ISSN 1798-4769
Journal of Language Teaching and Research, Vol. 6, No. 2, pp. 423-428, March 2015
DOI: http://dx.doi.org/10.17507/jltr.0602.24

Carroll's Autonomous Induction Theory: Combining Views from UG and Information Processing Theories

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***Abstract*—Without other mechanisms such as induction and parsers, UG-based approaches to linguistic cognition seem to fail to explain the logical problem of language acquisition. Hence, a property theory has to be adopted to combine UG views with other cognitive mechanisms like information processing and restructuring (Ellis, 2008). Pienemann (1998, 2003)'s Processibility Theory, and Levelt's (1989) psycholinguistic theory of speech production, Jackendof's (1987, 1997, 2002) MOGUL, and Carroll's (2001, 2002) Autonomous Induction Theory (AIT) are among the models which try to add new views to the UG-based approaches. Although suffering from a number of criticisms and having a high degree of abstractness, AIT with its major premises and conceptions related to the role of induction, attention, input, input processing, feedback, learning, and UG seems to be able to explain some of the UG enigma in second language acquisition.**

***Index Terms*—Autonomous Induction Theory, autonomy, induction, feedback, constraints, input**

I. Introduction

The role of prior knowledge and mental representations in the mind of an L2 learner is a matter of debate in second language acquisition (SLA). Accordingly, Carroll (1999) has posed three classic questions depicting the problem of environmental influence on SLA: "How does a signal in the perceptual environment become evidence for learning some linguistic distinction? How is prior grammatical knowledge involved in detecting grammatical distinctions…? How are conceptual representations involved in the detection and encoding of novel grammatical features?"(p. 339)

To Carroll, acquisition is defined as the mental representation of some linguistic features at a given time, and prior to that time the learner has no mental representations which properly encode this information. On the other hand, the input presented in the environment is insufficient to this end. Even through meaningful conversations, the learner has no representations of newly-exposed forms or their morphological relationship in his mind to initially perceive and analyze the input. Hence, how much exposure to those forms is needed to be able to generalize language patterns? What initial capacity enables the learner to detect and encode discrete units in the input? In the mind of an L2 learner, the initial stage of learning seems to be the first-language (L1) grammatical knowledge which helps him or her to extract rules from L2 input. This assumption can be partially acceptable only for elder L2 learners but not the very young ones who don't have enough schemas on all topics and enough skills in their L1. Then how is this going to be explained? In structuralism it is believed that the L1 transfer hinders the representation of different units from those of the L1grammar (the strong version of contrastive analysis). Carroll (1999; p. 340) believes that "… by the notion of transfer, structuralists cast doubt on the possibility of L2 learning at all: How do learners ever represent a variety of categories if these are filtered out by the transferred grammar? How does L1 grammatical knowledge help to detect cues to the grammatical features, categories, rules, etc.?" In order to compensate for the limitations of UG-based approaches to both L1 and L2 acquisition, some scholars, mainly emergentists, have proposed models which account for both development and acquisition (Jackendof, 1987, 1997, 2002; Levelt, 1989; Pienemann 1998, 2003; Carroll 2001, 2002; Hulstijn, 2007; Ellis, 2008).

There are two types of theories to explain SLA (Greg, 1993 cited in Carroll, 2001): a property theory (giving us information on what the knowledge of an L2 is), and a transition theory (describing how this knowledge is represented in the mind of an L1 or L2 learner and how it changes). Carroll (2001) believed in the need for a property theory (such as AIT) which defines the essential properties of grammatical systems and a transition theory to entail how grammars can change. Meanwhile, AIT asserts a remarkable role for *induction* in order to be a transition theory at the same time. Carroll (2001, 2002)'s Autonomous Induction Theory not only acknowledges the existence of UG as the initial state for language acquisition but also notices the language processing mechanisms such as parsers (instead of LAD) in the gradual development of interlanguages. The AIT tries to bridge the gap between UG-based and processing-based approaches (Jordan, 2004).

II. Underlying Concepts

AIT is based on a theory of cognition i.e. Representational Modularity developed by Ray Jackendoff (1987), and a formal theory of induction referring to proposals by Holland, Holyoak, Nisbett, and Thagard (1986) cited in Carroll (2001), in their book *Induction: Processes of inference, learning and discovery*.

The Representational Modularity model claims that cognitive universals (such as UG) tend to explain what people know about language and how they come to know it. UG is regarded as one of the several types of universals within the human cognitive system. AIT is derived from the Representational Modularity in that every representable concept in our conceptual systems cannot be encoded through phonological or morphosyntactic systems i.e. there are severe constraints on the conceptual system in the mind. Unlike many other theories, negative evidence is believed to be important in AIT. Feedback and correction mentally represented in conceptual representations can affect the grammatical restructuring.

Carroll attributes an important role to UG but to her, rather than containing a set of principles and rules, UG is constrained by other processing mechanisms. UG merely explains how learners possess the knowledge of grammar from first place. Then the notion of "access to UG" seems to be futile. In addition, LAD is not viewed as a box containing UG. In AIT, LAD is regarded as a processing mechanism responsible for some unconscious mental operations, such as "Unification" (Carroll, 2007, p. 155), which finally lead to the restructuring of grammars. LAD cannot perform the exact structural operations like a speech processor or a language parser.

Carroll believes that it is also possible to adopt a universalist/rationalist position without rejecting induction and committing to the UG- only claim (inductivist approaches). The solution is then to carefully distinguish between UG's function in the property and transition theories and regard it not as a unique mechanism of language acquisition. AIT seems to show how induction is constrained and how it does not lead to rogue grammars as a by-product of induction (Carroll, 2001). Inductivists (mainly functionalists) who believe in the Principles and Parameters theory reject induction as, in case of existing, it leads to wild grammar; as there are no rogue grammars because of access to UG during the SLA process, induction is refuted.

In AIT, difficulties in learning a second language are due to parsing problems. Learning is triggered by a failure to process incoming stimuli (Gass & Selinker, 2008). Parsing is a categorization of phonological items into some meaningful units (e.g., lexical, functional, syntactic) through assigning appropriate relationships.

III. The Autonomy Hypotheses In AIT

The *Autonomous* part of AIT refers to transfer and speech processing (Carroll, 1999). Autonomy can have various interpretations within AIT:

a) AIT hypothesizes that all signal processing operations and the parsing of intermediate representations are automatically transferred. If some dissimilar features are present between the two languages involved, an immediate parsing failure will take place. A good example of this notion is the case of dialects of the same language which have such inherent similarities that facilitate processing and lead to lexical activation. It is worth mentioning that in case the dialects of the same language do not have enough similarities, an inter-dialect unintelligibility may occur and some aspects of L1 acoustic-prosodic processing may transfer. All these operations take place autonomously and unconsciously.

b) In another sense, autonomy entails that human cognition is encoded in a variety of autonomous representational systems. Each autonomous system may associate with a distinct domain of knowledge. A representational system is regarded autonomous when it consists of at least some unique constituents, and principles of organization. Each representational system has its own syntax and structure. It is possible that a representation of one kind influence the organization of other representations provided that it is constrained by correspondence rules to allow the translation of constituents and structures from one representational system into another. Otherwise, no cross-system influence can occur.

IV. Induction in AIT

The basis for the development of AIT is the Induction Theory of Holland et al. (1986) cited in Carroll (2001); however, induction in AIT is regarded autonomous and interpreted in a way that its certain components operate autonomously within the theory of modularity. In order to show this difference, induction in AIT is called *i-learning* by Carroll (2001). L1 and UG-based researchers and generativists, who believe in the core grammar and nonexistence of rouge grammars, claim that induction leads to wild grammar due to the lack of appropriate constraints (Lardiere, 2004). Carroll (2001) distinguishes between induction in AIT and other types of induction as:

"Induction is a process which leads to the revision of representations so that they are consistent with information currently represented in working memory. Its defining property is that it is rooted in stimuli made available to the organism through the perceptual systems, coupled with input from LTM and current computations. I-learning is, however, different from mechanistic responses to environmental change in that the results of i-learning depend upon the contents of symbolic representations. "(p.131)

Holland et al. (1989: p. 10 cited in Carroll, 2001), describe induction as…" problem-solving. Problem-solving in turn is defined as a search through a mentally represented space."

Since interlanguages do not display crazy rules or rogue grammars, it is believed that principles of UG, like parameter setting, must have been operated in L2 acquisition and that induction can only be unconstrained and necessarily leads to crazy rules. The "no-constraint", "no-UG problem" (Carroll, 2002, p. 241) tends to be the major concern of induction. Even within models of cognition with their emphasis on unspecialized general processor, it has not been shown that hypothesis testing and induction should not be random. Carroll believes that induction must be taken seriously as a solution to the representational problem in SLA. Although, Carroll (2002) argues that nowhere in the literature is shown and explained that induction is never and could not be constrained.

Carroll accepts that UG can explain some of the primitives available to the L1 grammar and parsers and also constraints structure-building. To her, Induction alone will not explain these properties. Induction can be used to explain grammar restructuring and how learners move along an unanalyzed speech continuum of phonetic, phonological, morphosyntactic and semantic representations. Neither Grammar-based nor developmental research was able to explain fully how L2 learners are able to encode a particular kind of grammatical representation when facing a particular kind of stimulus. Rather, SLA involves essentially some Meta processes such as classification or encodings, reclassification or reorganizing the cues for a classification, distributional analysis, and structure-building processes which are explainable through I-learning.

Carroll draws a distinction between inductive reasoning and inductive learning:

Inductive reasoning takes place in that part of the mind computing conceptual structures. It is associated with problem-solving as a form of inferencing.

Inductive learning (i-learning) affects representations within the autonomous systems of the language faculty.

Carroll's version of "… inductive learning (i-learning) is initiated when we fail to parse incoming language stimuli adequately using our existing mental representations and analysis procedures." (Mitchell & Myles, 2004, p. 189-190). Inductive learning means learning through generalization from examples. The concept of i-learning in AIT differs from other inductive language learning theories such as the Competition Model in that it is constrained by the strongly-resistant-to-change preexisting mental representations of language.

V. Constraints on I-learning

Carroll's theory of learning is a highly constrained one. It includes various kinds of operations by classifier systems and a set of conditions that must be satisfied for an operation to take place. Imposing constraints on operations seems to be the central issue for any theory of SLA (Carroll, 2002). Many of these are extracted from the functional architecture of mind and some assumptions about language processing. The most important constraint on linguistic operations in our mind is the adoption of the Autonomy Hypotheses which was mentioned above. The autonomy of our faculty representational systems derives from our genetic endowment.

There are constraints in generating new hypotheses in that the learning mechanisms create minimally different representations. These constraints cause i-learning to be organized rather than random. Carroll (2001, p. 192-195) proposes five versions of such constraints in i-learning and each constraint on i-learning precedes and builds a basis for the next constraint until the final version, i.e. version 5. The final version of constraints on i-learning assert that there must be constraints on the ways in which the hypotheses generating system interacts with the autonomous linguistic representational systems' grammar.

VI. Perception and Attention in AIT

Schmidt (1990) introduced various uses of the term *attention*: attention-as-detection, attention-as-noticing, and attention-as-conscious-awareness. However, Lehiste (1970 cited in Carroll, 1999) argued that it is possible to have speech-signal processing without attention-as- noticing or attention-as-awareness. Learners may unconsciously and without awareness detect, encode and respond to linguistic sounds. Language users are not always consciously aware of their own mental representations. They don't always notice their own processing of segments and the internal organization of their own conceptual representations. It is possible for learners to notice when they are told to or focused on a property in the input. If they didn't get the point, they can ask for clarifications. The underlying semantic conditioning and processing of forms and meanings are not noticed by language users or learners. Then in AIT, *attention* is the result of processing not a prerequisite for parsers to process (Sun, 2008).

VII. The Role of Input in AIT

Since input serves several purposes in Carroll's theory, its role seems to be complicated (Gass, 2010). In Carroll's theory, intake and input, and not stimulus, are both regarded as mental constructs. Unlike many scholars in the field, Carroll makes a distinction between stimulus and input in that the former is more important and is something in the external environment. To Carroll, prior research on input processing has failed to explain how stimuli become intake. Hence a conceptual framework to account for the nature of signal processing and linguistic parsing is needed. This

framework will reflect the difference between 'input to processing' and 'input to language learning' (Rast, 2008). Three types of input are given by Carroll (2007) which play a role in acquisition:

- *Input-to-processing mechanisms* which are the actual data that serves as stimuli for learning.
- *Input-to-language- learning mechanisms*: When the phonetic processor which creates a structured prosodic representation as output using the speech signal as input. The resulting representation activates a lexical entry of the word in the mental lexicon. Then, the morphosyntactic processor uses the information in the activated lexical entry in the structure of the sentence.
- *Input-to-the-LAD* which is inserted into the LAD and for further restructuring of the L2 system.

Learning is input-driven, in that when parsing of the input fails to analyze the input data, learning is triggered. Albeit, the parser does not fail completely, some parts of the input will be interpreted and the unanalyzed parts of speech will be ignored. Otherwise, the total failure of the parser would block the detection of the problematic parts by L2 learners and consequently would result in a failure to trigger learning. Also it may be possible that during the initial phases of L2 acquisition, L1 parsing and production procedures will transfer (Meisel, 2011).

VIII. Processing in AIT

Speech processing in AIT starts with the auditory signal and is supposed to end with a conceptual representation. When people are exposed to input either linguistic or non-linguistic input, they are able to grasp both the meaning (the intention to communication) and the form of the message (how it has been articulated). Input enters speech processing system through the auditory signal, and the next link in the output of the first stage of speech processing which serves as input to the next stage.

AIT emphasizes comprehension over attention (Sun, 2008). As mentioned before, human language faculty is comprised of a chain of representations the lowest levels of which interact with physical stimuli, and the highest levels interact with conceptual representations. There are two types of processors which operate at each level of representation and form a sequential module:

- *The integrative processor* which is responsible for combining smaller representations into larger units,
- *The correspondence processor* which moves the representations from one level to the next.

UG-based or long-term memory-based rules are then responsible for the categorization and combination of the representations at each level of the module. This is how input is processed for parsing. Hence, there are two types of processing related to the two processors: processing for parsing, and processing for acquisition. Carroll (2004) proposes these processing assumptions of the AIT to show how entirely novel grammatical knowledge and parsing abilities can be. Speech processing in AIT has the following characteristics which distinguish it from other theories (Carroll, 2001):

Language processing in AIT is both autonomous and interactive with various representational systems.

Speech processing is both bottom-up and top-down.

There are different types of input related to the level of representation within the processing system e.g. input to processing and input to learning.

Novel encoding of information is triggered by on-line events related to the processing of a speech stimulus.

The novel encoding of information occurs when parsing fails.

"The linguistic stimuli, regardless of the linguistic source (L1 or L2) will be analyzed by the same language processors which parse L1 stimuli. There is no reason to assume that second language stimuli are not processed by the same mechanisms which process primary language stimuli, (otherwise)…it would be impossible to learn a second language" (p.190).

One of the processing assumptions proposed by Carroll is the Uniform Parsers Hypothesis: "Linguistic stimuli are processed by the same parsers regardless of the origin of the stimuli." (Carroll, 2001, p.190)

At the beginning of processing, the same parsing procedures as L1will be applied to L2 stimuli systematically and automatically based on the structural information encoded in the representational systems of the L1 grammar.

The fact that interlanguage cognition is going to display sensitivity to structural relations (such as c-command, dominance and sisterhood) is because of the operation of the Uniform Parsers Hypothesis and the Autonomy Hypotheses.

IX. Learning in AIT

Learning in AIT is deeply related with induction. UG provides the basic features of representations. Another function of UG is putting constrains on the combination of formal features. Also, it is assumed that some functional considerations are used to be combined with formal constraints e.g. when the combination of two sounds is impossible due to articulation problems. There are some universal constraints on how a syllable will form through the combination of segments. These categories and constrained are learned at any level of analysis. Hence learning a language either first, second, or third entails the learning of these category types as well as the related constraints and segmentation rules. Therefore, a theory of learning is required to explain how learners learn these categories. However, the AIT denies the idea of a general theory of learning for linguistic categories and also explicitly opposes the existence of general problem-solving mechanisms. Induction can take the place of general problem-solving mechanisms in that it can

recombine features to create new categories in limited ways. Induction can be constrained by the formal and functional universals of UG. Induction can also help learners to reorganize the positions of units in a structure category and combine new units into existing categories (e.g. the expansion). However, the learning of new types of operations (within the integrative processors) cannot be possible through induction. In fact, AIT assumes that no operation could be learned. The only learnable things are the categories which enter into equations, and the cues to identify these categories.

A major part of learning a new language is learning new cues to cross-level correspondences. These correspondences may not be the same among the world's languages. Carroll (1999) defines learning developmentally as the point beyond which no more restructuring and re-representation may take place. The definition given by Carroll is exactly the opposite of the notion of fossilization by Selinker (1972, cited in Carroll, 1999).

X. Conclusion

AIT shares some views with some other theories such as the Competition Model but is unique in some other ways which have been discussed earlier in this paper. These distinguishing features were described in terms of the role and the perception of each from the AIT point of view. Empirical investigation related to these AIT notions is fledgling and there is much work to be done with this regard (VanPattern, & Williams, 2007). Despite the new insights that theories like AIT provide for SLA by approaching the explanation of learning mechanisms through a different angle, they suffer from a number of demerits. For example, Ellis (2008, p.631) argues that "… these proposals are programmatic; they do not provide precise specifications of how UG and general cognitive mechanisms interact to shape learning."

Moreover, inductivists who believe in the P&P theory criticize the induction proposed by Carroll on the basis of the claim that there are no rogue grammars as a result of access to UG, and that induction leads to wild grammar. They believe that being unconstrained is an essential property of induction.

P & P is criticized by Carroll (2001) as: It not only fails to explain why language learning begins since it is not connected to a theory of perception and language processing, but also fails to explain the variability in L2 acquisition in that some phenomenon at a given point in time are acquired but not others. What are the triggers for parameters? Carroll (2001) also criticizes McWhinny (1987)'s Competition Model in that triggers in P&P theory are like cues to the Competition Model. The Competition Model needs more serious research into the nature of linguistic knowledge. As an alternative to these two theories, Carroll (2001, 2002) proposes the Autonomous Induction Theory. Unlike many learning models in psychology, Carroll does not think that the learner's mental representations reflect the environment in some ways. AIT is concerned with explaining learners' linguistic competence in terms of change in their mental grammar through the activities of psychological mechanisms such as LAD (Carroll, 2007).

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