

العنوان:	النماذج النفسية اللغوية لمعالجة النص : تحليل الخطاب من منظور معرفي : بحث باللغة الإنجليزية
المصدر:	حوليات الآداب والعلوم الاجتماعية
الناشر:	جامعة الكويت - مجلس النشر العلمي
المؤلف الرئيسي:	محمد، محمد طه
المجلد/العدد:	الحولية 27, الرسالة 261
محكمة:	نعم
التاريخ الميلادي:	2007
الشهر:	يونيو
الصفحات:	6 - 82
رقم MD:	476913
نوع المحتوى:	بحوث ومقالات
قواعد المعلومات:	EduSearch, AraBase
مواضيع:	النظريات النفسية، مستخلصات الأبحاث ، علم النفس التربوي، علماء النفس ، نظرية المجال العقلي، الدلالات اللغوية
رابط:	<a href="http://search.mandumah.com/Record/476913">http://search.mandumah.com/Record/476913</a>

الرسالة ٢٦١

**النماذج النفسية اللغوية لمعالجة النص  
تحليل الخطاب من منظور معرفي  
( بحث باللغة الإنجليزية )**

**د. محمد طه محمد**

قسم علم النفس - جامعة عين شمس  
جمهورية مصر العربية

حوليات الآداب والعلوم الاجتماعية - الحولية السابعة والعشرون - ١٤٢٨هـ / ٢٠٠٧م

**المؤلف:****د. محمد طه محمد**

- حصل على درجة الدكتوراه في علم النفس المعرفي من جامعة ماساتشوستس بالولايات المتحدة عام ٢٠٠٣. تخصص علم اللغة النفسي.
- أستاذ مساعد علم النفس واللغويات. كلية الآداب والعلوم. جامعة أبو ظبي. الإمارات. مدرس علم النفس. كلية الآداب. جامعة عين شمس. القاهرة. مصر.

**الإنتاج العلمي:****أبحاث باللغة العربية:**

- ١ - محمد طه (١٩٩٦). معالجة المعلومات. نشرة رابطة الأخصائيين النفسيين المصرية. عدد ٣٧، ص: ٦ - ٧.
- ٢ - وليام ر. ميللر وكارل أ. ثوريسن (تأليف) **محمد طه** (ترجمة) (٢٠٠٤). الروحانية والدين والصحة: مجال بحثي بازغ. مجلة الثقافة العالمية: المجلس الوطني للثقافة والفنون والآداب. دولة الكويت. العدد ١٢٣ مارس - أبريل.
- ٣ - محمد طه (٢٠٠٤). أزمة العلوم الاجتماعية والصراع العربي الإسرائيلي. في عبدالحليم عطية (تحرير)، في عالم عبدالوهاب المسيري. تقديم: محمد حسنين هيكل. دار الشروق. القاهرة.
- ٤ - محمد طه (مقبول للنشر). علم المعرفة: آفاق جديدة في دراسة العقل. مجلة عالم الفكر. المجلس الأعلى للثقافة والفنون والآداب. دولة الكويت.

**أبحاث باللغة الإنجليزية:**

- 1 - Mohamed, M. T., (2001). *Word Order in Arabic: A Psycholinguistic Exploration*. Unpublished Manuscript. University of Massachusetts, Amherst.
- 2 - Mohamed, M. T., & Clifton, C. (March, 2001). The effect of Interaction between Sentence and Text on Syntactic Ambiguity. *Poster Presented at 14<sup>th</sup> CUNY Conference on Human Sentence Processing, Philadelphia, PA.*
- 3 - Clifton, C., Traxler, M. J., **Mohamed, M. T.**, Williams, R. S., Morris, R. K., & Rayner, K. (November, 2002). The Use of Thematic Role Information in Parsing: Syntactic Processing Autonomy Revisited. *Paper Presented at 43<sup>rd</sup> Annual Meeting of the Psychonomic Society, Kansas City, Missouri.*
- 4 - Mohamed, M. T. (2003). Deductive Causal Relations. In Luis Alonso-Ovalle (Ed.). *On Semantic Processing*. UMOP. No. 27, 167 - 187.
- 5 - Clifton, C., Traxler, M. J., **Mohamed, M. T.**, Williams, R. S., Morris, R. K., & Rayner, K. (2003). The Use of Thematic Role Information in Parsing: Syntactic Processing Autonomy Revisited. *Journal of Memory and Language, 49*, 317 - 334.
- 6 - Mohamed, M. T., & Clifton, C. (November 2004). Causal Relations: Conceptual Determinants. *Poster Presented at 45<sup>th</sup> Annual Meeting of the Psychonomic Society, Minneapolis, Minnesota.*
- 7 - Mohamed, M. T., & Clifton, C. (submitted). Processing Causal Relations: Theoretical Refinements and Conceptual Determinants.

## الملخص

يعرض هذا البحث بالمناقشة والتقويم النماذج اللغوية النفسية لفهم الخطاب، التي قدمها علماء النفس المعرفيون واللغويون. وتغطي النماذج النفسية الاتجاهات قاعدية الأساس bottom-up (مثل نماذج كنتش، والنماذج القائمة على الذاكرة) والاتجاهات كلية الأساس top-down (مثل النماذج العقلية والنماذج التكوينية). أما النماذج اللغوية، فقد مثلت كلاً من الاتجاه التقليدي في علم اللغة مثل نظرية تغيير الملف لهايم Heim ، واتجاه اللغويات المعرفية مثل نظرية المجال العقلي لفوكنييه Fauconnier ، فبعد مقدمة قصيرة في مفهوم الخطاب وملامحه ودلالة الاتجاه المعرفي في دراسة اللغة، تم عرض ومناقشة النماذج النفسية واللغوية لفهم النص ومناقشتها؛ حيث عرضت الخصائص الرئيسية لكل نموذج والخلفية النظرية له بالإضافة إلى أساسه الإمبريقي وتقويم مختصر له. أما القسم الأخير من الدراسة فقد خصص لتلخيص أوجه الاتفاق والاختلاف بين النماذج وإمكانية التكامل بينها.

- Talmy, L. (2000). *Toward a Cognitive Semantics*. Vol 1. The MIT Press.
- Thorndyke, P. W. (1977). Cognitive Structures in Comprehension and Memory of Narrative Discourse. *Cognitive Psychology*, 9, 77-110.
- Trabasso, T., and van den Broek, P. (1985). Causal thinking and the representation of narrative events. *Journal of Memory and Language*, 24, 612-630.
- Trabasso, T., van den Broek, P., and Suh, S.Y. (1989). Logical Necessity and Transitivity of Causal Relations in Stories. *Discourse Processes*, 12, 1-25.
- Trabasso, T., and Sperry, L. (1985). Causal Relatedness and Importance of Story Events. *Journal of Memory and Language*, 24, 595-611.
- Van Dijk, T., and Kintsch, W. (1983). *Strategies of Discourse Comprehension*. New York: Academic Press.
- Zwaan, R. A., Langston, M. C., and Graesser, A.C. (1995). The Construction of Situation Models in Narrative Comprehension: An Event- Indexing Model. *Psychological Science*, 6, 292-297.
- Zwaan, R. A., and Radvansky, G. A. (1998). Situation Models in Language Comprehension and Memory. *Psychological Bulletin*, 123, 162- 185.

- O'Brien, E., and Myers, J.L. (1999). Text Comprehension: A view from The Bottom Up. In S. R. Goldman, and A. C. Graesser (Eds.), *Narrative Comprehension, Causality, and Coherence: Essays in Honor of Tom Trabasso*, (pp. 35-53), Lawrence Erlbaum Associates, Inc.
- O'Brien, E., Plews, S., and Albrecht, J. (1990). Antecedent Rehearsal Processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 241-249.
- O'Brien, E. J, Rizzella, M. L, Albrecht, J. E, and Halleran, J. G. (1998). Updating a Situation Model: A Memory-Based Text Processing View. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 24, 1200-1210.
- Rickheit, G., and Habel, C. (Eds.), (1999). *Mental Models in Discourse Processing and Reasoning*. Elsevier Science B. V.
- Sanford, A., and Garrod, S. (1998). The Role of Scenario Mapping in Text Comprehension. *Discourse Processing*, 26, 159-190.
- Sanford, A., Moar, K., and Garrod, S. (1988). Proper Names as Controllers of Discourse Focus. *Language and Speech*, 31, 43-56.
- Sanford, A., and Moxy, L. (1999). What Are Mental Models Made Of? In G. Rickheit, and C. Habel (Eds.), *Mental Models in Discourse Processing and Reasoning*, (pp. 57-76), Elsevier Science B. V.
- Singer, M., Graesser, A. C., and Trabasso, T. (1994). Minimal or Global Inference During Reading. *Journal of Memory and Language*, 33, 421-441.
- Skinner, B. (1957). *Verbal Behavior*. Englewood Cliffs, N.J.: Prentice-Hall.
- Sternberg, R. (1996). *Cognitive Psychology*. Holt, Rinehart and Winston, Inc.
- Suh, S., and Trabasso, T. (1993). Inferences During Reading: Converging Evidence from Discourse Analysis, Talk Aloud Protocols, and Recognition Priming. *Journal of Memory and Language*, 32, 279-300.

- McKoon, G., and Ratcliff, R. (1998). Memory-Based Language Processing: Psycholinguistic Research in The 1990s. *Annual Review of Psychology*, 49, 1998, 25-42.
- Miller, G. (1962). Some Psychological Studies of Grammar. *American Psychologist*, 17, 748-762.
- Miller, G. (1965). Some Preliminaries to Psycholinguistics. *American Psychologist*, 20, 15-20.
- Mohamed, M. T. (2001). Word Order in Arabic: A Psycholinguistic Exploration. Unpublished Manuscript. University of Massachusetts, Amherst.
- Morrow, D. G., Bower, G. H., and Greenspan, S. L. (1989). Updating Situation Models During Narrative Comprehension. *Journal of Memory and Language*, 28, 292- 312.
- Morrow, D. G., Greenspan, S. L., and Bower, G. H. (1987). Accessibility and Situation Models in Narrative Comprehension. *Journal of Memory and Language*, 26, 165-187.
- Myers, J., and O'Brien, E. J. (1998). Accessing the Discourse Representation During Reading. *Discourse Processes*, 26, 131-157.
- Myers, J., O'Brien, E. J., Albrecht, J. E., and Mason, R.A. (1994). Maintaining Global Coherence During Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 20, 876 - 886.
- O'Brien E., and Albrecht, J. (1992). Comprehension Strategies in the Development of a Mental Model. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 777-784.
- O'Brien E., Albrecht, J., Hakala, C., and Rizzell, M. (1995). Activation And Suppression of Antecedents During Reinstatement. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 626 - 634.
- O'Brien, E., and Myers, J.L. (1985). When Comprehension Difficulty Improves Memory for Text. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 11, 12-21.

- Theoretical Perspectives*. Stanford, CA: Stanford University Press.
- Langacker, R. W. (1991). *Foundations of Cognitive Grammar: Vol 2. Descriptive Applications*. Stanford, CA: Stanford University Press.
- Langston, M., and Trabasso, T. (1999). Modeling Causal Integration and Availability of Information During Comprehension of Narrative Text. In H. van Oostendrop, and S. R. Goldman (Eds.), *The Construction of Mental Representation During Reading*, (pp. 29-71), Lawrence Erlbaum Associates, Inc.
- Lorch, R.F. (1998) Memory-Based Text Processing: Assumptions and Issues. *Discourse Processes*, 26, 213-221.
- Malmkjaer, K. (1991). Discourse and Conversational Analysis. In Malmkjaer, K. (Ed.), *The Linguistics Encyclopedia*, (pp. 100-110), Routledge.
- Mannes, S. (1994). Strategic Processing of Text. *Journal of Educational Psychology*, 86, 577-588.
- Matthews, P. (1997). *The Concise Oxford Dictionary of Linguistics*. Oxford University Press.
- Mckoon, G., Gerrig, R., and Greene, S. B. (1996). Pronoun Resolution Without Pronouns: Some Consequences of Memory-Based Text Processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 22, 919-932.
- Mckoon, G., and Ratcliff, R. (1990). The Comprehension Processes And Memory Structures Involved in Anaphoric Reference. *Journal of Verbal Memory and Verbal Behavior*, 19, 668-682.
- Mckoon, G., and Ratcliff, R. (1992). Inference During Reading. *Psychological Review*. 99, 440-466.
- Mckoon, G., and Ratcliff, R. (1995). The Minimalist Hypothesis: Directions for Research. In G. Weaver, S. Mannes, and C. Fletcher (Eds.), *Discourse comprehension: Essays in Honor of Walter Kintsch*, (pp. 97-116), Hillsdale, NJ: Lawrence Erlbaum Associates.



- Kintsch, W. (1988). The Use of Knowledge in Discourse Processing: A Construction-Integration Model. *Psychological Review*, 95, 163-182.
- Kintsch, W. (1992). How Readers Construct Situation Models for Stories: The Role of Syntactic Cues and Causal Inferences. In A. F. Healy, S. M. Kosslyn, and R. M. Shiffrin (Eds.), *From Learning Processes to Cognitive Processes: Essays in Honor of William Estes*, (pp. 135-155), London: Lawrence Erlbaum Associates, Ltd.
- Kintsch, W. (1994). Text Comprehension, Memory, and Learning. *American Psychologist*, 49, 294-303.
- Kintsch, W. (1998). *Comprehension: A Paradigm for Cognition* Cambridge University Press.
- Kintsch, W., and Van Dijk, T. A. (1978). Toward a Model of Text Comprehension and Production. *Psychological Review*, 85, 363-394.
- Klin C., and Myers, J. (1993). Reinstatement of Causal Information During Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19, 554 - 560.
- Kuhn, T. (1968). *The Structure of Scientific Revolution*. Chicago: University of Chicago Press.
- Lakoff, G., and Sweetser, E. (1994). *Forward*. [to the second edition of Fauconnier's *Mental Spaces*], Cambridge University Press.
- Lakoff, G., and Thompson, H. (1975). Introducing Cognitive Grammar. *Proceedings of the First Annual Meeting of the Berkeley Linguistic Society*.
- Lakoff, G., and Thompson, H. (1975). Dative Questions in Cognitive Grammar. *Papers from The Parasession on Functionalism*, 337-350. Chicago: Chicago Linguistics Society.
- Langacker, R. W. (1986). An Introduction to Cognitive Grammar. *Cognitive Science*, 10, 1-40.
- Langacker, R. W. (1987). *Foundations of Cognitive Grammar: Vol 1*.

- Hintzman, D. (1986). "Schema Abstraction" in Multiple-Trace Memory Model. *Psychological Review*, 93, 411-428.
- Huitema, J. S., Dopkins, S., Klin, C. M., and Myers, J. L. (1993). Connecting Goals and Action During Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19, 1053-1060.
- Jackendoff, R. (1983). *Semantics and Cognition*. The MIT Press.
- Jackendoff, R. (1987). *Consciousness and the Computational Mind*. MIT Press.
- Jackendoff, R. (1990). *Semantic Structures*. MIT Press.
- Jackendoff, R. (1997). *The Architecture of Language Faculty*. The MIT Press.
- Johnson-Laird, P. N. (1983). *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Harvard University Press.
- Kamp, H. (1981). A Theory of Truth and Semantic Representation. In T. J. Groenendijk, and M. Stokhof (Eds.), *Formal Methods in the Study of Language*, (pp. 277-322), Amsterdam: Mathematical Centrum.
- Karttunen, L. (1976). Discourse Referents. In J. McCawley (Ed.), *Notes from the Linguistic Underground, Syntax and Semantics 7*, (pp. 363-385), Academic Press: New York.
- Kashak, M. P., and Glenberg, A. M. (2000). Constructing Meaning: The Role of Affordances and Grammatical Construction in Sentence Comprehension. *Journal of Memory and Language*, 43, 508-529.
- Kashak, M. P., and Glenberg, A. M. (2001). Grammatical Constructions and Language Comprehension: The Case of The Way-Construction. *A Poster Presented in 14<sup>th</sup> CUNY Conference*, Philadelphia.
- Kintsch, W. (1974). *The Representation of Meaning in Memory*. Hillsdale, NJ: Lawrence Erlbaum Associates.

- Functionality of Memory-Based Text Processing. *Discourse Processes*, 26, 67-86.
- Gillund, G., and Shiffrin, R. (1984). A Retrieval Model for Both Recognition and Recall. *Psychological Review*, 93, 1-67.
- Glenberg, A. M., Kruley, P., and Langston, W. E. (1994). Analogical Processes in Comprehension: Simulation of Mental Models. In M. A. Gernsbacher (Ed.), *Handbook of Psycholinguistics*, (pp. 133- 187), San Diego, CA: Academic Press.
- Glenberg, A. M., Meyer, M., and Lindem, K. (1987). Mental Models Contribute to Foregrounding During Text Comprehension. *Journal of Memory and Language*, 26, 69-83.
- Goldberg, A. (1995). *Constructions: A Construction Grammar to Argument Structure*. Chicago: University of Chicago Press.
- Graesser, A., and McMahan, C. (1993). Anomalous Information Triggers Questions When Adults Solve Quantitative Problems and Comprehend stories. *Journal of Educational Psychology*, 85, 136-151.
- Graesser, A., Singer, M., and Trabasso, T. (1994). Constructing Inferences During Narrative Text Comprehension. *Psychological Review*, 101, 371-395.
- Greene, S. B., McKoon, G., and Ratcliff, R. (1992). Pronoun Resolution and Discourse Models. *Journal of Experimental Psychology, Learning, Memory, and Cognition*, 18, 266-283.
- Guzman, A.E., and Klin, C. M. (2000). Maintaining Global Coherence in Reading: The Role of Sentence Boundaries. *Memory and Cognition*, 28, 722-730.
- Heim, I. R. (1982). *The Semantics of Definite and Indefinite Noun Phrases*. Ph.D. dissertation. UMass, Amherst. GLSA.
- Heim, I. R. (1983). File Change Semantics and the Familiarity Theory of Definiteness. In B. Rainer, C. Schwartze, and A. von Stechow (Eds.), *Meaning, Use, and Interpretation of Language*, (pp. 164-189), Berlin: de Gruyters.

- Language*, 35, 26-58.
- Fauconnier, G. (1994). *Mental Spaces: Aspects of Meaning Construction in Natural Language*, 2<sup>nd</sup> edition. Cambridge University Press.
- Fauconnier, G. (1997). *Mappings in Thought and Language*. Cambridge University Press.
- Fauconnier, G., and Turner, M. (1996). Blending As a Central Process in Grammar. In A. Goldberg (Ed.), *Conceptual Structure Discourse, and Language*, (pp. 113-130), CSLI Publications.
- Fauconnier, G., and Turner, M. (1998). Conceptual Integration Networks. *Cognitive Science*, 22, 133-187.
- Gardner, H. (1984). *The Mind's New Science: A History of the Cognitive Revolution*. Basic Books, Inc., Publishers: New York.
- Garnham, A. (1996). Discourse Comprehension Models. In T. Dijkxstra, and K. D. Smedt (Eds.), *Computational Psycholinguistics: IA and Connectionist Models of Human Language Processing*, (pp. 221-246), London: Taylor & Francis.
- Garnham, A. and Oakhill, J. (1992). Discourse Processing and Text Representation from a "Mental Models" Perspective. *Language and Cognitive Processes*, 7, 193-204.
- Garrod, S., and Sanford, A. (1983). Topic Dependent Effects on Language Processing. In G.B. Flores d'Arcais, and R. Jarvella (Eds.), *The Process of Language Comprehension*, (pp. 271-296), Chister, England:Wiley.
- Garrod, S., and Sanford, A. (1999). Incrementality in Discourse understanding. In H. van Oostendrop, and S. R. Goldman (Eds.), *The Construction of Mental Representation During Reading*, (pp. 3- 27), Lawrance Erlbaum Associates, Inc.
- Garrod, S., and Terras, M. (2000). The Contribution of Lexical and Situational Knowledge to Resolving Discourse Roles: Bonding and Resolution. *Journal of Memory and Language*, 42, 526-544.
- Gerrig, R.J, and McKoon, G. (1998). The readiness Is All: The

## 5. References

- Albrecht, J. E., and Myers, J.E. (1995). The Role of Context in Accessing Distant Information During Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 1459 - 1468.
- Albrecht, J. E., and O'Brien, E. J. (1993). Updating a Mental model: Maintaining Both Local and Global Coherence. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19, 1061 - 1070.
- Albrecht, J. E., and O'Brien, E. J. (1995). Goal Processing And the Maintenance of Global Coherence. In R. F. Lorch Jr, and E. J. O'Brien. (Eds.), *Sources of Coherence in Reading*, (pp. 263-278). Hillsdale, NJ: Erlbaum.
- Albrecht, J. E., O'Brien, E., Mason, R., and Myers, J. E. (1995). The Role of Perspective in the Accessibility of Goals During Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 364 - 372.
- Baars, B. (1986). *The Cognitive Revolution in Psychology*. New York: Guilford Press.
- Bransford, J. Barclay, J. and Franks, J. (1972). Sentence Memory: A Constructive versus Interpretive Approach. *Cognitive Psychology*, 3, 193-209.
- Van den Broek, P. (1988). The Effects of Causal Relations and Hierarchical Position on The Importance of Story Statements. *Journal of Memory and Language*, 27, 1-22.
- Brown, A., and Smiley, S. (1977). Rating the Importance of Structural Units of Prose Passages: A Problem of Metacognitive Development. *Child Development*, 48, 1-8.
- Chomsky, N. (1957). *Syntactic Structures*. The Hague: Mouton.
- Chomsky, N. (1959). A review of B.F. Skinner's Verbal Behavior.



**Footnotes:**

- 1 The Path room is the room that the protagonist goes through in order to move from the source room (in the example, the conference room) to the goal room (the laboratory).
2. Choosing the right logical form among almost infinite possible ones is a problem for any theory. Heim (1983) discussed how the processor chooses the right logical form. This aspect will not be presented here as it is not related to discourse comprehension.





builder or an anchor, upon which other uncertain aspects of the sentence are based.

However, much more research still needs to be done in order to empirically investigate the effects of mental spaces multiplicity, determinants of space availability, relative effect of different space builder, and the effects of the number of connector on ambiguity resolution. Investigating these issues among other points of interest is necessary to explore the validity of cognitive linguistics.

them. Information about tenses, moods, definite vs. indefinite NPs, verb implicit causality, and linguistic markers, play a significant role in discourse comprehension especially in regard to how sentence variables affect discourse representation. Including such variables into psychological models should make them more able to account for a wider range of psycholinguistics phenomena.

On the other hand, there is a need for an empirical investigation of linguistic models of discourse comprehension. Back in late 1950s and early 1960s, substantial progress in psycholinguistics was achieved by studying the psychological reality of transformational grammar as proposed by Chomsky. Similar efforts might be needed to test the validity of the claims made by cognitive linguists. Tentative work is being done especially on linguistic markers though mostly within psychological mental model framework. Another aspect of space building tools, the grammatical constructions (Goldberg, 1995), began to be investigated. According to this hypothesis, grammatical constructions such as syntactic frames carry meaning independent of the actual content of the sentence. For example, a construction like N- V- OBJ has the hypothesized meaning of "X acts on Y". Lexical items fill the slot to determine the specificity of the sentence meaning, as in "Jane drove the car" as fillers for the X, act, and Y, respectively. Kashack and Glenberg, reported a series of rating judgment experiments that showed that adult subjects are sensitive to these constructions regardless of the lexical item. Also, Mohamed (2001) studied preference of subject-verb-object (SVO) vs. verb-subject-object (VSO) word order in formal Arabic. He showed conditions where VSO is preferred and attributed the verb movement in these cases to result from the verb's being a space

#### 4. Concluding Remarks

Studying the same phenomenon from different perspectives enriches it and provides new thinking about the problems and new methods to address them. In the current context, psychological and linguistic approaches to studying discourse comprehension have generated areas of agreement and even more areas of disagreement. However, this interaction promised deeper level of study. In this section, basic, distinguishing aspects of each approach and possible sources of integration between them are highlighted in the following points.

- Psychological models are on-line models in most cases. The basic assumptions are either logically derived or formalized into computational model but they are always tested against the data of human subjects. This empirical investigation gives psychologists the chance to monitor the discourse comprehension processes on line in real time and to investigate the time course of highly interrelated processes. This approach avoids a criticism that was raised against earlier research in the field e.g., Bransford et al. (1972) who investigated discourse processes through memory or recognition question that followed presenting the text. Critics to this kind of research argued that the results may reflect inferences generated during the memory test but not during the comprehension. The same problem can be raised about research in non-psychological models.
- Psychological models take into account other aspects of human

different traditions within linguistics. To summarize the differences, file change model belongs to the main stream of linguistics, especially to formal linguistics, equipped with formal logic tools of analysis. It applies to human language the same rules that are applied to logical statements and it is concerned with truth conditions as the main criteria in accepting any statement. On the other hand, mental spaces model belongs to radical divergent tradition of cognitive linguistics. It considers human language different from logical statement and refuses linguistic analysis of single sentence isolated from context. This approach emphasizes that meaning is not a built-in characteristic but rather a dynamic process guided by language.

Though these differences both models indicate that discourse comprehension is a changing and developing process, and that it changes, more or less, with each new linguistic input. It might not be totally wrong idea to compare files in Heim's theory to spaces in Fauconnier's theory. They both develop as the discourse unfolds. They change continuously. Elements in spaces and cards in files are used dynamically. Different elements or cards can connect to the same entity or to no entity at all. An element or card can be removed from the space or the file depending on the discourse development. These similarities of course should not mask the fact that spaces' construction takes into account more linguistic cues than the file which seems to be dependent upon definiteness-indefiniteness cue. This made mental spaces model more able to interpret wider range of data than the file change model.

formally for the file change. To Show an example, consider (a) and (b) in 12 repeated below which shows how sentence (b) can change the file constructed for the discourse until (a) (the example is taken from Heim, 1983, p.174)

(12) (a) *A woman was bitten by a dog.* (b) *She hit it.*

The first step is to generate the logical form of (b) which is  $She_1 \text{ hit } it_2$ . By reviewing the domain, it is clear that they have equal domain, so

$$\text{DOM}(F_1) = \text{DOM}(F_2) = \{1, 2\}$$

The truth condition of the file until (a) is as follows;

$$\text{Sat}(F) = \{ \langle a_1, a_2 \rangle : \langle a_1, \text{ is a woman, } a_2 \text{ is a dog, } a_2 \text{ bit } a_1 \}$$

The file transition from  $\text{Sat}(F_1)$  to  $\text{Sat}(F_2)$  consists of keeping elements from  $F_1$  that are still valid and adding new elements and relations, as the extension of "hit". To put formally:

$$\text{Sat}(F_2) = \{ \langle a_1, a_2 \rangle : \langle a_1, a_2 \rangle \in \text{Sat}(F_1) \text{ and } \langle a_1, a_2 \rangle \in \text{Ext}(\text{"hit"}) \}$$

Thus, truth condition of the file after b being processed is as follows:

$$\text{Sat}(F_2) + \{ \langle a_1, a_2 \rangle : a_1, \text{ is a woman, } a_2 \text{ is a dog, } a_2 \text{ bit } a_1, \text{ and } a_1 \text{ hit } a_2 \}$$

As in this simplified example, the theory proceeds to account for complex cases of file changes.

### 3.3 Discussion

The two models discussed in this section have profound aspects of differences and of similarities. It is quite clear that they both belong to

woman. Card 2 was updated to mention that the dog jumped over the fence. The reader also adds a new card for the fence that includes the information that it was jumped over by the dog. The generalization that can be made from this example is that the clerk/reader adds new card for the indefinite NPs and updates the card for the old ones. The novelty-familiarity condition can be informally expressed in (13)

(13) *For every indefinite, start a new card. For every definite update an old one.*

File cards may not coincide with a referent and two of them may describe the same referent. Moreover, the card has a life span. That is, it can be removed from the file depending on how the discourse develops.

To formally describe the process of file change, Heim (1982) proposed a model in which sentences are analyzed by grammar. This analysis results in different levels of representations, among them is the logical form. Logical form of the sentence is assigned "a file change potential"<sup>(2)</sup>. This potential is a function that determines whether or not the file will be changed as a result of the new sentence or clause. These functions, however, are not assigned truth conditions. Rather, truth conditions are assigned only to the files. For the file to be true, there should be a correspondence between the cards in the file and the actual individuals. Moreover, each individual should fit the description on the corresponding card. In this case, the sequence of individuals satisfies the file, accordingly, truth condition can be formally expressed as in (14)

(14)  $F$  is true iff  $\text{Sat}(F) \neq \emptyset$  (and false otherwise)

One of sources of strength for Heim's theory is its ability to account

Building upon these theoretical developments, Heim proposed file change model. She equates her "file" concept with Stalnker's "common ground" concept (Heim, 1982, p.281) and her "file card" concept with Karttunen's "discourse referent" concept (p. 286). Though these similarities, Heim's theory developed a formal and detailed description of file changes and handled the discourse referents or the cards as inseparable from truth condition aspects of the semantic theory.

In Heim's theory, metaphorically, comprehender's task is like that of a file clerk. That is, the comprehender is assumed to open a file for the new discourse. The file in the beginning is empty. With receiving each new clause or sentence, the comprehender updates the contents of the file to be consistent with the information conveyed so far by the discourse. The file concept was introduced as an intermediate level of analysis between linguistic input and the world. File keeping procedures work as in the following example of comprehending the text in 12 (from Heim, 1983, p.167).

(12) (a) *A woman was bitten by a dog. (b) She hit it. (c) It jumps over a fence.*

Before reading or listening to the discourse, the file is empty. On encountering the discourse, the reader puts two cards in the file. Card 1 is for the woman and it includes information about her (as she was bitten). Card 2 is for the dog and includes information about it (it bit the woman). With sentence (b), updates both cards so that card 1 includes information that the woman hit the dog and card 2 includes information that the dog was hit by the woman. On reaching (C), there is no change in card 1, as no new information was presented about the

problem of the distinction between definite and indefinite referentiality. She was interested in defining the unique contribution of each of them in referring to information. Her work developed into a theory of discourse representation change.

The traditional solution of the problem was formulated in what is known as the "familiarity theory of definiteness". The basic claim of this theory is that definite noun phrases (NPs) refer to something familiar and already known while indefinite NPs introduce new referents. The theory faced a very strong objection, namely that there are many nonreferential uses of definite and indefinite NPs, as in sentences like "*every cat ate its food*" or "*John did not see a cat*" (from Heim, 1983, p. 164). Later work on the problem by many researchers, including Heim, was essentially an attempt to avoid this problem of referentiality.

Among the efforts to solve the problem, Karttunen (1976) proposed the notion of "discourse referent" as a substitute of "referent". Accordingly, definite NP will refer to a familiar discourse referent while indefinite NP will refer to a new one. Distinguishing "referent" from "discourse referent" kept the idea of novelty-familiarity contrast and made it avoid the problem of referentiality. That is, discourse referent could be either coincident with a referent or not, and therefore, it is possible to have a discourse referent for an NP that does not have referent. In another line of research, Stalnaker, depending on Grice's distinction between presuppositions and assertions, referred to reader's presuppositions as "common ground" that defines what is familiar to him. Assertions can be used then to introduce new facts or referents. (Heim, 1982).



components taken from each space in addition to its unique structure. Fauconnier argues that blending process goes through three steps to be accomplished. (1) Partial mapping of counterparts in the two input spaces, (2) building a generic structure with common features shared by the input spaces, and (3) blend structure is constructed with unique structure of its own. According to Fauconnier, blending process is used in processing discourses with multi-level interpretation. Fauconnier and Turner (1996) applied the blend mechanism on understanding a short discourse titled as "the great debate" about a philosophy professor lecturing his students saying:

*"I claim that reason is a self developing capacity. Kant disagrees with me on this point. He says it's innate but I answer that that's begging the question, to which he counters in critique of pure reason, that only innate ideas have power. But I say to that what about neuronal group selection? And he gives no answer."* (Fauconnier and Turner, 1996, p. 113).

In analyzing this discourse, Fauconnier and Turner showed it has three stages of blending process as outlined above. There are two separate input spaces: one for the professor and one for Kant. A mapping between Kant and the professor yielding the common features: they both are philosophers, make claims, and try to prove them. Finally, the blending process generates a unique space different from either of the input ones. In this space, the professor and Kant engage in a conversation and exchange ideas, in the same time, and using the same language.

### **3.2 Heim's File Change Model**

Heim's starting point in dealing with discourse analysis was the

presuppositions and pre-structured background schemas, and are externally linked by connecting functions. As the discourse unfolds, each new sentence interacts with existing cognitive configuration. New cognitive configuration emerges out of this interaction because of the dynamic features and information the sentence contains. These features have something to do with almost every aspect of the maze of spaces that the reader has to manage. Fauconnier (1997, pp. 39-40) summarized these features as follows:

1. Information about new spaces being set up, expressed by space builders.
2. Information about space currently in focus and how accessible it is, expressed by tenses and mood.
3. Descriptions that introduce new elements into spaces.
4. Descriptions, anaphors, and names that identify existing elements in spaces.
5. Lexical information that connect element from mental spaces to frames from background knowledge.
6. Presuppositional markings that propagate some structure through the space configuration.
7. Pragmatic and rhetorical information by words like even, only, but signal implicit scale for reasoning and argumentation.

This specification of discourse comprehension in the mental spaces framework makes it a creative process, where "meaning is negotiating". This creative aspect is expressed through the hypothesized *blending process*. Blending process operates on two spaces to create a third one. It is an integration process that results in a structure that has

that organize them, it is suitable to move to a discussion of how these constructions can be used in discourse comprehension.

### 3.1.2 Discourse Analysis

As mentioned before, the meaning of linguistic inputs is an open potentiality to be determined by the current mental spaces, available space builders, connecting paths, and pragmatic and cultural factors. With this in mind, discourse comprehension can't be a static, sequential process. Rather, it is a dynamic and creative process. With building a new mental space, its relation with previously established spaces becomes part of ongoing and ever changing discourse comprehension. Operations of establishing paths between spaces, mappings, defining counterparts, and specifying the suitable functions occur continuously. This means that the reader "has to keep track of the maze of spaces and connections being built" (Fauconnier, 1994, p. xxxiv).

To achieve that, the reader has to begin a *discourse management* task (Fauconnier, 1997, Ch.2). Three component spaces are crucial in this task. The first is the *base space*, which is the starting point for building any space and also is accessible anytime. The second component is the *viewpoint space*, the space from which other spaces are accessed or set up. The last component is the *focus space*, the space that is being built or has the majority of attentional resources. These components are not rigidly determined. Rather, they change and exchange roles as the discourse unfolds. According to this framework, discourse comprehension is a sequence of cognitive configurations. Mental spaces are constructed and ordered in a subordination relation specified by the inclusion relationship. Spaces are internally structured through available

(10) *Oedipus believes that the queen of Thebes is a spy.*

Transparent reading is the interpretation of the sentence from the speaker's point of view whereas opaque reading of it is the interpretation of the sentence from the subject's point of view (Oedipus in 10). According to mental spaces theory, this multiplicity of interpretation results from having two mental spaces. One for the speaker's point of view R and the other is built by the space builder "Oedipus believes.." and it is from Oedipus's point of view. Each of the two spaces includes an element that represents the object in the sentence. Accordingly, Space R includes the element queen of Thebes while the space includes an element spy. If using the ID principle, any of the two elements was described in term of the other, there is a possibility for recognizing the same person with two properties (e.g., a queen but Oedipus believes she is a spy). This leads to the transparent reading. On the other hand, if an element is recognized in terms of itself (through the identity function), then common element would be described as a queen and a spy. This leads to the opaque reading. According to mental space theory, ambiguity of transparent-opaque readings is just a special case of general rules where the ambiguity results from the existence of multiple paths between spaces that can distort the mapping process. This can be seen in sentences of split co-reference when an element in the source space has connections to two elements in the target space (multiple counterparts), as in (11) (in Lakoff and Sweetse, 1994 and in Fauconnier, 1994).

(11) *If Woody Alan had been born twins, they would have been sorry for each other but he was not and so he is only sorry for himself.*

With this understanding of mental spaces and the general principles

However, as it can be seen from the analysis of 7 and 8, there should be a counterpart of the trigger for the ID principle to work. In 7, Plato's books were the target counterpart of Plato the author. In 8, the girl with green eyes in reality was a counterpart of the girl with blue eyes in the painting.

The general mechanism for the connections between mental spaces is a *mapping* process from source space to target space (Fauconnier, 1997). Previously discussed connection between mental spaces that depends on the ID principle is one kind of mapping called *pragmatic function mappings*. Another kind of mapping is the *projection mapping*. In this kind of mapping, the structure and vocabulary of the source space is used to think or talk about the target space. To explain this mapping, Fauconnier mentions using time as a target space and space as a source one which is reflected in the common practice of using space terms to describe time as in expressions like *Christmas is approaching*, *weeks go by*, *summer is around the corner*, and many others. According to Lakoff and Sweetser (1994), this interpretation accounts for the metaphorical aspects of language in a way that is not available in any other formal logic-based theory of semantics. Similar mapping between a source domain (human body) and a target domain (Paris) can be seen in the following sentence 9 (from Fauconnier, 1997, p.146).

(9) *If Ile de la cite is the heart of Paris, then the Siene is the aorta.*

Another phenomenon that mapping mechanism accounts for is sentence ambiguity. According to the mental spaces framework, ambiguity results from the existence of multiple connecting paths that allow multiple readings of the same sentence. For example, the theory claims the ability to account for classical transparent-opaque ambiguity, as in 10

(6) *Max believes that in Len's pictures the flowers are yellow.*

In 6, there is a space builder "Max believes.." which builds a parent space for another space built by another space builder "in Len's picture..". Determining the parenthood relationship among spaces is critical for determining the constructed meaning, as explained below.

Elements in different spaces can be connected via pragmatic functions where it is appropriate to refer to an element in terms of another if they are appropriately linked. Fauconnier expresses this idea as the identification Principle (ID principle which states that "if two objects (in most general sense) a and b are linked by a *pragmatic function*  $F(b = F(a))$ , a description of a,  $da$ , may be used to identify its counterpart b." This, in 7, a description of Plato, the author, identifies his "books". In this case, "Plato" is said to be the trigger while the "books" is called *target*. The function that connects the trigger and the target here is the identity function.

(7) *Plato is on top shelf.*

Other kind of function, the image function, helps to understand elusive sentences as Jackendoff's famous sentence 8,

(8) *In Len's painting, the girl with blue eyes has green eyes.*

Fauconnier deals with these sentences by postulating a mental space P, corresponding to the painting and another mental space R corresponding to the real world. Elements in space P (the girl with blue eyes) can be viewed as a trigger which can be used to describe its target counterpart in space R (the girl with green eyes) through using image connector. Different kinds of connectors can be used to connect mental spaces.

### 3.1.1 General Framework

Consistent with the main stream in cognitive linguistics, Fauconnier considers that language does not carry meaning but it guides its construction. Unlike the main stream in linguistics and most psychological models of discourse comprehension, Fauconnier argues that sentences don't carry propositions that determine its meaning and relations to other sentences. Rather, sentence is an underspecified form with several potentialities of meaning that provides cues so the processor can reach the right one. More specifically, according to Fauconnier, reading a clause or a sentence leads to setting up a cognitive domain (a mental space) through the meaning construction process. Fauconnier (1994) defines the mental space as a "construct distinct from linguistic structure but built up in any discourse according to guidelines provided by the linguistic expression." (p. 16). To anticipate the discussion of discourse level, reading a discourse implies, according to this analysis, constructing a sequence of dynamically interrelated mental spaces.

According to theory, mental spaces are internally structured as set with elements and relations among them. Establishing a mental space can be triggered by some linguistic expressions that are called space builders. Space builders include propositional phrases, adverbs, connectives, and attitude verbs, among others. Order relation between mental spaces is usually expressed as inclusion relationship. Accordingly, each newly established space is considered to be included in some other space, the parent space. For example, sentence 6 below (from Fauconnier, 1994) demonstrates an embedding relationship between two mental spaces.

composition, cognitive linguistics considers linguistic inputs cues that evoke a process of "meaning construction" depending on all available resources. Cognitive linguists, therefore, abandoned many of the central assumptions developed within the main stream of linguistics. In semantics, they rejected the idea that sentences in human languages are similar to the statements in formal logic. Accordingly, they think that sentences can't be interpreted using truth-conditional semantic rules as developed in formal semantics. Also, they criticized transformational grammar, as developed by Chomsky, because it is based on analyzing single sentences. According to cognitive linguists, these sentences are analyzed out of context and native speakers' judgments in these cases reflect the minimal context that subjects will interpret the meaning within. So, they claim, this procedure can't provide insight into "meaning construction" process in more complex contexts (see Fauconnier, 1994 and Langancker, 1987). This criticism is rooted into a very basic premise of cognitive linguistics. That is, there is no fixed meaning of any linguistic input. Rather, there is always meaning potentials. The meaning of a sentence can't be seen outside the sentence-discourse interaction as will be explained below. Moreover, according to cognitive linguistics, the traditional conceptualization of sentence and semantics led to artificial division of field of study in linguistics into syntax, semantics, phonology, and pragmatics with comparable division of data to choose data suitable for each field. This attitude, they continue, led to excluding illuminating pieces of data as they don't fit precisely within a specific field. Having this in mind, cognitive linguists tried to develop a linguistic theory that is based on the capacities of the human mind. From now on, I'll concentrate on Fauconnier's theory on mental spaces beginning from the general framework and reaching his discourse analysis, in the next two subsections.



### **3. Linguistic Models of Discourse Comprehension**

In this section, two linguistic models of discourse comprehension will be discussed. They were chosen to represent two major traditions in linguistics. The first is Fauconnier's theory of mental spaces and it was chosen to represent recently developed cognitive linguistics. The second model is Heim's file change theory which, more or less, belongs to the main tradition in linguistics. A brief discussion of the differences and similarities between these two models will be presented at the end of the section.

#### **3.1 Fauconnier's Mental Spaces Model**

Fauconnier's work on mental spaces belongs to a newly emerging tradition in linguistics called cognitive linguistics which was elaborated in 1980s. This approach is marked by contributions made by Fauconnier on mental spaces (1994; 1997; Fauconnier and Turner, 1998), by Lngancker on cognitive grammar (1986; 1987; 1991), by Jackendoff on semantic structures (1983; 1987, 1990, 1997), and by Talmy on cognitive semantics (2000).

The starting point for the whole approach is considering language comprehension a cognitive act. The ultimate goal of the approach as defined by Langancker (1986) is "to characterize the types of cognitive events whose occurrence constitutes a given mental experience". (p.3). Thus, rather than assuming a fixed built-in meanings of words from which sentence meaning can be derived by rules of semantic

a more complicated model of the protagonist's behavior as complicated and not quite predictable. Accordingly, the resulting model that the reader might have is not simply a result of disregarding some information and adopting other ones. Rather, it is a more complicated model, a fact that makes integrating incoming information with it more difficult. If this analysis is correct, the longer reading time of the target sentence in the qualification condition in comparison to the consistent condition can be attributed to the difficulty of integrating target sentence with a more complicated mental model.

To sum up, this mutual exchange of theoretical frameworks and techniques between bottom-up approach to discourse processing (e.g., memory based models and Kintsch's models) and top-down one (e.g., constructionist models) indicates the need for a new approach that takes into consideration points of strength in each approach and avoids their points of weakness. For this new approach to be successful, it needs to incorporate recent developments in linguistic models of discourse processing. In what follows, basic aspects of these models and their significance will be presented.

other hand, according to the same logic, the constructionist position assumes that the existence of inconsistent information in the qualification condition will resonate to the input in the target sentence. This, presumably, causes comprehension difficulty on reading the target sentence resulting in longer reading time of it in qualification condition than in case of reading it within the consistent condition.

The results were consistent with the predictions of memory-based position. That is, reading time of the target sentence was longer in the qualified condition than it was in the consistent condition (experiment 1). This pattern of results remained after strengthening the qualifying sentence (experiment 2), and were repeated when the inconsistency was qualified by changing the time frame (experiment 3), and even after strengthening the qualifying sentence (experiment 4). Again, this pattern of results was found when the inconsistency was qualified by negating it (experiment 5).

Though these consistent results, the study might not present the best way to differentiate between the memory-based and constructionist positions. That is, the hypothesis that the constructionist position assumes equal reading times for the target sentence in consistent and qualification conditions might not be quite justifiable. This analysis assumes mental models are necessarily homogenous and simple. Rather, recent developments in mental model theory (e.g., Zwaan, Langston, and Graesser, 1995; Zwaan, Magliano, and Graesser, 1995) stress the multidimensionality of mental models, as discussed above. Accordingly, adding qualifying sentence to the inconsistent condition would unlikely result in simple, updated model, especially with the addition of information contradictory to the earlier ones. Rather, it would result in

inconsistent with the target sentence), subjects were presented with what they called "qualified" condition. The qualified condition was identical to inconsistent condition except that it included a statement that restricted the description given to the protagonist. Thus, to give an example, the target sentence could be *Mary ordered a cheeseburger and fries* while the consistent condition would include description consistent with that such as *Marry is a fast food addict*. The inconsistent condition, on the other hand, would include description inconsistent with that as *Marry is a strict vegetarian*. In both consistent and inconsistent conditions, this description of the protagonist takes about four or five sentences. In the qualified condition, a sentence was added to the description of the protagonist in the inconsistent condition like *Nevertheless, Mary never stuck to her diet when she dined out with friends* (experiment 1). In experiment 2, this qualification was strengthened by providing a reason for that, like *Nevertheless, Mary never stuck to her diet when she dined out with friends because she enjoyed eating meat occasionally*.

The logic behind this manipulation was that while both memory-based and constructionist positions predict that reading time of the target sentence after the inconsistent condition will be longer than after the consistent one, they provide different predictions in regard to the qualified condition. According to O'Brien and his colleagues, constructionist position assumes that the added qualifying sentence should fully update the mental model and that should eliminate any comprehension difficulty on reading the target sentence. Accordingly, reading time of the target sentence in the qualification condition should be equivalent to its reading time in the consistent condition. On the

reader makes these new associations unnecessary. Though unexpected, these results are consistent with some previous results in the literature. O'Brien and Myers (1985) found that unpredictable words in the sentence increase its reading time but facilitate recognizing the words. Also, Graesser and McMahan (1993) found that anomalous information presented to adult subjects while they are reading a story or solving a quantitative problem led to triggering more questions.

Another sign of convergence is that both traditions adopt similar concepts. A special case here is the concept of mental models. Both traditions present similar data in regard to maintaining global and constructing mental model to support their theoretical positions. Interestingly, the same work by Myers, O'Brien, and their colleagues (discussed above) was cited in two review articles that discussed recent developments in the constructionist tradition (Zwaan and Radvansky, 1998) and memory based models (McKoon and Ratcliff, 1998). The authors of both articles considered this work supporting to their approach. Specifically, both camps have similar claims that global coherence of discourse is maintained all the time and remote elements in the text are accessible all the time. However, they propose sharply different theoretical accounts to interpret these findings. Accordingly, there is a need to test the different claims of each tradition. Perhaps the only study that addressed this point directly was conducted by O'Brien et al., (1998) and therefore it deserves special consideration here.

In a series of 5 experiments, O'Brien and his colleagues presented their subjects with the same passages used in Albrecht and O'Brien's (1993) mentioned above. However, in addition to consistent and inconsistent conditions (where the description of the protagonist is consistent or

down theorists began to use techniques that were traditionally distinguishing the bottom-up approach. For example Langston and Trabasso (1999) presented an attempt to model causal processes involved in discourse comprehension using connectionist approach. Using such kind of modeling that emphasizes the associationistic aspects of processing and even assigns almost random values for nodes and parameters (though within their theoretical framework) may not be quite consistent with the fundamental premises of constructionist approach which emphasizes the active search for meaning and the role of previous knowledge.

On the other side, a bottom-up theorist like Kintsch (1994) assigned a constructive role to the reader and distinguishes between remembering and learning. According to Kintsch, while remembering is more or less a verbatim retrieval or reproduction of the text, learning is the ability to use the information in the text for solving a problem in a new environment. Kintsch (1994; Mannes, 1994) reviewed several studies that showed complete similarity between reader's knowledge structure and the text structure results in good remembering but less learning. On the other hand, a certain degree (not specified yet) of inconsistency between them resulted in better learning in terms of performance on learning and problem solving tasks. However, it also resulted in losing detailed information as indicated by relatively poor performance on memory tasks. Kintsch interpreted these results to mean that the inconsistency between the text and the reader leads to deeper processing of the text which, in turn, leads to forming new and different associations between information in the text and the structure of information in the reader's memory. On the other hand, the consistency between the text and the

of as cameras. Rather, building a mental model is a selective, multi-dimensional process. So what are the determinants of selecting something and ignoring the other? Why is some information included in the model while others are not? Does this have anything to do with situations that enhance more tolerance to ambiguity or with individuals who are more tolerant to ambiguity and accept more complicated models of reality? Finally, with introducing the notion of multi-dimensionality of mental models, is it possible to get some inconsistency between different dimensions in the same model? This question is different from the question about inconsistency between models. So, inconsistency could be inter-model or intra-model. How can intra-model inconsistency affect discourse comprehension? And if the reader has to choose, which dimension should be assigned a central role?

#### **2.4 Discussion**

Looking back at the psychological models of discourse comprehension, it can be seen that there are two major frameworks dominant in the literature. The first is a bottom-up, low level, automatic and passive approach while the other is top-down, effortful, high level, and constructive approach. The first tradition includes memory-based models and Kintsch's models. The second includes constructionist models of causal relatedness and mental models. Though these differences, the distinction between the two models is not clear cut and they might not be mutually exclusive. In this section, some signs of emerging convergence between the two traditions will be mentioned briefly.

One aspect of convergence is that followers of both traditions began to recognize that the other tradition has something useful. Accordingly, top-

units whereas the mental model is about a very specific situation (general scheme of dining at a restaurant vs. dining in specific day with specific people in a specific restaurant).

Recent developments in mental model concept indicate that there is a transition from thinking of mental model as simple and homogeneous to thinking about multi-dimensional mental model as in the event-indexing model proposed by Zwaan and his colleagues (Zwaan et al., 1995. See also Zwaan and Radvansky, 1998). According to this model, to build a mental model, the reader simultaneously monitors continuities in five dimensions: characters and objects, time, space, causality, and intentionality. If the incoming sentence describes a situation that is consistent with these dimensions in the current mental model, there is a smooth movement of processing. If there is a discontinuity in regard to any of these dimensions, the reader must go through an effortful process to update the mental model or to build a new one. Though it is kind of progress in comparison to one-dimension models, event-indexing model does not consider how the model is built and whether there is only one model or many of them. Moreover, even within psycholinguists, the notion of multi-dimensional mental model is not implemented on the empirical level. In Zwaan and Radvansky's (1998) words, "there appear to be discrepancy between the multidimensionality of situational models on the theoretical plan and their one dimensionality in empirical research" (p. 163).

To end this discussion of the concept of mental model, it might be appropriate to mention some questions that the current stage of theory of mental model raises but they don't seem to receive considerable attention among researchers in the field. Mental models are not thought



*the conference room into the laboratory.* Morrow et al., reasoned that the protagonist went through the Path room more recently than the source room. Accordingly, the Path room might have more salient location in the mental model than the explicitly mentioned source room. The results confirmed this prediction. Objects in the implicitly mentioned Path room were more accessible than objects in the explicitly mentioned, but less relevant, source room. In experiment 2 of the same study, objects in the room that the protagonist was thinking about were more accessible than objects in the protagonist's physical location. These results were interpreted to mean that subjects built mental models around the protagonist and the accessibility of information for them was determined by how close or far the source of information is to the protagonist. Consistent with these results, Glenberg et al., (1987) found that probe recognition time for objects spatially associated with the protagonist was faster than the recognition time for counterpart objects that are spatially dissociated from the protagonist.

For better understanding of the concept of mental model, it should be emphasized that it is neither an abstract, content-free concept nor it is a general stereotypical representation of information. In their discussion of the concept, Sanford and Moxy (1999) argued that mental models can be understood in terms of content and that it needs to be integrated with situation-specific knowledge. In SMF model, they continue, "language activates situation-specific background knowledge and the resultant text-to-knowledge mapping constitutes the mental model of the situation" (Sanford and Moxy, 1999, p.60). On the other hand, Zwaan and Radvansky (1998) distinguished the concept of mental models from the concept of scheme. The scheme is about general situation with basic

sentences. While 6 and 6a have almost the same spatial layout (turtles on the top of a log and the log is above the fish), 7 and 7a describe different spatial layout. In 7, the fish is beneath the turtles but not the log. In 7a, it is beneath the log but not the turtles. The results were interpreted to mean that on reading a sentence, readers built a model of the situation described in the sentence and they checked them for later recognition decision. However, the interpretation was disputed as the data was collected using later recognition and the difference might reflect memory strategies rather than comprehension strategies.

A more direct test of the hypothesis was carried out by Morrow and his colleagues in a series of experiments (Morrow et al., 1987; 1989). In Morrow et al., (1987), subjects studied and memorized a diagram of a building. Later, they read a story about a person moving in building. After reading a sentence like *He walked from the storage area into the wash room* reading was interrupted and names of two objects were presented on the screen. Subjects had to decide whether these objects were in the same room or not. It was found that reaction time (RT) for objects from the goal room (where the protagonist was located) were faster than RT for objects in any other room. Moreover, it was found that with the increase of distance of the probed room from the goal room, accessibility of objects tended to decrease. Similar method and technique was used to test whether implicit information related to the protagonist can be inferred and be part of the mental model more than explicitly mentioned information. In another study, Morrow et al., (1989) had their subjects read sentences similar to those read on the previous study but without mentioning the Path room<sup>(1)</sup> (but it can be easily inferred). Accordingly, they read sentences like *He walked from*

### 2.3.2 Mental Models

The notion of mental or situational model is not restricted to the constructionist models. Rather it can be found as a higher level process in memory-based models of discourse comprehension. Van Dijk and Kintsch (1983) added the situational model as the highest level of discourse representation in addition to surface and text base levels. However, the concept of mental model is more related to constructionist models. Within this framework, the reader tries to construct a coherent mental model of the discourse which represents the people, events, and actions as they are mentioned explicitly in the discourse or as inferred based on world knowledge. If, at any time, the reader encounters new information, s/he rechecks the model and updates it if necessary. Accordingly, building a mental model is a constructive, top-down process.

The first empirical study to show that readers construct mental description of the linguistic input was presented by Bransford et al., (1972). They had their subjects listen to sentences as 6 and 7. Later, subjects were presented with sentences like 6a and 7a. Their task was to decide as quickly as possible whether they listened to the sentence or not.

- (6) *Three turtles rested on a floating log, and a fish swam beneath them.*
- (6a) *Three turtles rested on a floating log, and a fish swam beneath it.*
- (7) *Three turtles rested beside a floating log, and a fish swam beneath them.*
- (7a) *Three turtles rested on a floating log, and a fish swam beneath it.*

While the sentences are almost identical on the surface level, subjects confused 6 and 6a more frequently than 7 and 7a. Bransford et al., attributed the difference to the spatial layout described by each pair of

measurements, which might reflect memory strategies rather than comprehension process, Suh and Trabasso (1993) used talk-aloud protocols and probe recognition techniques to show that goals and plans statements were available to their subjects in accordance with the predictions of causal discourse analysis.

In a recent work, Langston and Trabasso (1999) developed a computational model of the effects of causal relations as the main mechanism of discourse comprehension. The model is a mixture of discourse analysis developed earlier by Trabasso and his colleagues and the connectionist approach to modeling. Langston and Trabasso analyzed a narrative text and derived causal network of nodes that represent clauses or sentences and the connections between these nodes. A matrix of these nodes and of the strengths of connections among them was used as an input to the model. They run simulation experiment where the model proceeded in cycles. With each cycle the model integrated the input and generated a new matrix reflecting the nodes and the values of the strength of connections among them. The main computational mechanism is the spread of activation and there were two parameters: the activation value of each node and the connection strengths among them. These two parameters reflect the importance of each node and its availability over time. Comparing the model's performance with actual human subjects' data as presented in the literature showed that the model significantly predicted the data well in general. However, there were some inconsistencies that Langston and Trabasso attributed to (1) the different techniques used in collecting and analyzing data from human subjects and (2) human subjects' inability to identify all possible causal relations while the model can do that easily. This latter factor made the performance of the model higher than actual human subjects' performance.

then A is necessary for C. The third criterion is *weak sufficiency* where A is sufficient for B if it is the case that if A exists and events are allowed to go on from there, B will occur.

According to Trabasso, applying these criteria on discourse to determine causal relations is not an automatic process. Rather, to infer causal relations, the reader should infer the "context" of the discourse. This context provides what Trabasso and Sperry (1985) call the "circumstances" of background conditions and presuppositions necessary for inferring causal relations. Deriving causal relations leads to constructing a causal network representation of the discourse. The network can be used to determine the causal chain in the discourse, which is the longest chain of causes and effects in the discourse. Events with causes and consequences are in the causal chain while events that lack causes or don't lead to a consequence are "dead-end" event.

To test this method of analysis, Trabasso and Sperry (1985) used multiple regression technique. They used number of causal connections of each statement and whether it is on causal chain or not as predictors. The dependent factor was the importance ratings of statements in six stories as rated by subjects in a study by Brown and Smiley (1977). The results indicated that the model accounted for a significant proportion of variance (average 30%). Similar results were found by Treabasso and van den Broek (1985) and by van den Broek (1988). In general, number of connections and being in causal chain accounted for significant proportion of the variance using measure of memory, importance ratings, and summarization. On the other hand, factors as serial position and argument overlap among events did not account significantly for the data. To avoid the criticism of using off line

coherent mental model of events and characters described in it. In general, according to this approach, discourse comprehension is a "search after meaning" process that is based on the following assumptions (Graesser et al., 1994):

1. The reader constructs a meaning representation that addresses his or her goals.
2. The reader attempts to construct a meaning representation that is coherent at both local and global levels.
3. The reader attempts to explain why actions, events, and states are mentioned in the text.

This section will be divided into two parts: the first is for presenting research on causal relatedness and the second will be for presenting research on mental models.

### **2.3.1 Causal Relatedness**

Early systematic investigation of the causal relations among parts of long discourse was done by Trabasso and his colleagues (e.g., Trabasso and van den Broek, 1985; Trabasso and Sperry; Suh and Trabasso, 1993). Trabasso began his work by attempting to develop a systematic and reliable method to determine causal relations among parts of discourse. He specified three logical criteria to judge whether a causal relation between two events exists or not. The first is *necessity* which is tested by counterfactual argument if not A then not B. Accordingly, A is necessary for B if that is the case that if A did not occur, B would not occur. The second criterion is *transitivity* which identifies indirect causes. According to this criterion, if A is necessary for B and B is necessary for C,

region in case of contextual plausibility (using a pen for writing a letter and chalk for writing an exercise on the blackboard) than in case of contextual implausibility.

The results were interpreted to be consistent with a two-stage model. The first stage, bonding process, bottom-up, automatic process that depends on lexical properties and occurs immediately as its effect appears on first pass time. The second process, the resolution process, is a top-down, conscious process that can be delayed (its effect appears on regression measures). However, the results might contradict with SMF model. That is, a basic assumption in the model is that the discourse activates scenario and entities in the explicit focus are mapped in the role slots of the scenario. It follows that scenario should guide the propositional and lexical aspects of the sentence. In other words, unlike the empirical findings of this study, SMF model would expect the contextual effect should come before the effect of lexical properties of the verb.

Moreover, generally SMF model faces the same problem that faces the models that depend on the notion of scheme. Assuming that scenarios are like schema makes it difficult for the model to account for unusual or rarely encountered events and assumes a rigid and inflexible processor.

### **2.3 Constructionist Models**

In this section, top-down models of discourse comprehension will be presented. Maybe the common factor among these models is that readers are considered active participants who are trying to find causal relations among parts of discourse and to come up with a relatively

The target sentence was either contextually plausible or implausible (5)  
(5) The pen/chalk fell on the floor.

The predictions were as follows. If lexical properties of the verb checked first, then the dominant filler "pen" would be better integrated with the verb "write" than the non-dominant filler, regardless of the context. This integration would be reflected equal reading times of the target sentence (in "pen" condition) after both the implicit and explicit mention of the filler. Based on previous research, Garrod and Terras reasoned that in case of integration difficulty, it would be facilitated by explicit mention of the filler. Consequently, in case of non-dominant filler "chalk", there should be a significantly longer reading time of target sentence after implicit mention in comparison to explicit mention. Again this should be the case regardless of contextual plausibility. On the other hand, if contextual plausibility checked first and played the major role in discourse comprehension, the role-filler (pen or chalk) will be better integrated with the plausible situation. Accordingly, the role-filler "pen" would be easily integrated in the situation of writing a letter but not in the situation of writing an exercise on the blackboard. The opposite is correct for the "chalk".

The results indicated two major findings. The first is that measures of initial processing like first pass time supported the role of lexical properties. In other words, the first pass times of target sentence (in "pen" condition) were equal in implicit and explicit mention. However, the difference was significant in case of non-dominant filler (in "chalk" condition). Secondly, the patterns of regression supported the role of contextual plausibility. That is, there were less regressions from the verb



is clear scenario-based constraint on what is to be activated in long term memory. They found that words that are part of initially constructed scenario but not mentioned explicitly in the discourse can be read as fast as words that were explicitly mentioned. Accordingly, sentences that refer to "snow" took the same reading time as sentences that mentioned it explicitly if it comes after a situation that was set to imply the existence of "snow" as in case of reading a text about "going to skiing". This result was interpreted to mean that the retrieved scenario work as a background information against which further analysis are worked out.

The logic of SMF model implies immediate role mapping of information from explicit focus (characters and roles) into actions and events in the implicit focus. This process, according to the model, should occur before constructing propositional or full-blown contextual representations. To test this hypothesis, Garrod and Terras (2000) compared the relative effect of lexical verb properties (role-fillers) and contextual plausibility on discourse comprehension. Using eyetracking technique, they had their subjects read sentences with either dominant (write-pen as in 1 and 2) or non-dominant (write-chalk as in 3 and 4) role-fillers.

- (1) *The teacher was busy writing a letter of complaint to a parent.* (explicit)
- (2) *The teacher was busy writing a letter of complaint to a parent with a pen.* (implicit)
- (3) *The teacher was busy writing an exercise on the blackboard.* (explicit)
- (4) *The teacher was busy writing an exercise on the blackboard with chalk.* (implicit)

events, actions) which are not just a reflection of the text but an interpretation of it. The model works as follows. On reading a discourse the processor keeps the relevant entities in the explicit focus and activates scenario in the implicit focus. Scenario activation is a passive, automatic process that works in a manner similar to the resonance process. Interpretation begins with mapping from entities in the explicit focus to the role slots of scenario in the implicit focus. The result of this mapping process is a primary active representation of the discourse. Only after this representation is constructed, can higher order interpretation of the discourse take place. According to this conceptualization, explicit focus has changing content with limited capacity. Keeping an element in the explicit focus depends on factors like recency of mention, reintroducing entity through subsequent reference, and topicalization. Implicit focus, on the other hand, is the currently active part of long term memory where scenario is a representation of specific situation. This notion of the scenario makes it similar to the scheme.

For a long time, Sanford, Garrod, and their colleagues presented empirical data to support SMF model. Early in 1981, Sanford and Garrod (cited in Sanford and Garrod, 1998) reasoned that if the characters in a text are mapped from explicit focus into role slots of implicit focus, then these characters should inherit the characteristics of the role. They presented subjects with sentences like *John was on his way to school. He was worried about the math lesson.* On subsequent sentences, subjects were faster in reading sentences that confirmed the initially assigned role (in this example, that sentence that cast John as a schoolboy rather than a teacher).

In another research line, Sanford and Garrod (1983) showed that there

### **2.2.3 Scenario-Mapping and Focus Model**

Unlike previous models, scenario-mapping and focus (SMF) model developed mainly by Sanford and Garrod (see below), assumes that the sentence representation follows from contextual, situational representation of the discourse. This argument is opposite to other models that begin from proposition-based representation of the sentence to reach global contextual representation of the discourse. Thus, according to SMF, discourse processing chain goes from the text to background situation (scenario) mapping into sentence propositional representation. The question of how these scenarios can be constructed is of central importance to the model.

According to Sanford and Garrod (1998), discourse is interpreted against a fourfold partitioning of memory. In this partitioning, there are two dynamic attentional components: (1) the explicit focus which includes active and focused entities from the discourse, and (2) the implicit focus which includes implicitly focused world knowledge. Each of these components has a static extension. The explicit focus has a static extension in memory of the discourse as represented in long term memory. On the other hand, implicit focus has a static extension in the static, general world knowledge.

In this scheme, dynamic parts include representation of incoming linguistic input whereas the static parts include relatively permanent but updatable representation of either the current discourse or the world knowledge. It is assumed that explicit focus deals with discourse tokens that represent discourse entities (e.g., characters and roles), while implicit focus deals with the situations represented in the discourse (e.g.,

the receiving elements. The model has two parameters: (1) the attention parameter which is the decay rate, and (2) the threshold where a signal strength that falls below it is set to 0. The output of the cycle is a set of the most resonant elements to be stored in the working memory to begin the next cycle together with incoming linguistic input. The simulation results were similar to results provided by human subjects especially for the threshold and the decay rate. Though these results, Myers and O'Brien admitted their inability to model background knowledge (which is a shortcoming common in most models of discourse comprehension) and recognized the need for a more complex model.

Maybe the basic criticism of the resonance model is that it didn't take into account the relative importance of concepts to the structure of the text. Even if they all are relevant, some concepts play more central role in the text and may be signaled more frequently. For example, if a person reads a story about somebody who went to buy some grocery and met a ghost. Even after several sentences and even with no further elaboration, if concept "ghost" was probed or was used as an antecedent, it probably would be activated faster than any other concept in the text with the same physical distance or featural overlap. In a recent review, McKoon and Ratcliff mentioned that "how to integrate the resonance idea with the prominence of never before or rarely encountered conceptual combination is a problem that has not yet been adequately formulated" (McKoon and Ratcliff, 1998). This problem might require developing some mechanism that works in parallel to the resonance mechanism and gives more weight to the important syntactic and semantic cues.

antecedents were backgrounded, the more distant one required more time to be activated. This was interpreted to mean that the strength of resonance decay over time making the closer antecedent more available. However, the effect of physical distance can be overridden if the distant antecedent is more elaborated or if it has common features with the anaphors. (Myers and O'Brien, 1998).

Another variable that plays a role in the resonance process is the feature overlap. Resonance works as a pattern-matching device. Accordingly, elements that share common features with elements in working memory are more likely to receive more signals. McKoon and Ratcliff (1980) found that response time to a probe word that was mentioned before (e.g., a burglar) was faster if the anaphor was a repetition of the antecedent than when it was a synonym (e.g., criminal). It is assumed that repeated names have greater feature overlap than synonymous nouns.

Also *elaborated* elements were found to attract more activation than less elaborated ones. That is, elements that are repeatedly mentioned or explained further are found to be retrieved more quickly as indicated by response times to their probe words (O'Brien et al., 1990). It is assumed that elaboration increases routes necessary for transferring signals from working memory to the elaborated element.

Myers and O'Brien (1998) presented formalized version of the resonance model. In this version, resonance process was represented as a series of discrete cycles, where elements from discourse representation resonate to signals from elements in working memory. The signal from one element was set to have a strength value of 1 that is divided among

The resonance process is assumed to work as follows. Incoming linguistic stimuli send signals in parallel to all of long term memory contents. Backgrounded text propositions and/or related world knowledge resonate to this signal according to the degree of association and featured overlap between them and the input. This process is automatic and passive but the intensity of the signal depends on the degree of attention given to the corresponding text element. Similar to the construction stage in C-I model (Kintsch, 1988), resonance process is (1) continual (with every new input to the working memory signals different elements in long term memory) and (2) dumb (activation depends on reaching a specific threshold regardless of whether activated elements will facilitate or hinder the comprehension process). When the resonance process fails, readers become involved in a strategic problem solving activities trying to find elements that resonate to the current input. These activities will be reflected in longer reading time.

Accordingly, the dumb nature of resonance process implies that all elements can receive activation and resonate to the incoming linguistic input. Thus, unlike the minimalist hypothesis, inactive elements in long term memory can receive signals and resonate regardless of whether the text is locally coherent or not. This was proved in several studies by Myers, O'Brien, and their colleagues (e.g., Albrecht and O'Brien, 1993; O'Brien and Albrecht, 1992, and others reviewed above)

Resonance process is affected by several variables. Among them is *physical distance*. Generally, pronouns with more distant antecedents are more difficult to be resolved. O'Brien et al., (1995) found that if two

incoherent sentences than in reading globally coherent ones. This result is inconsistent with the minimalist hypothesis as it shows that subjects made connections with contents of long term memory even if the local content is coherent. Consistent with these results, O'Brien and Albrecht (1992) found that subjects spent more time in reading sentences that defines the location of the protagonist if it is different from his or her initially stated location few sentences ago, even with no local coherence break. These results that showed that subjects are aware of global incoherence, though local coherence was intact, were replicated in regard to background protagonist's characteristics (Myers et al., 1994), protagonist's goals and actions (Huitema et al., 1993), and causes of events (Klin and Myers, 1993).

It is obvious that these results can be consistent with either a constructionist framework or with a memory-based resonance process model (both will be discussed below). The implications of these two different viewpoints, and an attempt to address this issue will be presented in section 2.4.

### **2.2.2 Resonance model**

The term "memory-based" was used originally "to describe the idea that a text's words, concepts, and propositions are understood in term of the information they evoke from memory individually and in combination". (McKoon and Ratcliff, 1998). This idea can be seen most clearly in the resonance model proposed by Myers and O'Brien (1998). Then the idea of local vs. global coherence became less important as the main interest was in specifying the relation between textual elements and contents of memory.

locally inconsistent passages, subjects read sentences like "*Diane bike was broken and she could not afford a new one. So she went to the grocery store to buy grapefruit and yoghurt.*" After the final sentence of each passage, subjects had to respond to a probe word taken from global level to see to what extent information on the global level was available. Consistent with the minimalist hypothesis, in globally inconsistent condition, response time to probe words didn't differ from its counterpart in a control passage that showed global consistency. This result was interpreted to mean that when there is a local coherence, there is no need to retrieve information on the global level from long term memory. On the other hand, in locally inconsistent condition, response time to the probe word was faster than its counterpart in a passage that showed local consistency. This result was interpreted to mean that only when there is a local coherence break, readers search long term memory to establish global coherence. Taken together, these results showed that contents of long term memory were available only in case of local coherence break while they were less available, if checked at all, when local coherence was intact.

In response to this proposal, several researchers (as indicated below) presented data that showed that readers maintain both local and global coherence. For example, Albrecht and O'Brien (1993) presented subjects with passages that contained a description of the protagonist in the beginning (e.g., as a fast food addict or as a strict vegetarian). After few sentences, they presented the target sentence "she ordered cheeseburger and fries" which was locally coherent (consistent with the immediately previous sentence) but can be globally coherent or incoherent. They found that subjects spent longer reading time reading globally



### 2.2.1 Minimalist Hypothesis

About a decade ago, McKoon and Ratcliff (1992) proposed their minimalist hypothesis. According to this hypothesis, on reading a text, readers establish connections between the incoming linguistic input in the text and the propositions in the working memory. As long as there is consistency between these two components, text comprehension will proceed smoothly and the readers will not need to establish any connection with the propositions in the long term memory. This local coherence, according to McKoon and Ratcliff, makes reading times of sentences in the text shorter and makes text comprehension dependent on minimal cognitive resources. According to the hypothesis, only when there is a local break or when world knowledge is readily available, readers establish connections between current information and information in long-term memory. Searching long term memory to establish global coherence is not cost-free and can be seen in longer reading times. McKoon and Ratcliff emphasized, however, that previous description applies "in the absence of specific, goal-directed strategic processes". (p. 440).

To support their point, McKoon and Ratcliff (1992) presented data that indicated fast recognition times of probed words or phrases from long term memory only in case of local coherence break. For example, in experiment 2 they had their subjects read either globally inconsistent but locally consistent passages or locally inconsistent but globally consistent ones. In globally consistent paragraphs, they read sentences like "*his arm was healing from an injury and needed a workout before the big match*" and after some intervening sentences they read "*so Curtis decided to go home and study videotapes of his serve instead*". In the

the way a schema can be used, depending on referential coherence, and defining the strategies of choosing elements to be stored in the buffer. However, the model is still unable to account clearly for the role of background knowledge or for the complexity of human language as seen in the structure of events, connectives, and syntactic cues.

For a fuller picture of Kintsch's work, it should be mentioned that he and Van Dijk (Van Dijk and Kintsch, 1983) developed the macro-structure representation into a *situational model* of the events expressed in the discourse. Also, Kintsch (1992) reconsidered the syntactic cues as important source of information and tried to integrate it within his C-I model, though not very convincingly. The implications of the situational models will be discussed in the discussion section.

## **2.2. Memory- based models**

In this section, three models of discourse comprehension will be presented: the minimalist hypothesis (McKoon and Ratcliff, 1992; 1995), resonance model (Myers and O'Brien, 1998), and scenario-mapping and focus model (Sanford and Garrod, 1998). What is common among these different models is that they all consider discourse comprehension a bottom-up, passive process that requires low cognitive resources. Also, they agree that to comprehend a discourse, there is no need for the readers' active participation. Of particular significance, they all assign memory a basic role in discourse comprehension. That is, they are theoretically rooted in recent theoretical developments in memory research (Gillund and Shiffrin, 1984; Hintzman, 1986). In general, like Kintsch (1988), they consider discourse comprehension a perception-like process and not a problem-solving one.

discourses. On the other hand, flexible rules might not be as accurate as highly constrained ones but they can deal with different situations and, hence, are more tolerant with more initial mistakes. Also, the whole approach adopted in this model avoids the problem of establishing coherence only on the basis of referentiality. That is, using these flexible rules enables elements from different linguistic kinds to be activated.

The second stage in the model is the *integration* process. It works in connectionist manner to exclude the irrelevant elements. Thus, with each new processing cycle a new net is constructed as described above. Then, the integration process takes over. Activation vector passes through the network and the weights are updated so that positively connected elements get more activation strength while weakly connected elements lose activation strength. This process is repeated until the weights of interconnections stop changing and the system stabilizes. If this process goes smoothly, this basic perception-like C-I process would be sufficient for comprehension. However, if it fails, the processor may be involved in problem solving activity where new constructions are added to the net and integration is attempted again. In this cyclic processing, the contents of the memory buffer may be determined by the level of activation. This avoids the controversy over the strategies used to select the items that will be stored in the memory buffer.

To summarize, the C-I model is more bottom-up, automatic model that provides the processor with the flexibility necessary to include everything but, in the same time, the processor pays the price. According to the model, it has to go through another processing stage to remove irrelevancies and inconsistencies. The model made a good job in getting rid of some of the earlier model's problems such as describing

### **2.1.2 Kintsch's (1988) Construction-Integration Model**

Ten years later, Kintsch developed his second model of discourse processing. The C-I model is a mixture between symbolic production rules and connectionist computation. As its name indicates, the model consists of two major stages. The first *construction* aims to build a text base using linguistic input and reader's knowledge base. During this first stage, a whole set of elements is activated in response to the linguistic input. The activation process is weakly constrained and maximally flexible to activate as much as possible candidates for further processing. Because of this flexibility, the production rules are strong enough to include not only the right elements but also the irrelevant or inappropriate ones. Kintsch specifies the steps necessary for constructing a text base as "(a) forming the concepts and propositions directly from corresponding to linguistic input, (b) elaborate each of these elements by selecting a small number of its own most closely associated neighbors from general knowledge net, (c) inferring certain additional propositions, and (d) assigning connection strengths to all pairs of elements that have been created." (Kintsch, 1988, p.166). The output of this construction process is a network of lexical nodes of propositions, inferences and elaborations that had been made. This network is usually expressed in connectivity matrix.

The use of these bottom-up, weakly constrained production rules is an attempt to avoid the difficulties that resulted from using schema to control macro-rules that transform micro-structures into macro-structures in Kintsch and Van Dijk earlier model. Using highly constrained rules like schema leads to the activation of correct elements but schema can't deal with infinitely changing situations that can be found in different

propositions to be retained in short term memory buffer. Kintsch and Van Dijk mentioned factors as recency and importance of propositions as considerations that characterize good strategies. That is, propositions that are more recent and/or have more connections with other propositions are more likely to be kept in the buffer. However, in their words, "unfortunately, these considerations don't specify a unique selection strategy but a whole family of strategies" (p.370).

3. Restricting the model to referentiality-based coherence limits its perspective to feature-based detection of similarity among propositions. That also deprives the model from other meaning-based sources of coherence.
4. The model does not specify the details of the role of background knowledge and inferences. To account for the interaction between knowledge base and current text, the model gives central role to the notion of "scheme". However, here the criticism that is usually used against this notion can be used against the model. That is, schemes are rigid and culturally determined and they might not be able to account for discourses that don't fit within any common schema in the culture or that fit within a schema that is not known to the reader.
5. The model does not deal with communicative and pragmatic contexts in which the reader establishes a textual coherence even without developing fully formal coherent representation of the text. To be fair with Kintsch and Van Dijk's model, it should be mentioned that this is not a problem only to this model. Rather, it is the approach taken by almost all researchers in the field to adopt strategy of excluding social variables in current stage of research.

Kintsch and Van Dijk tested a specific version of the model (with buffer set to 4) using a computer simulation to recall a part of report on a social psychology experiment. The model produced recall and summarization protocols. By adjusting the parameters of the model, there was a goodness of fit between the simulated recall and summary protocols, on one hand, and the performance of human subjects who recalled and summarized the same text, on the other hand. In addition to that, the model is claimed to interpret what is known as the "level effect". That is, it was found that propositions on high level on the text base hierarchy are better recalled than propositions on the low level (Kintsch, 1974). The model accounts for this finding as resulting from the fact that these central propositions are more likely to be selected among propositions stored in short term buffer for many cycles. Accordingly, they are more likely to be processed more frequently, which in turn makes these propositions more familiar to the reader, and consequently, easier to remember than other propositions.

Several facets of criticism targeted the Kintsch and Van Dijk (1978) model. Some of these criticisms were specific to the model whereas some were shared by all bottom-up models of discourse processing. In general, these facets of criticism can be summarized in the following points:

1. Methodologically, the model depends on off line test of its claims and specifically on recall and summarization. This aspect makes the empirical verification of the model vulnerable to the objection that the results reflect processes that occurred during the retrieval rather than the reading process.
2. The model does not specify the strategies used to select the

capacity limitations, the processor can't check the whole list of propositions at once. Rather, it checks the discourse in chunks of propositions at a time. In doing so, the processor follows a sequential order from left to right in leftward languages like English. The number of propositions in each chunk is determined by the discourse surface structure and reader's characteristics. With the processing of a chunk with  $n$  propositions, a few of them is selected and retained in the short term memory buffer. The criteria for choosing these propositions are not clear in the model (more discussion of this point is below). These propositions are used as a connection between the already processed chunks and the new, yet-to-come ones. If there is an argument overlap between the new input and the propositions in the buffer, a connection is established and the discourse is locally coherent. Otherwise, the processor searches all previously processed propositions (in long term memory or by rereading the text) until it finds at least one proposition that shares argument(s) with the input propositions. If this search fails to find such a proposition, the processor makes inferences that close the gaps in the referential coherence of the discourse.

To summarize, the model assumes cyclical processing that tries to establish referential coherence depending on argument overlap between propositions of the new cycle, on one hand, and the propositions kept in the short term memory buffer, on the other hand. This process is automatic and requires low amount of resources except when no connection can be established between arguments of propositions. Then, the processor begins a resource consuming search in long term memory for propositions that have argument overlap with the new propositions and/or makes inferences to establish a coherent representation of the discourse.

so on. If there are gaps between propositions and, therefore, the discourse is not fully coherent inferences are made to close these gaps. This leads to adding more propositions to the text base representation.

Macrostructure, on the other hand, is the global level of discourse. At this level, a global structure of the discourse is maintained using scheme of conventional, culturally-determined discourse types as in reading story, an argument, or research report. These structures consist of sets of categories and rules of formation that determine possible order of categories and their possible variations. Macrostructure level of discourse is constructed through a set of macro-rules that map microstructure representation into a global macrostructure one. The basic function of these rules is to preserve the truth and meaning of the microstructure in this transformation. This can be achieved, according to the model, by either (1) deleting irrelevant propositions with no direct relation to other propositions, by (2) generalizing from a sequence of propositions into a general proposition, sometimes referred to as *macroproposition*, or by (3) constructing proposition denoting a global fact that is an abstraction of facts. On performing these operations, macro-rules are guided by a schema of texts of similar type. These schemas constrain the level of details/abstraction in conducting the macro-rules operations. More importantly, they add to the macrostructure information that is not explicitly mentioned in the text base, as in adding information about "ordering food" to the macrostructure of a discourse about having a dinner at a restaurant, even if this information is not mentioned explicitly.

On processing level, the processor checks the list of propositions derived from the discourse to determine the referential coherence among them and to add necessary inferences. Because of working memory



## 2. Psychological Models of Discourse Comprehension

### 2.1 Kintsch's models

Over the last 25 years, research efforts of Professor Walter Kintsch, at the University of Colorado, were perhaps the first systematic attempts to develop models of discourse comprehension. In what follows, a discussion of Kintsch's models will be presented.

#### 2.1.1 Kintsch and Van Dijk (1978) Model

In this model, Kintsch and Van Dijk assume that the basic unit of discourse surface structure is the *proposition*. Each proposition includes a predicate and one or more arguments. Deriving a set of propositions for a specific text can be done using a notational system proposed earlier by Kintsch (1974). It is also assumed that there are two levels of discourse semantic structure: the *microstructure* and *macrostructure* levels which are related together by a set of macro-rules or *macro-operators*. Microstructure is the local level of discourse and it consists of hierarchical network of individual propositions and their relations. The resulting representation is called the *text base*. The hierarchical order and interrelations among propositions are determined by *argument overlap*. If two propositions share one or more arguments, they are said to be referentially coherent. Accordingly, those propositions with the largest number of connections with other propositions via argument overlap are considered to be in the highest level of the hierarchy. Propositions with less number of connections are in the next level, and

### Acknowledgment

I'd like to express my sincere gratitude to Chuck Clifton, Lyn Frazier, and Jerry Myers for their suggestions and comments on this paper. Discussions with them helped me to get better thinking about the ideas presented in this study. However, all errors and mistake remain mine.

these two kinds of models will be discussed throughout the study, especially in the last section.

### **Organization of the current study**

As a brief description of the paper layout, the general plan is to have two major sections, sections 2 and 3, for psychological and linguistic models respectively. They are followed by a section (section 4) about the conclusions of the research. Section 2, on psychological models, was divided into four parts. In part 1, Kintsch's models (Kintsch, 1988; Kintsch and Van Dijk, 1978) were discussed. In part 2, memory-based models were grouped together. In this part, minimalist hypothesis, resonance model, and scenario-mapping and focus model were discussed. In part 3, constructionist models of causal relatedness and mental models were presented. Each group of models was followed by a critical evaluation. General discussion of psychological models and the relations among them was presented in part 4 of section 2.

In section 3, linguistic models of discourse comprehension were presented. The representative models were chosen from cognitive linguistics framework (Fauconnier's mental space in part 1) and from the mainstream of linguistics (Heim's file change model in part 2). A brief discussion of the two models and the significance of the relations among them is presented in part 3.

Section 4 was dedicated to concluding remarks about points of agreement, disagreement, and possible integration between the psychological and linguistic models of discourse comprehension.

faculty is rule-governed, and using these rules, we can generate infinite number of sentences. Chomsky's efforts led to his early "transformational grammar" (Chomsky, 1957). Chomsky's contribution here is to show that language has a cognitive structure that is systematic and rule-governed. Language comprehension, production, and acquisition, accordingly, are internal cognitive processes that can't be understood away from understanding these rules. This reasoning led to a collaboration between psychologists and linguists in order to verify the psychological reality of Chomsky's hypotheses (e.g., Miller, 1962; 1965), and eventually to the establishment of psycholinguistics as an independent field that studies the psychological basis of language function. Chomsky's efforts were concerned mainly with sentence levels. The extension of this cognitive framework to discourse came later in mid 1970s, beginning from Kintsch's efforts in cognitive psychology.

The current study is an attempt to study and evaluate models of discourse processing in psycholinguistics, focusing on the recent developments in these models. For the sake of clarity and organization, I have two sections for presenting the discussed models: one for psychological models and the other is for linguistic models. Mainly, psychological models were proposed by psychologists, whereas linguistic models were proposed by linguists. However, it should be clear that there is no clear-cut distinction between the two fields in this regard. Theorists from both camps study the same phenomenon, use similar terminology, and depend heavily on recent developments in the other camp's specialty. The difference between them is mainly about the relative weight they give to either the psychological or the linguistic variables in their models. Aspects of difference and agreement between

Kuhn's (1968) conceptualization of the progress of science). According to this new framework, the behavioral, simplistic analysis of human behavior as a result of stimulus-response connections was found unable to account for complex human behavior such as thinking, problem-solving, reasoning, creativity, constructive aspects of memory, and usage of language. Instead, a new framework of theory and research was presented to reflect a more positive, dynamic conceptualization of humans as active processors of information who have many intervening processes such as thinking, planning, and decision-making between getting a stimulus and producing a response. This was a major shift from the mechanical conceptualization of humans that was dominant in behaviorism.

Among the major trends in the cognitive revolution was the new approach to studying language. Chomsky started this new perspective in his famous review (Chomsky, 1959) of Skinner's book on verbal behavior (Skinner, 1957). In his review, Chomsky was able to show that acquiring language does not depend on parental reinforcement of correct verbal behavior. Rather, Chomsky argued that a child's acquisition of his native language is an innate, universal facility that is achieved by each normal child regardless of his environment. Moreover, Chomsky showed that children are able to produce more sentences with more linguistic structures than they ever heard and that their mistakes are not random but follow general rules. For example, a child born to English-speaking parents may add ed even after irregular verbs to get the past tense (e.g., past tense of give may be gived), which means that he extracted a rule and applied it (before he discovers later the idea of irregular verbs). Chomsky concluded from that that our language

analyze any connected text (Malmakjaer, 1991). Currently, we can distinguish between three approaches to studying discourse. The first is **psycholinguistic** and it addresses the linguistic aspects of the discourse, its structure, its markers, idioms, and metaphors that are used in the discourse, on one hand, and the schema(s) it evokes, and cognitive processes involved in processing the discourse and mentally representing it, on the other hand. The second approach is **sociologically-based**. This approach addresses the discourse in its social context. Accordingly, it investigates (1) social dimensions of the discourse like the role it plays in a social situation (e.g., plea, reprimand, or informing), and (2) socially-determined role structure and hierarchy of power, as reflected in the discourse. The third approach to discourse analysis is **ideologically-based**. It explores the latent cultural, philosophical, political, and ideological implications latent in the discourse. It is about the interaction between the discourse and its recipient (a listener or a reader) and the relative independence of the discourse from the author where it can be deconstructed to get to its basic core (as in the post modernistic approaches to studying discourse).

The topic of the current research belongs to the psycholinguistic approach to discourse analysis. It investigates the cognitive structures and processes involved in comprehending a discourse (a written text). Development of this approach was mainly influenced by the cognitive framework in cognitive psychology and linguistics. In what follows, a short historical background of this development will be presented (for more details, see Baars, 1986, Gardner, 1984, Sternberg, 1996). The reemergence of cognitive psychology in 1960s in the U.S. represents a scientific revolution that launched a new paradigm of psychology (after

## 1. Introduction

This study is an attempt to critically present and evaluate the current efforts in studying discourse comprehension in the field of psycholinguistics. More specifically, it addresses the efforts of cognitive psychologists and linguists to understand the nature of text processing. The study introduces the major theoretical models and describes how these models were formally formulated, how predictions were derived, how these predictions were tested, and whether they were verified or not. In this specification of the different models, main trends were emphasized, points of convergence and divergence among models were crystallized, the significance of each model was indicated, and the future pathways of theory and research in this field were anticipated.

Many models of discourse processing have been presented over the last 30 years. These efforts were part of a larger, multi-level work on discourse analysis. Thus, briefly presenting the big picture may be an appropriate introduction useful to understand the significance of the major issues in this research. Technically, discourse is defined in *The Concise Oxford Dictionary of Linguistics* as "any coherent succession of sentences, spoken or (in most usage) written... Often equivalent to text" (Matthews, 1997, p. 100). Accordingly, a novel, a conversation, a speech, a paragraph, or a textbook, can be considered a discourse. Thus, any connected text beyond a single sentence can be an object of discourse analysis. The term "discourse analysis" was first used in 1952 by Zellig Harris to describe the extension of the usage of grammatical transformation rules, used normally to analyze single sentences, to





## Index

### Table of Contents

1- Introduction .....	11
2- Psychological Models of Discourse Comprehension .....	17
2.1 - Kintsch's models.....	17
2.1.1 Kintsch and Van Dijk (1978) Model.....	17
2.1.2 Kintsch's (1988) Construction-Integration Model....	22
2.2 - Memory- based models.....	24
2.2.1 Minimalist Hypothesis.....	25
2.2.2 Resonance model .....	27
2.2.3 Scenario-Mapping and Focus Model .....	31
2.3 - Constructionist Models.....	35
2.3.1 Causal Relatedness.....	36
2.3.2 Mental Models.....	39
2.4 - Discussion.....	43
3 - Linguistic Models of Discourse Comprehension.....	49
3.1 - Fauconnier's Mental Spaces Model .....	49
3.1.1 General Framework .....	51
3.1.2 Discourse Analysis .....	55
3.2 - Heim's File Change Model.....	57
3.3 - Discussion.....	61
4 - Concluding Remarks.....	63
Footnotes:.....	68
5 - References .....	70



## **Psycholinguistic Models of Text Processing Discourse Analysis from a Cognitive Perspective**

### **ABSTRACT**

This research presents, discusses, and critically evaluates psycholinguistic models of discourse comprehension as presented by cognitive psychologists and linguistics. Psychological models include bottom-up models (e. g., Kintsch's models, and memory-based models) and top-down models (e. g., mental models, and constructionist models). Linguistic models, on the other hand, represents both the traditional, mainstream linguistic models, as in Heim's file change theory, and cognitive linguistic models, as Fauconnier's mental space theory. After a short introduction to the concept of discourse, its aspects, and the significance of cognitive approach to studying language processing, psychological and linguistic models of text comprehension were presented and discussed. Distinguishing characteristics of each model is presented along with its theoretical background, its empirical basis, and a short evaluation of it. The final section in the study is dedicated to concluding points of convergence, divergence, and possible integration among these models.

**Author:****Dr. Mohamed Taha Mohamed**

- Ph. D. in Cognitive Psychology. University of Massachusetts in 2003 (Area of specialization: Psycholinguistics).
- Assistant Professor of Psychology and Linguistics, College of Arts and Sciences. Abu Dhabi University. Emirates.
- Lecturer of Psychology. Faculty of Arts. Ain Shams University. Cairo. Egypt.

**Publications :****In Arabic:**

- 1 - Mohamed. M. T. The Concept of Information Processing. *Bulletin of the Association of Egyptian Psychologists*, Issue, 37, pp. 6-7. (1996).
- 2 - Miller, W., & Thoresen, K. (Authors), Mohamed, M. T. (Translation). (2004). *Spirituality, Religion, and Health*. Althaqafa Alalamya (World Culture), Kuwait, 123 (March-April), 64-87.
- 3 - Mohamed. M. T. The crisis of Social Sciences and Arab-Israeli Conflict. In A. Attia (Ed.), *In the Realm of Abdel Wahab El-Messiri*. Forwarded by Mohamed Hassanein Heikl (pp. 281-289). Dar Al Shourok. Cairo (2004).
- 4 - Mohamed. M. T. (In Press). Cognitive Science: New Horizons in Studying Mind. *Alam El-Fikr (World of Thought)*, 35, 167-200. Kuwait.

**In English:**

- 1 - Mohamed, M. T., (2001). *Word Order in Arabic: A Psycholinguistic Exploration*. Unpublished Manuscript. University of Massachusetts, Amherst.
- 2 - Mohamed, M. T., & Clifton, C. (March, 2001). The effect of Interaction between Sentence and Text on Syntactic Ambiguity. *Poster Presented at 14<sup>th</sup> CUNY Conference on Human Sentence Processing, Philadelphia, PA.*
- 3 - Clifton, C., Traxler, M. J., **Mohamed**, M. T., Williams, R. S., Morris, R. K., & Rayner, K. (November, 2002). The Use of Thematic Role Information in Parsing: Syntactic Processing Autonomy Revisited. *Paper Presented at 43<sup>rd</sup> Annual Meeting of the Psychonomic Society, Kansas City, Missouri.*
- 4 - Mohamed, M. T. (2003). Deductive Causal Relations. In Luis Alonso-Ovalle (Ed.), *On Semantic Processing*. UMOP. No. 27, 167 - 187.
- 5 - Clifton, C., Traxler, M. J., **Mohamed**, M. T., Williams, R. S., Morris, R. K., & Rayner, K. (2003). The Use of Thematic Role Information in Parsing: Syntactic Processing Autonomy Revisited. *Journal of Memory and Language*, 49, 317 - 334.
- 6 - Mohamed. M. T., & Clifton, C. (November 2004). Causal Relations: Conceptual Determinants. *Poster Presented at 45<sup>th</sup> Annual Meeting of the Psychonomic Society, Minneapolis, Minnesota.*
- 7 - Mohamed, M. T., & Clifton, C. (submitted). Processing Causal Relations: Theoretical Refinements and Conceptual Determinants.

**MONOGRAPH 261**

**Psycholinguistic Models of Text  
Processing  
Discourse Analysis from a Cognitive  
Perspective**

**Dr. Mohamed Taha Mohamed**

Department of Psychology

Ain Shams University

Egypt

**Annals of the Arts and Social Sciences - Monograph 261 - 2007**