture in which different tasks in this framework are distributed over a number of agents. This is illustrated in figure 4.

In this framework, PLOTLearner interacts with a statistical database connected with a supervisor agent. This agent supervises the learning success of the learner based on statistical data which is send from PLOTLearner to the database. The supervisor agent supervises the learning statistics of the learner that are stored in the database. Once this agent recognizes that a learner gets stuck in her learning due to, for

example, making many mistakes or due to a very long response time, the supervisor agent calls the conversational agent, which starts a communication with the learner. The conversational agent is connected with an Emdros knowledge base, which contains knowledge on grammatical questions and which can be manually populated by the users of PLOTLearner. In this paper I focus on the architecture of the conversational agent and how RRG can be implemented within such a computational framework. Therefore, in figure 5 the architecture of the conversational framework as practical implementation of RRG is given.

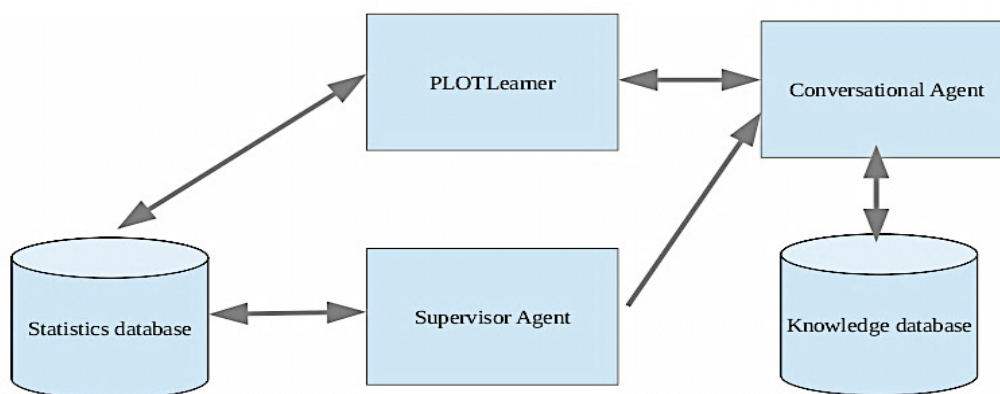


Figure 4: Rough architecture of BDI-agent based extension of PLOTLearner

The architecture of the parse and generation process for the conversational agent given in this figure describes a flow of a number of bi-directional processes which starts with an input sentence typed in by a learner and ends with an output sentence generated by the sentence generator. It is organized in a number of phases which are laid out in detail in what follows: The phases described in the following are crucially influenced by an approach presented in Murtagh (2011).

Phase 1 Processing

In the first phase, an English sentence is input by the user. It is stored as string. Based on an approach in Murtagh (2011: 98) with regard to RRG the sentence is classified as State, Activity, Achievement or Accomplishment. After this took place the sentence is tokenized. Each token is a word and it is stored in terms of a suitable data structure. The tokens are searched in the lexicon in terms of an attribute value matrix [AVM] and based on this information the relevant grammatical information is assigned. As pointed out in Murtagh (2011: 98) the information must be stored with the lexical item in a specified data structure. The result of this step is that for all tokens there will be a better sense of the word order of the string (cf. Murtagh 2011: 98).

Phase 2 – Parsing

In phase 2 the tokenized and annotated tokens are parsed and an RRG-based syntax tree in terms of a data structure is generated. As pointed out in Van Valin and LaPolla (1997: 69ff) syntactic templates as used in Van Valin and LaPolla (1997) and Van Valin (2005) are formally equivalent to an ID/LP-syntax as found in GPSG. This allows the use of an ID/LP-parser in which an extended version of an Earley

algorithm applies. This parsing method for RRG is similar to an approach which is described in Guest (2008) and in Wilson (2009). In both approaches to RRG-parsing the syntactic templates used by Van Valin are broken down to simple ID/LP rules for the corresponding language and stored as data structure in the construction repository. Once the algorithm applied the ID/LP-rules can be used and a syntax tree is generated.

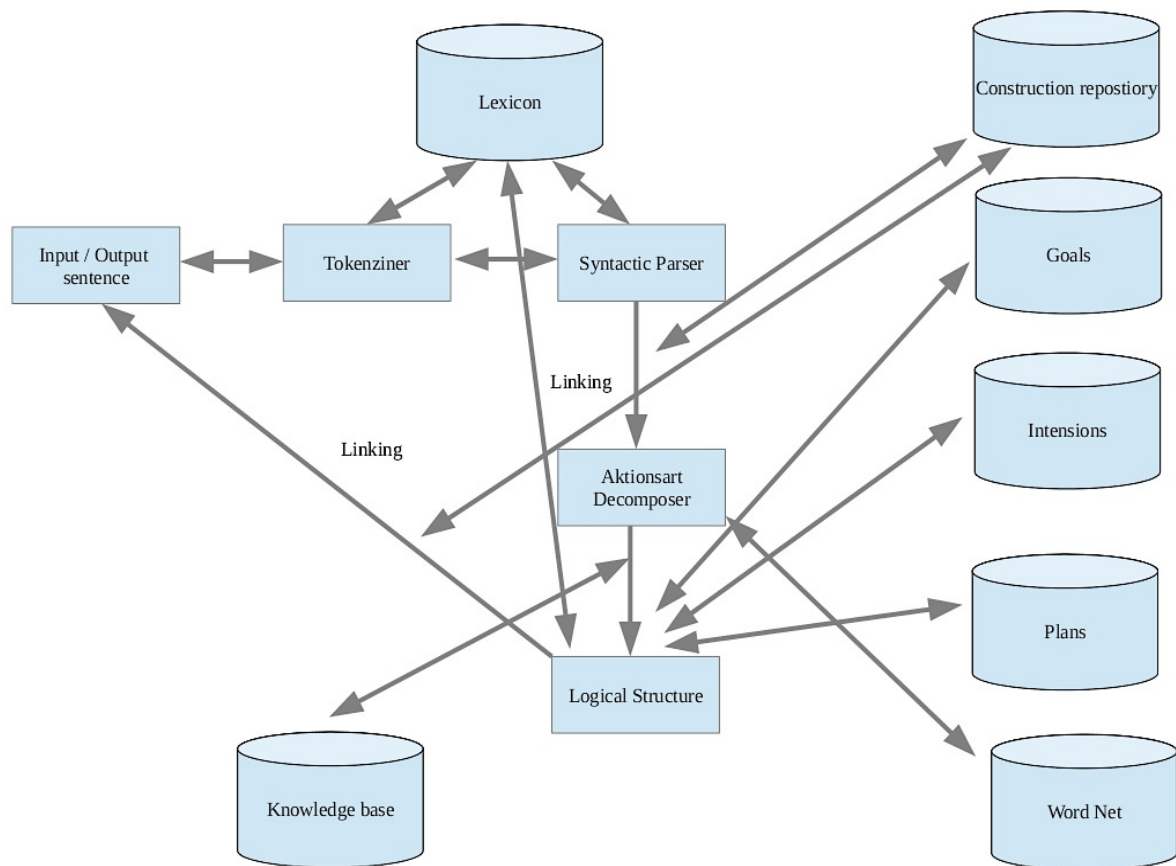


Figure 5: Architecture of the language module

Phase 3 – Linking algorithm

In phase 3 the linking algorithm is executed. For this a revised version of the linking algorithm developed in Van Valin (2005) will be used which is informed by a computational process for the generation of conceptual graphs developed in Petersen (2007). The approach here is that the ID/LP-informed trees generated in phase 2 are decomposed as conceptual graph.

The linking algorithm is actually extended to a computational processing model of RRG as initially suggested in Gottschalk (2012). Here the linking algorithm is part of what Bordini, Hübner and Wooldridge (2007: 20f) call a control loop in which the belief, desire and intention database of the teaching agent is constantly updated. In the case where the linking algorithm is activated the agent is called by the user herself and, by her question, the beliefs are updated. This way, the CG needed for language production in phase 4 is updated by a formal representation of updated

beliefs represented in the CG metalanguage. Also in this phase initial intentions that the agent has are updated in the sense of the activation of the intention to support the learner in her learning progress. In order to update intentions speech acts are used which are formally stored in the lexicon.

This idea is based on work of Austin (1962) and Searle (1969). Here speech act theory starts from the principle that language is action and that an utterance either in terms of language, or in this case in terms of extra-linguistic statistical information, is an attempt to change the world. These speech acts are used to motivate the agent to have the intention to change the world. Desires in this context are different options the agent has in order to act according to the intentions it has derived from speech acts. Speech acts in this framework are stored in terms of a limited number of hard-wired AVMs in the lexicon. Inheritance networks in the mental lexicon as well as a Wordnet-based ontology are used to be able to derive speech acts from input sentences.

If the conversational agent is called by the supervisor agent beliefs, intentions and desires are called by the statistical information derived. The conceptual graph necessary for further communication with the agent is generated by a function that can derive information from the statistical database into CGs.

Phase 4 – Semantics to Syntax linking

This step applies when the agent responds to a request from the user or when the supervisor agent has called the conversational agent. In both situations the response by the agent is informed by a CG activated in phase 3. In a first step the logical structure in form of a CG is generated and is informed by information from the beliefs, desires and intentions which have been updated in phase 3. Here the agent has used information from speech acts stored in the lexicon and generated from the input CG in phase 3. In the course of the execution of this linking algorithm the different linking steps as outlined in Gottschalk (2012) will be executed and the output sentence projected from a CG generated in response to information the agent received in phase 3.

For the generation of such a CG not only lexical information plays an important role but also discourse pragmatics applies. For this discourse representation structures in terms of AVMs as well as speech acts are used. In order to properly generate a response to the user, the Emdros database that contains information on the learning object is called. The agent this way generates its response from different sources: the beliefs, intention and desires updated in phase 3, the lexicon which it needs for the necessary vocabulary and the knowledge from the Emdros knowledge base. How this is formally and technically done is a topic for future research.

Further, this step is informed by the construction repository since, as shown in Gottschalk (2012), constructional schemas, which are like objects in a programming language and activate when the standard linking algorithm cannot apply, are needed in this step.

7. Conclusion

Based on an empirical study and its analysis with grounded theory it was possible to identify the need for feedback and support even in self-directed learners as a driving force in their learning progress and to see that there is a great need for a teaching agent which serves these desires. It was possible to show that RRG, as a functional linguistic theory, can be used as the linguistic engine for a BDI teaching agent as the RRG linking algorithm naturally fits into the conception of natural language processing. The empirical study helped to develop an architecture for a teaching agent in which communication is used for effective learning with PLOTLearner. This pedagogical approach was crucially informed by conversation theory as developed in Laurillard (2009).

The architecture of the teaching agent shows how far a descriptive linguistic theory like RRG can be translated into a computational processing model. A first starting point for this is the inclusion of speech acts to the standard theory of RRG and which can result in a computational device that actually talks.

This paper is the starting point for broad research on the development of RRG-driven teaching software and many topics like the development of a CG-based approach to the semantic representation in RRG are still under development. It will be a task for future research to formally include speech acts to RRG and to develop an ID/LP-parser for parsing in RRG.

8. References

- Austin, John L. 1962. *How to do things with words*. Oxford: Oxford University Press.
- Bordini, Rafael H, Jomi Fred Hübner and Michael Wooldridge. 2007. *Programming multi-agent systems in AgentSpeak using Jason*. West Sussex: John Wiley and Sons Ltd.
- Bratman, ME. 1987. *Intention, Plans, and Practical Reason*. Cambridge: Harvard University Press.
- Conole, G, M. Dyke, M. Oliver and J. Selle. 2004. Mapping pedagogy and tools for effective learning designs. *Computers & Education* 43: 17 – 33.
- Diedrichsen, Elke. 2008. Where is the precore slot? – Mapping the layered structure of the clause and German sentence topology. In R. D. Van Valin, Jr. (Ed.): *Investigations of the syntax-semantics-pragmatics interface*, 203 – 224. Amsterdam / Philadelphia: John Benjamins Publishing Company.
- Dowty, David (1979): *Word meaning and Montague Grammar*. Dordrecht: Reidel.
- Glaser Barney G. and Anselm L. Strauss. 1967. *The Discovery of Grounded Theory. Strategies for Qualitative Research*. London: Aldine.
- Gottschalk, Judith. 2010. Storage of linguistic knowledge in the mental lexicon: An approach within Role and Reference Grammar. *ITB Journal Issue 19*. Available at: <http://www.itb.ie/ResearchatITB/itbjournal.html>
- Gottschalk, Judith. 2012. Three-place predicates in English: Towards a unification-based computationally adequate approach to Role and Reference Grammar. *ITB Journal Issue 22*. Available at: <http://www.itb.ie/ResearchatITB/itbjournal.html>
- Guest, Elizabeth. 2008. Parsing for Role and Reference Grammar. In Van Valin, Robert D., Jr. (ed). *Investigations of the Syntax-Semantics-Pragmatics Interface*. Amsterdam: John Benjamins.
- Hanington, Bruce. 2003. Methods in the making: a perspective on the state of human research in design, *Design Issues* 19/4 (2003) 9–18.

- Keinonen, Turkka. 2009. Design Contribution Square. *Advanced Engineering Informatics* 23 (2009): 142 – 148.
- Laurillard, Diana. 2009. The pedagogical challenges to collaborative technologies. *Computer Supported Collaborative Learning*. 4: 5-20.
- Murtagh, Irene. 2011. Towards a Linguistically Motivated Irish Sign Language Conversational Avatar. *ITB Journal* Issue 19. 72 – 101.
- Petersen, Ulrik. 2007. *Genesis 1:1-3 in Graphs: Extracting Conceptual Structures from Biblical Hebrew*, SEE-J Hiphil Volume 4, [<http://www.see-j.net/hiphil>], Accessed 2007-02-19.
- Rogers, Yvonne, Helen Sharp and Jenny Preece. 2011. *Interaction Design: Beyond Human Computer Interaction*. Third Edition. New York: Wiley and Sons.
- Sanders, Elizabeth, B.-N. 2005. Information, inspiration and co-creation, in: Sixth International Conference of the European Academy of Design, March 29–31, 2005. University of the Arts, Bremen, Germany.
- Searle, John, R. 1969. *Speech Acts and Essay in the Philosophy of Language*. Cambridge: Cambridge University Press.
- Smith, Carlotta. 1997. *The parameter of aspect* (2nd edn). Dordrecht: Reidel.
- Van Valin, Robert D., Jr. 1991. Another look at Icelandic case marking and grammatical relations. *Natural Language and Linguistic Theory* 9: 145 – 94.
- Van Valin, Robert D., Jr. 2005. *Exploring the Syntax-Semantics Interface*, Cambridge: Cambridge University Press.
- Van Valin, Robert D., Jr., and Randy J. LaPolla. 1997. *Syntax: Structure, meaning and function*. Cambridge: Cambridge University Press.
- Vendler, Zeno (1969): *Linguistics in philosophy*. Ithaca: Cornell University Press.
- Wilson, Chris. 2009. Lex: A Software Project for Linguists. *Technical Report SEE-J Hiphil 6* [<http://www.see-j.net/index.php/hiphil>] (2009). Available at <http://www.see-j.net/index.php/hiphil/article/view/60>
- Winther-Nielsen, Nicolai. 2012. *Presentation at EGST* October 29, 2012.
- Wooldridge, Michael. 2002. Intelligent Agents: The key concepts. In *Proceedings of the 9th ECCAI-ACAI/EASSS 2001, AEMAS 2001, HoloMAS 2001 on Multi-Agent-Systems and Applications II Selected Revised Papers, ser. LNAI*

Appendix of sample responses

<i>Imagine the learning software could give you advice via text messages when you get stuck with an exercise would you like that - Give reasons!</i>	
Answer	Sample codes generated and notes
It would be a great help. Specially if there is links to more knowledge.	<ol style="list-style-type: none"> 1. Desire for support. 2. <u>Knowledge building</u> through links to more knowledge
Absolutely, that will be great, because it removes unnecessary waste of time and frustration in the learning process	<ol style="list-style-type: none"> 1. Reduction of frustration through timely and <u>efficient</u> support. 2. <u>Encouragement</u> through reduction of frustration
I would be helpful. To solve learning problems immediately is good.	<ol style="list-style-type: none"> 1. <u>Support</u> in leaning through immediate feedback. 2. <u>Efficiency</u> through immediate feedback

<i>Imagine you are supervised by the learning software via textual dialogues. What feedback would you like to have from the learning software - Give examples!</i>	
Answer	Sample codes generated and notes
Suggestions to where i need to improve. Information about what my most common mistakes is.	<ol style="list-style-type: none"> 1. <u>Knowledge building</u> through suggestions for improvement. 2. Display of most common mistake for <u>efficient</u> learning.
Not answered	
Just short and specific grammatical advice.	<ol style="list-style-type: none"> 1. <u>Knowledge building</u> through advice. 2. <u>Efficiency</u> through short and succinct advice.

<i>Imagine the learning software could negotiate learning outcomes with you before you do your exercises via a text messaging system and could give you feedback on how well you did on your exercises after your learning session is done, would that improve your learning progress?</i>	
Answer	Sample codes generated and notes
I think it would be an improvement to have a more direct feedback...then I can work on the problems.	<ol style="list-style-type: none"> 1. Desire for <u>support</u> through <u>feedback</u>. 2. Through <u>efficient</u> <u>feedback</u> opportunity to solve problems. 3. <u>Knowledge building</u> through <u>feedback</u>
I don't think so	<ol style="list-style-type: none"> 1. Improvement of learning through <u>feedback</u>
It's kind of hypothetical, and hard to imagine, but I think it would be beneficially.	<ol style="list-style-type: none"> 1. Improvement of learning process through <u>feedback</u>

<i>Would you like to cooperate with other learners in doing your exercises?</i>	
Answer	Sample codes generated and notes
We could compete and help each other	<ol style="list-style-type: none"> 1. Knowledge building and <u>improvement</u> of learning through <u>competition</u>. 2. Desire for <u>cooperation</u> through competition and <u>supporting each other</u>.
Discuss some topics on grammar could be helpful.	<ol style="list-style-type: none"> 1. Knowledge building through <u>collaborative discussion</u> and <u>communication</u>. 2. Efficient talking about grammatical questions to this way gaining knowledge in <u>specific areas</u>.
I work best in my own speed and level.	<ol style="list-style-type: none"> 1. Desire for self-directed learning and <u>independence</u>

<i>Imagine you get stuck and the learning software could direct you to other learners who already mastered this exercises would you like to have a cooperation - Give reasons?</i>	
Answer	Sample codes generated and notes
I think it would be a good idea.	<ol style="list-style-type: none"> 1. Desire for <u>collaboration</u> through <u>communication</u>.
Sure, if that was possible	<ol style="list-style-type: none"> 1. Desire for <u>collaboration</u> through <u>communication</u>.
The system or a student... I don't care, as long as I get help.	<ol style="list-style-type: none"> 1. Desire for <u>efficient support</u>. 2. Wish for getting <u>feedback</u>.

<i>Imagine PLOTlearner had an interactive help function which starts to communicate with you once it recognizes that you get stuck. Please state an advice.</i>	
Answer	Sample codes generated and notes
I think it would be very helpful if the system gave me feedback but I am not sure whether I would like to interact with other users.	<ol style="list-style-type: none"> 1. Desire for getting feedback. 2. Due to <u>self-directed learning</u> <u>limited desire for collaboration</u>.
Yes, it would be an advantage if I had the possibility to be supervised by the system but the question is whether it would help me to interact with other users.	<ol style="list-style-type: none"> 1. Advantage of being supervised through the system and getting feedback through interaction. 2. Questions interaction with users. Maybe <u>doubts whether the feedback is qualified</u>.

<i>Imagine you where sitting alone without a teacher and you get stuck on the exercise and the system does not have an answer for you could it then be helpful to have other users you can support you?</i>	
Answer	Sample codes generated and notes
In this case yes, if you work together with another user who has mastered the exercise and you could Skype with him this could be an advantage.	<ol style="list-style-type: none"> 1. Desire for <u>feedback</u> and support through <u>communication</u>. 2. <u>Collaboration</u> with other users is desired if it <u>supports</u> the knowledge building.

<i>Would you like to be an advisor with theses things? What if you had a system in which you could get badges?</i>	
Answer	Sample codes generated and notes
This could be a nice advantage. I think this could be a motivation for me to be an advisor and I would like to discuss problems with other users. So I think that such an interactive help function could be an advantage for me in my learning progress.	<ol style="list-style-type: none"> 1. <u>Role changing</u> is a motivation. 2. <u>Desire to communicate</u> to get <u>support</u> and support other users in their knowledge building process. 3. Help function would be desirable to get <u>feedback</u> and to have an <u>efficient way of learning</u>.
Yes, indeed that would be a help and a good system then	<ol style="list-style-type: none"> 1. Role changing through reward system is desirable. 2. Desire for <u>efficient learning</u> through feedback and <u>communication</u>.

ITB Journal



<http://www.itb.ie/ResearchatITB/itbjournal.html>