

# ASPECTS OF COHESION, TENSE AND PRONOUN USAGE IN THE DISCOURSE OF THE OLDER LANGUAGE-IMPAIRED CHILD

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## SUMMARY

Aspects of the discourse of 5 language-impaired children and 5 children with no language impairment, aged approximately 9 years, were compared. A film and a story sequence were utilised to elicit narratives on which measures of cohesion, tense and pronouns were appraised. Measures of cohesion refer to the ability to indicate appropriately the relations of meaning with regard to situational context. Measures of tense include aspects of tense range and tense continuity. Measures of pronouns refer to the anaphoric use of pronouns with non-ambiguous referents. The group of language-impaired children was found to be significantly poorer on measures of cohesion and pronominal usage than the normal children, whereas a significant difference between the two groups was not revealed on measures of tense. Possible factors accounting for these findings were discussed, and implications for the diagnosis and therapy of the older language-impaired child were considered.

## OPSOMMING

Aspekte van die uiting van 5 taalversteurde kinders en 5 kinders sonder taalversteuring, van ongeveer 9 jaar, is vergelyk. 'n Film en 'n storie-reeks is gebruik om 'n vertelling te ontlok waarvolgens maatstawwe van kohesie, tyd en voornaamwoorde geëvalueer is. Maatstawwe van kohesie verwys na die vermoë om die verhouding van betekenis met betrekking tot situasie konteks toepaslik aan te dui. Maatstawwe van tydsvorme sluit in aspekte van die omvang van tydsvorme en die aaneenskakeling van tydsvorme. Maatstawwe van voornaamwoorde verwys na die anaforiese gebruik van voornaamwoorde met ondubbelsinnige verwysings. Die groep taalversteurde kinders het beduidend swakker presteer ten opsigte van maatstawwe van kohesie en voornaamwoord gebruik as die normale kinders, terwyl geen beduidende verskil uitgewys is tussen die twee groepe kinders met betrekking tot tydsvorme nie. Moontlike faktore verantwoordelik vir hierdie bevindinge is bespreek en implikasies vir diagnose en terapie van die ouer taalversteurde kind is oorweeg.

Recent research in child language has indicated the need to view pragmatics. This has highlighted the importance of accounting for 'real-life', communication situations, for example, the appropriateness of utterances with reference to the context in which they are produced and understood.<sup>6, 20, 24, 28</sup> Application of this to the field of language pathology suggests a number of implications for the diagnosis of and therapy for language disorders. An examination of aspects of pragmatics is afforded by discourse, that is, the sentences spoken or written in succession by one or more persons in a single situation.<sup>14</sup>

The concept of cohesion may be considered as central to discourse. It refers to the relation of meaning expressed in discourse and the appropriate linking of these relations.<sup>12</sup> Semantic cohesion is described as

characterizing the 'backbone' of narratives and is formed by appropriately relating the chain of events.<sup>14</sup> Syntactic cohesion refers to the linguistic forms used to indicate appropriately the interrelationships between utterances and draws partly from the syntax and partly from the vocabulary.<sup>12</sup>

Description of the language of the older child, that is, the child from five years of age, is limited.<sup>22</sup> Research in this area has focused on the understanding and production of isolated sentences with an emphasis on the adequacy of syntactic form and to some extent semantic aspects.<sup>9, 10, 17</sup> However, language beyond the single sentence within a context has received less attention. The importance of accounting for these aspects is aptly stated by Cazden:<sup>8</sup> *A child's manifest verbal behaviour or performance has both grammatical and pragmatic aspects.* Thus, a consideration of discourse becomes particularly relevant in examining the child's communicative ability.

The discourse of the older clinical child deserves attention, as it has been stated that these children lack the ability to . . . *talk coherently and to the point.*<sup>24</sup> A study conducted by Tuch<sup>27</sup> investigated this aspect in the narratives of a group of 9-year old language-impaired and normal speaking children. Results revealed the language-impaired group's failure to convey logicity resulting in incoherent narratives. Thus the clinical child may be competent on a sentence level, but may manifest difficulty with the expression of inter-sentence relations in discourse.

Two syntactic forms which rely on inter-sentence relations in discourse, and have relevance for the clinical child, are tense and pronouns. Research on both these aspects has dealt largely with the acquisition process.<sup>7, 15, 18, 19, 21, 29</sup>

With reference to tense, emerging linguistic forms indicating the relationship of events in time have been viewed together with the child's cognitive development.<sup>1, 4, 5</sup> A consideration of the scope of tense reveals that the linguistic forms of the present and past tense are closely related to aspect, that is, the view of the verbal action either as in progress — the progressive aspect, or as completed — the perfect aspect.<sup>25</sup> This results in a number of complex tense forms. These tenses are acquired later than the simple tenses in the developmental sequence.<sup>4</sup> Only a small proportion of studies in this area make reference to the older child. In terms of acquisition of tense use, it appears that from approximately six to seven years of age, the child's ability is comparable to that of the adult.<sup>5</sup> This however does not account for the specific handling of tense beyond the single sentence level, for example, the reporting of direct speech in discourse. Hendricks<sup>14</sup> uses the term "intersentence concord" to refer to the consistent use of the same tense of the main verbs in the sentences comprising a narrative. This affords an examination of tense continuity or the extent of tense shifts.

Research on pronouns has indicated that the child of nine years has mastered the various features of pronoun selection on a sentence level, such as person, gender and number, as well as the grammatical rules that the pronominalization process is subject to.<sup>18, 19, 29</sup> However there has

been little research carried out on the use of pronouns in discourse. Aspects of pragmatics such as role-playing have to be taken into consideration in a discourse situation where, for example, a child is required to realize that if there are two male participants in a narrative, pronominalization of both after the initial naming will cause confusion.<sup>14</sup> Aspects of pronoun usage in discourse which contribute to cohesion, are anaphoric pronouns which function as replacements for co-referential noun phrases (NP's) in preceding clauses. The pronoun as a reference item functions as a deictic, that is, it refers to an NP or to knowledge shared by the speaker and listener.<sup>16</sup> For cohesive purposes the identification of the pronoun must be specific. For example, "John went to town. He bought shoes". The pronoun "he" is an anaphoric pronoun as it replaces the NP "John"; or, "For he is a jolly good fellow". In this case, the speaker and listener should be able to identify "he" from their mutual knowledge of the context for the identification of "he" to be specific. Application of the measurement and characterization of aspects of discourse has received little attention. Thus the present report aims to examine the older language-impaired child's discourse, and proposes parameters which are relevant for such an analysis.

## METHODOLOGY

### AIM

To examine aspects of the communicative ability as revealed by discourse, of a group of older language-impaired children and to compare the communicative ability of this group with that of non language-impaired children of the same age range. Specifically, to compare the two groups on the following measures:-

Measures of Cohesion — the ability to relate the chain of events such that the relation of meaning is expressed.<sup>12, 14</sup> This involves a consideration of appropriateness to situational context, the logicity and sequence with which events are recounted, as well as fluency.

Measures of Tense — the appropriate use of complex tenses, as well as tense range and tense continuity.

Measures of Pronouns — the anaphoric use of third person pronouns with non-ambiguous referents.

### SUBJECTS

Two groups of subjects (Ss) comprising an experimental (E) group of 5 language-impaired children and a control (C) group of 5 non language-impaired children were used. Age range was from 8,4 to 9,6 years.

The E Ss had language problems predominantly of an expressive nature, as assessed by the speech therapists attached to the two remedial schools from which the Ss were selected. Ss were receiving speech therapy at the time of testing.

All Ss came from White English-speaking, middle-class South African homes.

Ss in the E and C groups met the following criteria for subject selection:-

- (1) Age:- The older child was selected as, according to Piaget,<sup>23</sup> there is a decline in egocentric language from 8 years of age, and children begin to be more explicit in their narrative. This aspect was relevant for the study of pronouns in discourse and cohesion. Secondly, by 8 years of age, features of tense have been acquired on the single sentence level,<sup>5</sup> but the extent of competence in discourse has not been explored.
- (2) Intelligence:- The intelligence of all Ss was considered to be within normal limits. For the E group, IQ scores on the New South African Individual Scale were obtained from the case-files at the respective remedial schools. Exact scores were unavailable for the C group, however all C Ss were judged by their teachers to be of average intelligence.

#### TASKS

The data to be analysed was derived from the retelling of a film or story sequence. This was felt to be a close approximation to a 'real-life' discourse situation. Also, children tend to talk more when presented with this type of stimulus as compared with pictures or a toy.<sup>8</sup> The following tasks were therefore administered:-

- (1) One sequence (1 minute 15 seconds) was selected from a film of the "Three Stooges", and presented audio-visually.  
In terms of investigating the child's anaphoric use of third person pronouns (he; him; they; them; it) with non-ambiguous referents; the film sequence was required to have more than 2 male actors with equal interaction. This was aimed at creating a potentially ambiguous situation where there were 2 or more referents of the same sex.
- (2) One story sequence presented auditorily. This task was devised particularly for analysis of tense use. Results from a pilot study carried out by the writers revealed that a film sequence (such as that described in (1) above) required relating events that have occurred in the immediate past, and therefore would not be sufficiently taxing for assessing complex tense use. Thus a story sequence was devised which contained some later developing conjunctions,<sup>18</sup> for example, since; when; while; unless; if; after; before, and temporal adverbs — all of which require the use of more complex tenses.  
The story was tape-recorded to ensure that presentation to each subject was consistent.

To control for memory span, the number of events in the film and story sequence was limited to 7.

#### PROCEDURE

All Ss were tested individually by 2 experimenters (the writers E1 and E2). Testing was carried out in 2 rooms — 1 room where the film and story sequences were presented by E1 and a second room, where the narratives

were recorded by a 'naive' listener (E2). The following is an explanation of the procedure followed for each S:

- (1) A period of casual conversation between the S and experimenters preceded the presentation of tasks. This was aimed at creating a relaxed atmosphere in an attempt to control for the influence of the testing situation on communication.
- (2) The instructions for the film and story tasks included the information that the S was retelling the sequences to a listener who was unfamiliar with the content (E2). This was aimed at approximating a 'real-life' situation which requires that the speaker be explicit rather than rely on the listener's previous knowledge of the content of the sequences.
- (3) E1 presented the film first, followed by the story. After the presentation, the S was required to retell the narrative to E2 who had not been present during the task presentation. A methodological point of significance was the use of "... tell me ..." as part of the instructions to each subject. This prevented the influence of the tense used in the instructions on the tense of the S's narratives.<sup>5</sup>
- (4) During the S's discourse, E2 acknowledged his comments with the expression of "mm" and nodding of the head so as to approximate a natural speaker-listener effect.
- (5) The S's narratives were tape-recorded and transcribed on both tasks. The scoring system devised by the writers was then applied to the protocols — measures of cohesion, tense and pronouns were analysed on the film task; measures of cohesion and tense (but not pronouns) were analysed on the story task.

#### MEASURING AND SCORING SYSTEM.

The measures of aspects of communicative ability may be divided into 3 main sections following the aim of the study.

- (I) Measures of cohesion
- (II) Measures of tense
- (III) Measures of pronouns

Each of these measures and the scoring system used is outlined below.

#### (I) MEASURES OF COHESION

This represents an appraisal of the ability to relate appropriately the chain of events such that the relation of meaning is expressed.<sup>12, 14</sup> Measures of this ability were divided as follows:-

#### (A) Semantic Content

This was measured by:-

- (a) Number of main events. The film and story sequences were each divided into 7 main events. The number of events reported by each S on each task was tallied. The requirement was that the event be mentioned irrespective of its position in the narrative or its grammaticality.

(b) Number of inaccuracies of content. This was felt to detract from the general cohesiveness of the narrative. The number of inaccurately reported events on each task was tallied.

**(B) Semantic Cohesion**

(a) Sequencing of events and logicity. This measure was derived from Piaget's work<sup>23</sup> on the "egocentric" language characterizing children's narratives. This measure refers to the ability to express appropriately casual relations, that is, the "how" of events; the ability to order events in the correct time sequence; and the ability to recount all parts of a narrative into a meaningful whole. This was measured by:-

(1) The number of events related logically and in sequence (+ log seq). The number of events related logically and in sequence in each narrative were tallied as (+ log seq). The following example is an extract from a C S's narrative to illustrate this measure:-

"It was about a cow and they're trying to milk it and they're using its tail and it didn't give milk . . ."

(2) The number of errors in logic and sequence (- log seq). The number of errors in logic and sequence in each narrative were tallied as (- log seq). Errors were evident where events were listed without any form of logical, temporal or casual connection such that no interrelationship was implied, and where narratives lacked specificity and events were omitted. The following example is an extract from an E S's narrative to illustrate this measure:-

"Then they try, they milk the cow - So, so then on it was a hole in one side and went into his face".

With regard to both (1) and (2), the ability to express the semantic relations of the original story was considered together with the use of appropriate syntactic forms in the expression of these relations.

(b) Fluency. This measure was based on the categories applied by Haynes and Hood<sup>13</sup> when analysing fluency changes as a function of linguistic complexity. These were: interjections; part-word, word and phrase repetitions; revisions; incomplete phrases and tense pauses.

The number of times when dysfluency was felt to affect the cohesiveness of the narrative was tallied. This was determined according to a subjective evaluation by E1 and E2.

From the measures of semantic content and semantic cohesion, a general appraisal of cohesion was obtained.

Protocols were scored independently by the writers, and concurrence was reached in the majority of instances. Where there was a discrepancy, the writers reviewed the narratives.

**(II) MEASURES OF TENSE**

**(A) Tense range**

This was measured by:-

(a) The number of complex tenses used appropriately. The number of appropriate present and past forms of the progressive, perfect and

perfect progressive were tallied. In addition, the variety of present and past tense forms was qualitatively examined.

The following example is taken from a C S's narrative on the story task and illustrates the appropriate use of the present and past progressive tenses:

"Sam's class was going to the zoo. They were very excited. When Sam came into the class, the teacher said to him: "Why are you so dirty". Sam said: "While I was playing soccer, another boy tripped me . . ."

#### (B) Tense Continuity

This was measured by:-

(a) The number of inappropriate tense shifts of a main verb. This measure determined the extent of tense shifting before or after the reporting of direct speech. A score was obtained by tallying the number of inappropriate tense shifts of a main verb. The following example is taken from a C S's narrative to illustrate this:

". . . and he did it about three times and nothing happened. So he says: "Try again", and then it went into his face, and he says: "That's a nice flavour".

The verb "says" in both instances is in the present tense instead of the past tense. From a consideration of aspects of complex tense use and tense continuity, a measure of tense in discourse was obtained.

#### (III) MEASURES OF PRONOUNS

##### (A) Ambiguous pronoun usage

This was measured by:-

(a) The number of nonindexed pronouns — that is, where there was no referent corresponding to the pronouns. The number of nonindexed pronouns was tallied. The following example is taken from an E S's narrative to illustrate this measure:-

"When he brought a cow into the house and he wanted to milk it so he didn't know . . ."

One is unable to determine to whom the "he" refers.

(b) Ambiguous pronouns — that is, where the identity of the referent corresponding to the pronoun was ambiguous. The number of instances when this occurred was tallied.

The following example is taken from an E S's narrative to illustrate this measure:

"The man went flying . . . and then the other man said: 'I'll show you how'. . . and then he took the long . . . then he pulled, then he said: "What's wrong".

There are two possible referents for "he", that is, 'the man' and 'the other man', resulting in ambiguity.

(c) Incorrect reference of the pronoun — That is, where identity of the referent was incorrect. This was based on the experimenters' knowledge of the content of the narrative.

From a consideration of each of the above measures, a general measure of ambiguous pronoun usage in discourse was obtained.

#### STATISTICAL TREATMENT OF DATA

Due to the 'free production' nature of the discourse tasks, the E and C groups' narratives could not be directly compared.<sup>26</sup> Thus a co-variate for each task had to be identified. The co-variate selected was the number of words on the film task, and the number of sentences on the story task. The Spearman Rank Order Correlation test was used to correlate each of the measures with the co-variate. Where correlations were significant, i.e., where the co-variate influenced the scores obtained, the scores were divided by the co-variate. A Mann Whitney U test for Significance was then carried out to compare the E and C groups on each measure.

#### RESULTS

A significant difference between the E and C groups was found on measures of semantic cohesion and ambiguous pronoun usage. The groups did not differ significantly on measures of semantic content, tense range and tense continuity (Table I).

Measures of Cohesion	Film Task	Story Task
Semantic Content		
Number of main events	7,5	4,5
Number of inaccuracies	8,5	8
Semantic Cohesion		
(+ log seq)	3 X	1 X
(- log seq)	3 X	3 X
Fluency	6	2,5 X
Measures of Tense		
Tense Range		
The number of complex tenses used appropriately	11,5	10
Tense Continuity		
The number of inappropriate tense shifts of a main verb	11	5
Measures of Pronouns		
Measures of ambiguous pronoun usage	4 X	Not analysed

Values represent the Mann Whitney U scores obtained on each measure.

X - Significant differences between the E and C groups ( $p = 0,05$ ).

(+ log seq) - the number of events related logically and in sequence.

(- log seq) - the number of errors in logic and sequence.

TABLE I. Summary table of significant differences between the E and C groups on measures of cohesion, tense and pronouns.

## DISCUSSION OF RESULTS

## Measures of cohesion

On measures of semantic content, the E and C groups did not differ significantly, demonstrating the ability to include the relevant features in their narratives.

The significant difference between the groups on measures of cohesion related to the *manner* in which the events were related. The E groups' narratives were characterized by more errors affecting logic and general sequence. With this group events were merely listed resulting in incoherent narratives which the Ss were unable to communicate effectively. In contrast, the C group scored higher on the number of events related logically and in sequence, thus producing coherent stories. Contributing to the E Ss' incoherence, was their dysfluency in relating the narratives. This created discontinuity and reduced the speaker's communicative efficiency.

## Measures of tense

From Table I it can be seen that the E Ss did not experience difficulty with aspects of tense use in discourse. However with regard to aspects of tense range, a qualitative difference between the two groups was found. This manifested in the variety and range of simple and complex tenses used. For example, all Ss utilised simple tenses, however the E Ss used fewer complex tenses than the C Ss. Generally the E Ss used a small variety of tense forms, specifically in terms of complex tense usage. For example, no E S used the present progressive, present perfect, and perfect progressive tenses, although these were used by all C Ss.

Results on tense continuity revealed a small number of tense shifts characterizing the narratives of both groups. An in-depth analysis of the narratives revealed that all instances of tense shift of a main verb occurred either preceding or following the reporting of direct speech. This was illustrated by the substitution of present tense for past tense. For example:

"... and some stones fell on top of his head and then the fat one says: 'Try again' and then another man came over . . ."

A consideration of the appropriateness of the tasks employed for measuring tense range and tense continuity indicated that the story task was more revealing of aspects of tense range than the film task. It seems that this was related to the presence of temporal conjunctions and adverbs ('since' and 'while' in the example below) in the story task which implied complex tense usage. This is illustrated in the following example taken from a C S's narrative on the story task:

"Sam's class wanted to go to the zoo and they had been looking forward to it since the beginning of the term . . . His teacher said: 'Why are your clothes so dirty'. So he said: 'While I was playing soccer somebody came and tripped me . . ."

With regard to tense continuity, the film task was more appropriate than the story task. Since the film contained direct speech only, Ss tended to

recount as much of this as possible. This therefore provided the context for tense shifts to occur.

### Measures of pronouns

A significant difference between the E and C groups was found on measures of ambiguous pronoun usage. The E Ss used more non-indexed pronouns in their narratives than the C Ss, that is, the E Ss violated the rule of referring to an NP and appeared to rely on presupposed mutual knowledge shared by the speaker and listener. For example:

"You see, he was sitting on the floor, and then he said that, then he said: 'Wait a minute' — because he wanted to try and get him up".

Both groups demonstrated a certain amount of difficulty with explicit reference to pronouns. Where there were two possible referents for a pronoun, Ss did not use the pronouns specifically. For example: "The one man was sitting on the floor and the other tried to get him onto the bed and they were trying to get it out and he comes and he cuts their trousers and he hit him and he went flying onto the top bunk."

### GENERAL DISCUSSION

From the above results, it is apparent that the E group's discourse was inferior to that of the C group, in that the E group's narratives demonstrated poor semantic cohesion and restricted syntactic forms in comparison to the C group. It is interesting to note that restricted forms were seen not only in terms of smaller tense range and less explicit reference in pronouns, but also on other aspects (not directly analysed) such as vocabulary, length of NP, for example. "the other man with the straight hair" versus "the man", and overall length of narrative. The C group's narratives reflected what could be described as "richness" as compared with the E group's. This is illustrated in the following examples taken from an E and C S's narratives:-

E S: "Alright you see, the man brought this cow in and then they didn't know, they were pumping like water . . ."

C S: "There was the Three Stooges and one of the big fat ones brings in the cow and then he says 'How do we milk the cow?' So another one of the Three Stooges takes the bottle and he puts it down and he says: 'Give', and the cow is supposed to give milk and it doesn't so he goes to the back and he pulls its tail like you do with a water pump . . ."

Cognitive, linguistic and social factors can be considered in accounting for the differences in the communicative ability of the E and C groups:

#### Cognitive factors

Two modes of style characteristic of the young child's egocentric language<sup>23</sup> were identified in the E group's narratives. These were juxtaposition and syncretism. For example Ss tended to list events and did not link them in the causal, temporal and logical relationship conveyed in the task. According to Bates,<sup>3</sup> a particular level of cognitive maturity is required to transform information received into a meaningful

message. Since the E Ss were, according to their age, past the stage of 'egocentricity', some form of cognitive immaturity/delay may be suggested to account for their performance.

#### Linguistic factors

In accounting for the results obtained, it is important to consider the characteristics of verbal discourse. Firstly, it is produced in a situational context and not in isolation. This requires expression of semantic relations appropriate to the context. Secondly, the linguistic formalisation of the semantic relations requires syntax which extends beyond the syntactic structure of a single sentence. It seems then that discourse places great demands on linguistic processing as well as cognitive capacity. It is possible that the E group were unable to cope on this level.

#### Social factors

Social factors, such as the ability to role-play, are important for effective communication. According to Flavell,<sup>11</sup> *ellipsis and indefinite pronouns in a message are evidence of a basic failure on the part of the child to keep the listener's role in mind while communicating to him*. This suggests that the E group's increased use of ambiguous pronouns as compared with the C group may be related to their inability to role play.

In summary, it seems that the child's communicative ability in discourse should be viewed in the context of a combination of cognitive, linguistic and social factors.

### CONCLUSION

The present research has shown that a consideration of language beyond the single sentence level is relevant as it has highlighted differences between the E and C groups. This implies the need for diagnosis and therapy of expressive language disorders in the older child to be considered with reference to discourse. Failure to consider this may result in subtle language errors going undetected. It may also lead to the premature dismissal from therapy of children who demonstrate competence on the sentence level, but who have a more complex linguistic difficulty. It has been reported that children with a history of language disorders frequently have learning difficulties in later schooling<sup>2</sup> — further highlighting the value of viewing language within a discourse framework.

Discourse appears to be a useful tool for assessing a broad range of language function as it taps semantic and syntactic aspects. Specific discourse situations could be devised to evaluate and teach aspects important for effective communication. In therapy, the child's attention could be drawn to semantic relations as well as the appropriate expression of these relations. Areas such as nonfluency, logical sequencing of events, appropriate use of pronouns in terms of indexing pronouns for reference and eliminating ambiguities, and abilities such as role-playing could be considered in a therapy program. Situations such as having two or more actors of the same sex could be utilised to teach the use of pronouns.

It would seem that future research specifically directed to the application of discourse in diagnosis and therapy of the older language-impaired child would be of value.

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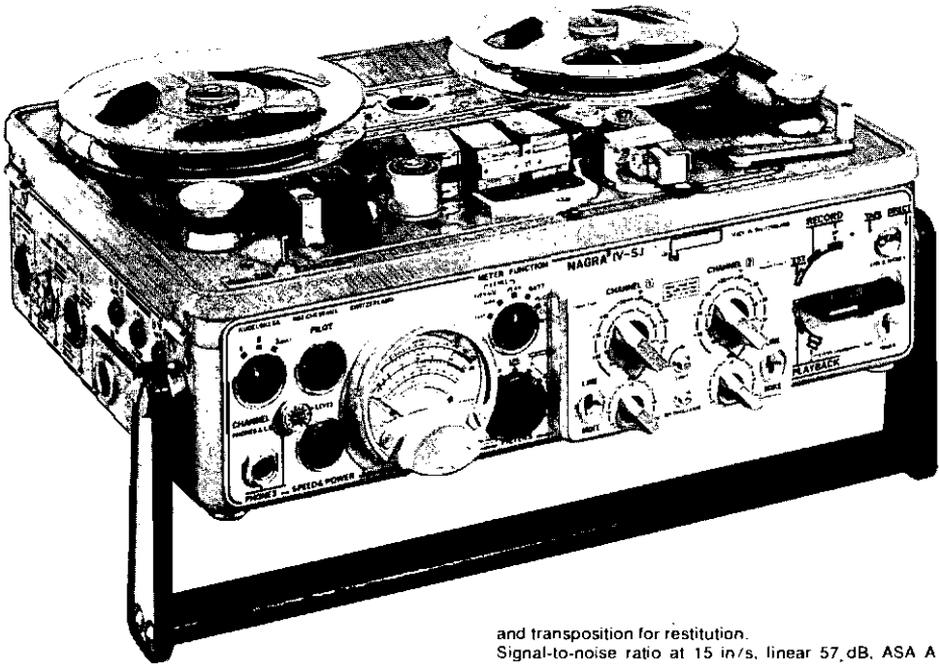
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# Self contained 3-track instrumentation tape recorder for scientific analysis



**Four speed recorder: 15, 7½, 3½ and 1½ in/s. Two direct recording tracks and one FM track. Application as a precision sound level meter when a measurement microphone is connected.**

**SPECIFICATIONS (typical values)**

Unbalanced line input, impedance 100 kΩ, 10 mV for MPL (maximum peak level).  
Line output at MPL, 1 V into 10 kΩ  
Loudspeaker amplifier 1 W  
Performance obtained by recording:  
Frequency response, 20 dB below MPL,  
15 in/s 25 Hz - 35 kHz ± 1,0 dB; 7½ in/s 25 Hz - 20 kHz ± 1,0 dB; 3½ in/s 25 Hz - 10 kHz ± 1,5 dB; 1½ in/s 25 Hz - 3,5 kHz ± 1,5 dB; at 1½ in/s recording from 2,5 Hz

and transposition for restitution.

Signal-to-noise ratio at 15 in/s, linear 57 dB, ASA A weighted CCIR 64 dB and NAB 62 dB  
Distortion at MPL = 320 nWb/m, h3 ≤ 1,5%  
Crosstalk attenuation at 10 kHz ≥ 50 dB  
Phase fluctuation ± 12° between tracks at 7½ in/s and 10 kHz  
FM-track at 15 and 7½ in/s:  
Carrier frequency 17 kHz  
Maximum frequency deviation ± 45%  
Peak-to-peak input voltage 2 V  
Frequency response 0 Hz to 4 kHz -3 dB  
Signal-to-noise ratio 44 dB  
Speed stability at 15, 7½ and 3½ in/s: ± 0,1%

Wow and flutter, DIN 45 507 weighted peak-to-peak value, 15 in/s ± 0,05%, 7½ in/s ± 0,07%, 3½ in/s 0,12%, 1½ in/s ± 0,25%

**NAGRA KUDELSKI**

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