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ABSTRACT

This study was undertaken to measure emotional expression as mediated by the automatic nervous system during reading and during other tasks related to school work. Subjects for this research were eight normal readers, reading above the 46th percentile on the Davis Reading Test Form 1-A, used as a control group and sixteen abnormal readers drawn from a junior college remedial reading center, who tested at the 1st to 25th percentile. The abnormal group was split into two sub-groups termed hypotensive or hypertensive according to their behavior during reading. Physiological data were collected during the reading process using a polygraph machine and a psychogalvanoscope. The data introduced evidence to the effect that two opposing coping behaviors are evidently associated with long term reading dysfunction. The first is a hypotensive reaction indicating a drop below the normal activation or arousal necessary for optimal processing of information, registration and storage to occur. The other reaction is one of hypertensiveness where all arousal mediating sympathetic nervous system factors are activated into an alarm reaction, making it equally difficult to attend to external stimuli and information processing as during reading. The control group exhibited a moderate range of emotions. (MKM)

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Brain Functions In Reading And Reading Disability

Psychophysiological Correlates of Reading Dysfunction In Junior College Students With A Long History Of Reading Problems

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PROBLEM

The notion that conditioned emotional states are able to interact with reading performance facilitating or hampering that ability has been explored by several theorists for quite some time (1). This study was undertaken to measure emotional expression as mediated by the autonomic nervous system during reading and during other tasks related to school work, serving as a control.

Germane, then to this research is the notion that there exists in each individual a range of values of nervous system activity associated with any information processing such as reading and if this range of values is subjected to negative reinforcement in being associated with a series of punitive situations, then the probability of these neurological and behavioral internal events will decline as much as is possible within the biological limits of the system or within the social limits that the individual has to deal with. That is to say, not only will that person who has been subjected to negative reinforcement in relation to reading not read if at all possible, but when that individual does engage in reading, the attention-arousal level that normally would occur will have a value higher or lower than if it had not been

exposed to the same life situation of negative reinforcement in conjunction with reading.

In other words, a form of biological feedback is hypothesized as having taken place during reading for all groups. The disabled group having experienced threat to survival and negative feedback in conjunction with a certain level or range of expressed ANS activity internally integrates and interprets that level of arousal or that state as part of the negative experience. The able reader group is hypothesized as having developed through winning during reading, a positive attitude toward this task and has associated pleasure with the level of arousal centered around the information processing task of reading.

Biological feedback procedures have for some time now proven effective in altering certain biological rhythms thought previously to be immune to environmental manipulation (2), (3), (4). Given these previous findings, it was hypothesized that a form of biological feedback mechanism could be operating in the classroom in conjunction with reading performance, thus altering neurological events associated with positive or negative affect.

Hypotheses

1. If general nonspecifically conditioned innate or hereditary arousal-attentional (AA) indices are interacting with difficulties in information processing, then differences

between groups should show up for our measures across the board, including rest periods.

2. If general arousal-attentional (AA) indices show group separation only during tasks, then this would be considered evidence for situational specific conditioning of AA with general learning tasks.

3. If AA differences are significantly greater between reading when compared with other tasks such as mental multiplication and reproducing a simple figure, this would be considered evidence for specific conditioning to reading perhaps generalizing outward to other tasks associated with classroom learning.

4. If specific conditioning has affected adrenergic systems over cholinergic systems, then blood flow (BF) in the skin and heart rate differences between groups or between tasks should be more salient with BF showing the most effect due to its "pure" adrenergic mediation.

5. If the effect has been principally mediated through cholinergic systems, then galvanic skin conductance response differences between groups should be more salient and specific.

6. If general ANS responses simply as "affect" have been brought under control of environmental contingencies during reading, then all three of our measures should covary

positively with each other and the separation should be simply between groups during reading. That is, all responses should go up or down or remain static together.

Physiological parameters associated with orienting, attention, or information intake, have been shown (5), (6) to be: lowered sensory thresholds, pupil dilation, mild cutaneous constriction (in the skin of the hands), mild increases in conductance of the skin (increased galvanic skin response) and increased heart rate fluctuation, with heart rate increasing mildly. An autonomic nervous system defense reaction has been defined (7), (8) as a hypertensive or hypotensive reaction in relation to this mild activation associated with information processing. The hypertensive reaction is thus a massive pressor activation of the sympathetic nervous system while the hypotensive reaction is observed as an inhibition of sympathetic tone resulting in extreme cases in fainting (9).

METHOD

Dependent Variables

Galvanic skin conductance responses, GSCR or GSR, i.e., either a monophasic fall in resistance or rise in conductance

of the palm. Although innervated by sympathetic fibers, the transmitting agent has been shown to be acetylcholine (10).

Our second measure is heart rate inter beat intervals (IBI's, the reciprocals of heart rates). Heart rate has been shown to increase under sympathetic drive and decrease under parasympathetic innervation (11).

Our third measure is blood flow as finger pulse pressure. This measure of cutaneous-constriction-dilation of blood vessels in the skin is recorded using a photoplethysmograph. This arousal indicator has been shown to be sympathetically innervated and adrenergic (12).

Independent Variables

Two samples of the Minnesota Perceptual Form Board Test were reproduced by each subject as Task 1 and 2.

The second stimulus was a multiplication task (3) where each subject was required to multiply two-place numbers in their head ranging from easy, i.e., ten times ten to difficult, i.e., 24 times 13, and verbally answer.

The 4th, 5th, and 6th tasks involved each subject in reading three excerpts from the Gray Oral Reading Test at their reading level. This was grade four to nine for the dysfunctional reading group and grade eleven to thirteen for the norm group.

Subjects

Twenty-four subjects were tested. Sixteen abnormal readers drawn from the remedial reading center at De Anza Junior College, Cupertino, California, reading from the first to the twenty-fifth percentile on the Davis Reading Test Form 1-A were tested. Eight normal readers drawn from the general population reading above the forty-six percentile were used as a control group. The abnormal reading group was split into two sub-groups termed hypotensive or hypertensive according to their behavior, i.e., quiet, placid, passive, etc., defined them as hypotensive along with a dilational response for cutaneous constriction BF prior to and during reading; the hypertensive group exhibited extreme nervousness, hyperkinetic behavior, etc., and exhibited cutaneous constriction prior to and during reading in sharp contrast to the hypo group. Normals were not segregated and were drawn at random.

Procedure

Subjects were run in an open laboratory setting at a large table facing away from the apparatus. All electrodes and the photo pick-up for finger pulse pressure BF were attached to the non-writing hand of each subject. Subjects were run randomly alternating between abnormal and normal.

Stimuli were introduced in the following order: perceptual motor drawing one and two, then rest, then mental multiplication, rest, read one (easiest reading), time out, read two, time out, read three (the most difficult reading). A rest period followed the run. Physiological data was collected continuously.

Apparatus

A Grass Model 8 four-channel polygraph interfaced with a Narco-Bio-Systems, Inc., Solid-State Channel, Amplifier Type 7070 with photoelectric pulse pickup was utilized in collecting heart rate and blood flow in each s. A Stoelting's psychogalvanoscope Cat. No. 24206 with digital readout dial was used in collecting galvanic skin responses.

RESULTS

Table I presents the result of the Kruskalwallis one-way analysis of variance by ranks on these data. This test allows us to decide if these response samples categorized as hypotensive, hypertensive, or normal under different treatments, i.e., resting, perceptual motor treatment, mental multiplication, and during reading, come from the same population with respect to the measured characteristic, i.e., finger pulse pressure, heart rate, and galvanic skin response.

Insert Table I About Here

The three groups were compared using this test for all tasks including the pre-task rest level. The test statistic H taking the chi square distribution must be at or above 5.99 for significance at the .05 level or 9.21 for significance at the .01 level. This is for two degrees of freedom which we have in forming three groups.

The following table lists values of H for FPP, HR, and GSR under the experimental circumstances we have imposed. As can be seen, there is no evidence for a difference between groups showing up during the pre-tasks rest period. Original base resistance differences between groups were computed to ascertain if the base level of resistance matched by our internal bridge network to achieve zero phasic conductance was significantly different between these groups.

Response differences between groups during perceptual motor 2 (the simple drawing task eliciting the most ANS activity) also proved nonsignificant.

During mental multiplication HR and FPP differences proved to be nonsignificant between groups; however, GSR does show up as a highly significant difference during this task.

FPP and GSR both show up as significantly different between groups during this reading period. HR, however, is

nonsignificant during this first reading.

All three measures introduce evidence for a significant difference between groups during the second reading period. H for all three measures shows up as significantly different below the .01 level.

During the third and most difficult reading task all three measures show a significant difference between groups; however, heart rate drops somewhat in its significance level.

TABLE RESULTS I

Resting prior to tasks:	HR:	H = 2.00 NS
	GSR:	H = 3.32 NS
	FPP:	H = 4.76 NS
Perceptual Motor 2:	HR:	H = 2.57 NS
	GSR:	H = 1.80 NS
	FPP:	H = 1.20 NS
Mental Multiplication:	HR:	H = 3.25 NS
	GSR:	H = 12.28 Sig. below .01
	FPP:	H = .90 NS
Read 1:	HR:	H = 2.26 NS
	GSR:	H = 15.48 Sig. below .01
	FPP:	H = 9.33 Sig. below .01
Read 2:	HR:	H = 22 Sig. below .01
	GSR:	H = 16.36 Sign. below .01
	FPP:	H = 14.62 Sig. below .01
Read 3:	HR:	H = 10 Sig. below .01
	GSR:	H = 13.52 Sig. below .01
	FPP:	H = 13.52 Sig. below .01

Figure I Insert Figure I above here.

Data presented above is from the cutaneous constriction measure of finger pulse pressure for all groups across the tasks resting, perceptual motor one, perceptual motor two, mental multiplication, and the three reading periods. The most difficult being the third. As can be seen, the greatest separation between groups is during reading with the third reading task eliciting the greatest hypotensive or hypertensive effect in the abnormal reading groups.

Figure II Insert Figure II above here.

Data presented above is from the galvanic skin response measure for all groups across the tasks resting, perceptual motor one, perceptual motor two, mental multiplication, and the three reading periods. The most difficult being the third. This response measure presents evidence for unitary response of hyper GSR for the abnormal group when compared with the norm group from the math task on. The hypotensive group is actually showing more overall activation on this cholinergically mediated galvanic skin response than the hyper group in sharp contrast to their behavior on the adrenergically mediated cutaneous constriction FPP response category.

Figure III Insert Figure III above here.

Data presented above is from the heart rate measure for all groups across the tasks resting, perceptual motor one,

perceptual motor two, mental multiplication, and the three reading periods. The most difficult being the third. The most massive defense or alarm reaction during reading is exhibited by the hyper group presented in this figure during reading their heart rate their accelerates to an upper limit of 110 beats per minute BPM. The hypo group exhibits a "rebound" during the first reading showing a switch-over to parasympathetic enervation or an inhibition of sympathetic drive or the depletion of adrenergic neurotransmitters associated with accelerating heart rate. The norm group exhibits a mild activation of heart rate placing it between both hypo and hyper groups across tasks, but particularly during reading performance. Inter beat intervals are presented here as the amount of distance between heart beats in millimeters, so that heart rate acceleration is toward the bottom of this figure.

The following three figures (4, 5, 6) present individual data on one subject representative of each of the groups (hypo, hyper, norm). On the ordinate axes of these figures are presented values for: finger pulse pressure, heart rate in millimeters with activation, arousal or sympathetic hyperactivity going toward the top of the figure. Galvanic skin

responses are presented in arbitrary units of phasic up-down conductance able to vary on our scale between -10 and +35 units. This allows a portrayal of the going-togetherness of these three autonomic nervous system variables for each subject across the rest period and tasks.

Figure IV Insert Figure IV above here.

This figure presents data on one normal subject (GF). All values plotted are in the mid-range indicating mild arousal across tasks with considerable fluctuation showing interaction between activating and deactivating forces in the sympathetic nervous system. During reading periods there is a definite, predictable, mild activation on these three variables, and in particular, for finger pulse pressure associated with reading performance in this subject.

Figure V Insert Figure V above here.

Data is presented here on one hypo subject (CT). This figure, in sharp contrast to the previous one, shows a dramatic absence of sympathetic drive activating cutaneous constriction, heart rate and to some extent galvanic skin response. This subject, reading at the 9th percentile rank, exhibits a very flat response pattern from the math task on, in particular.

Figure VI Insert Figure VI above here.

Data on one hyper subject (BY) is presented. This figure shows a definite predictable hyper autonomic nervous system activity associated with reading. Of particular note is the hyper-activation of adrenergically mediated cutaneous constriction and heart rate. This response drop down during the time-out periods being activated as a predictable conditioned effect during reading. Galvanic skin response remains, in general, from the first reading on at the upper limit of its scale.

DISCUSSION

Hypothesis 1

No support is given to the hypothesis that inate, or hereditary, autonomic nervous system differences are responsible for abnormal ANS responses during reading. Although some differences were found between groups in resting FPP values, these proved nonsignificant.

Hypothesis 2

Some evidence has been introduced for a general situational difference between groups for tasks including reading but also other than reading, i.e. a significant difference for GSR during mental multiplication.

However, FPP and heart rate were nonsignificant between groups except during the reading periods.

Hypothesis 3

Evidence is introduced for a specific conditioning of these abnormal (in this context) ANS responses to reading generalizing outward to other tasks.

Hypothesis 4

Adrenergic systems, i.e. FPP and HR, show the most specific bi-phasic conditioning effect. That is to say, hypo and hyper groups place above and below the norm group on these two measures.

Hypothesis 5

The cholinergically mediated GSR shows a diffuse hyperreactive pattern for both dysfunctional reading groups. However, the pattern of this hyperactivity is unidirectional, that is, both dysfunctional groups place above the norm group. This means that for the hypo group there is exhibited a split between the adrenergically mediated cutaneous constriction response category and the cholinergically mediated GSR. Heart rate tends to follow GSR during reading; however, for the group as a whole during Read 1, there is a rebound effect showing the possibility of heart rate following or drop-

ping out with the absence of cutaneous constriction.

These data introduce evidence to the effect that two opposing, coping behaviors are evidentally associated with long term reading dysfunction. The first is a hypotensive reaction indicating a drop below the normal activation or arousal necessary for optimal processing of information, registration and storage to occur. The other reaction is one of hypertensiveness where all arousal mediating sympathetic nervous system factors are activated into an alarm reaction, making it equally difficult to attend to external stimuli and information processing as during reading.

These data introduce evidence whereby noradrenaline in hyper or hypo amounts within the peripheral nervous system is associated with long term reading dysfunction.

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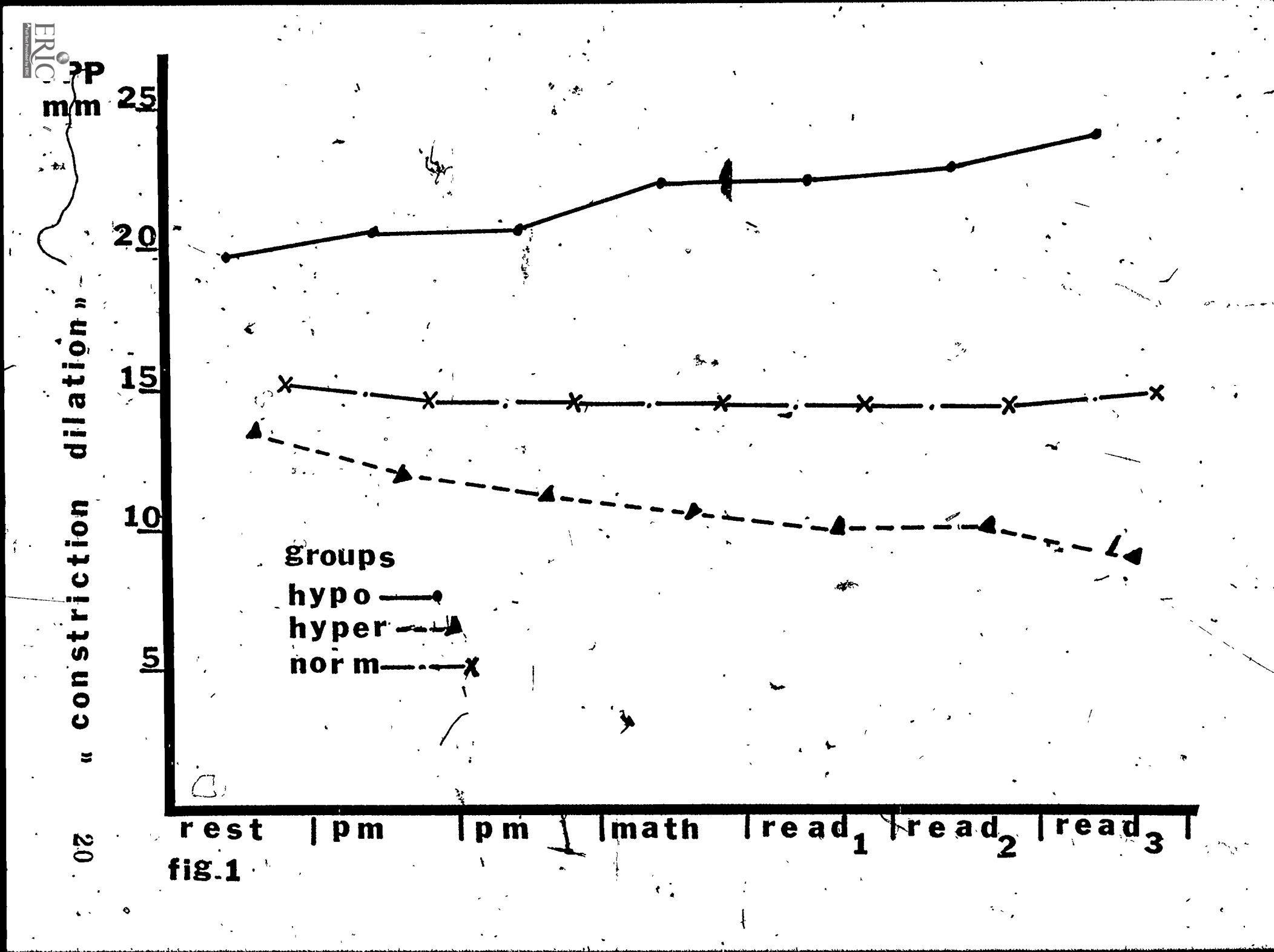
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fig.1

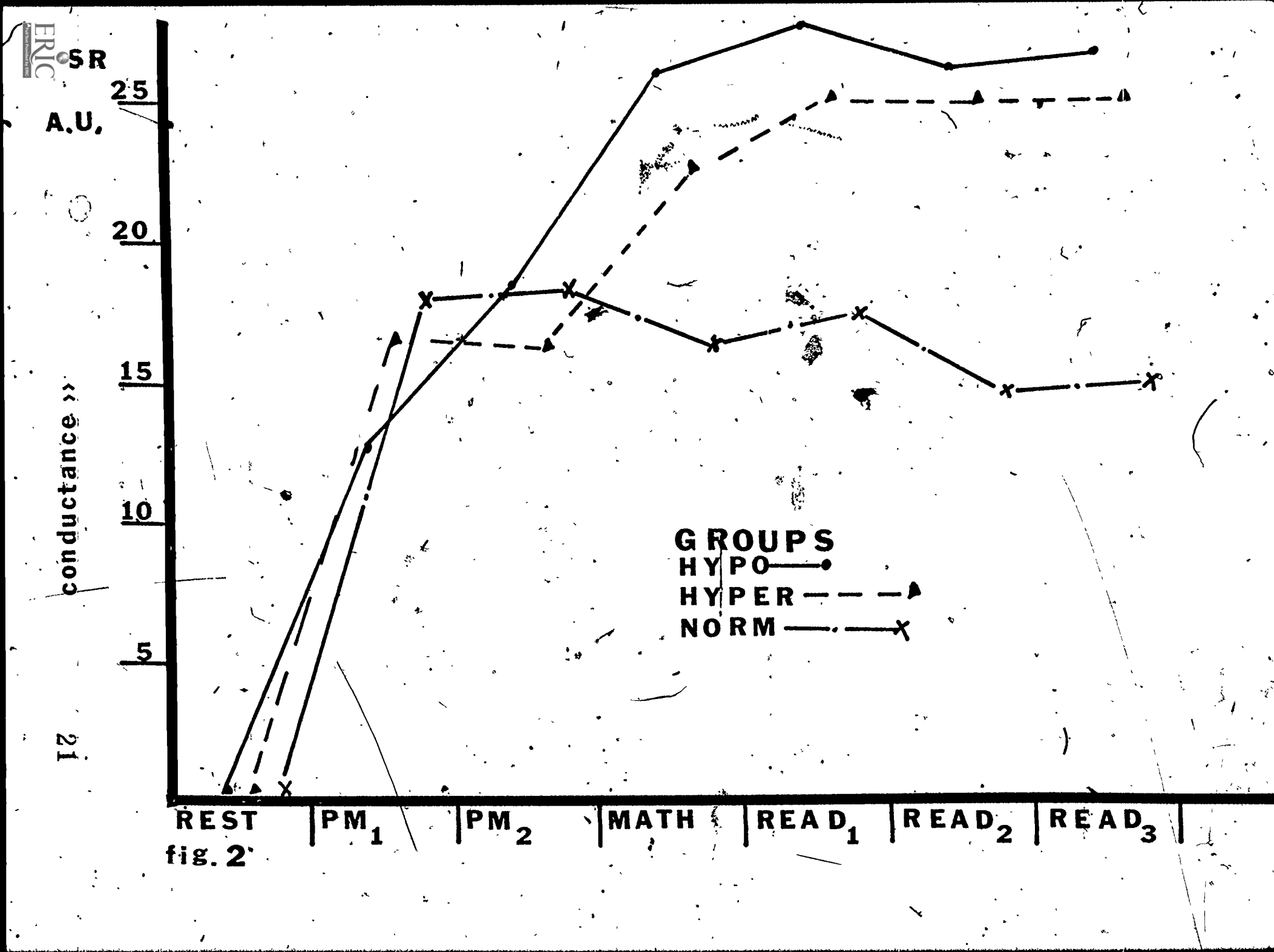
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fig. 2

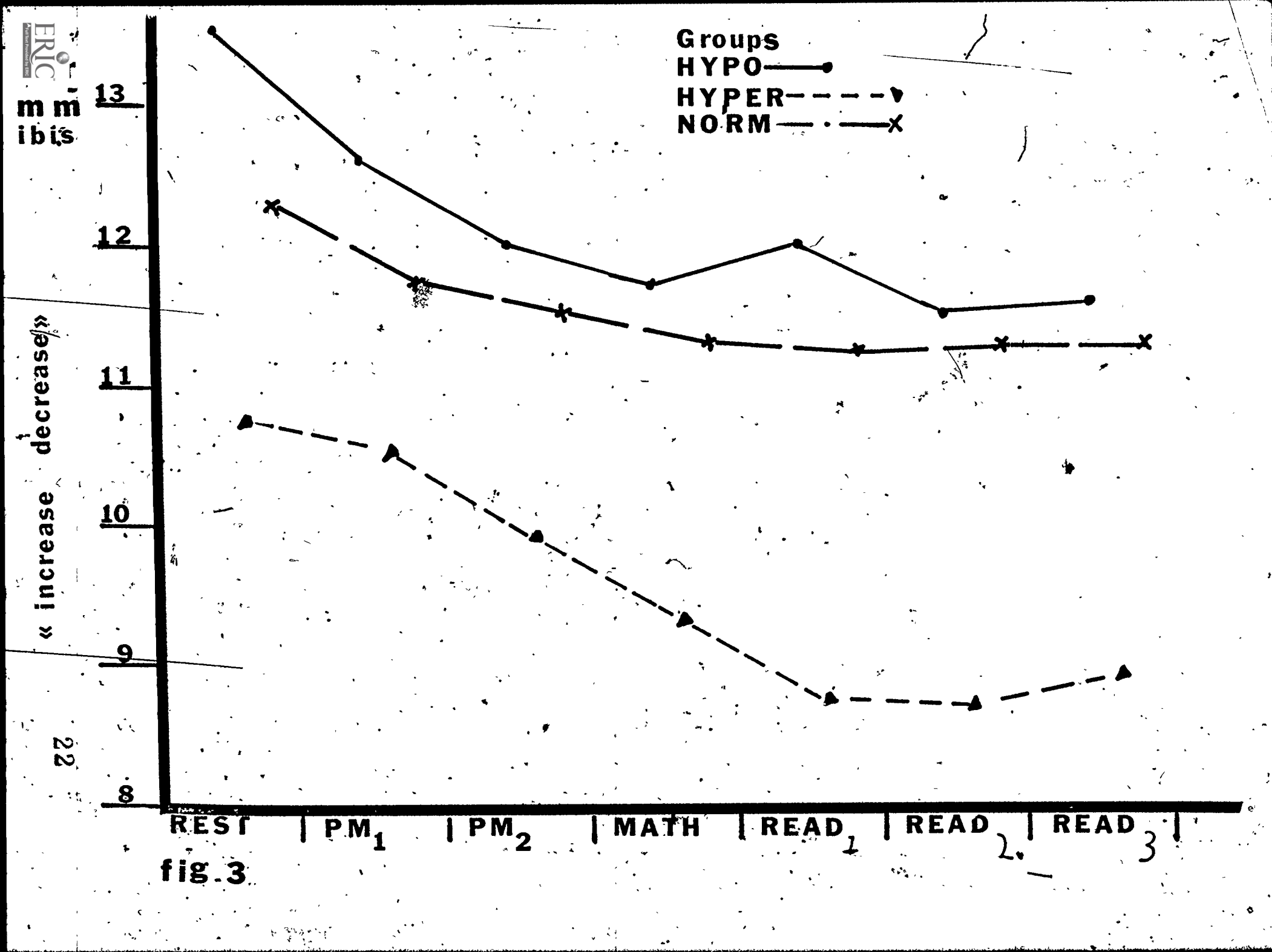
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fig. 3

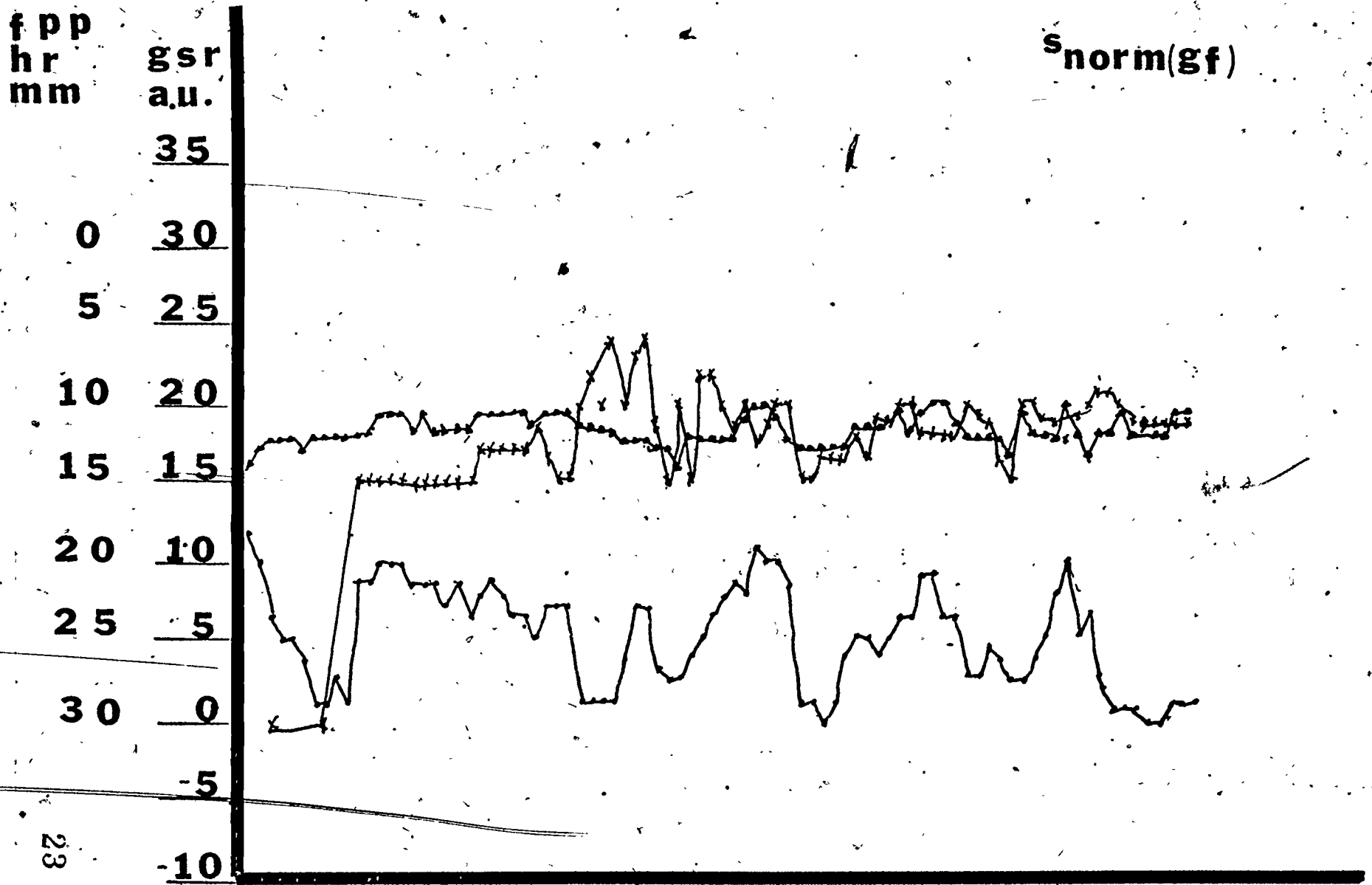
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fig.4

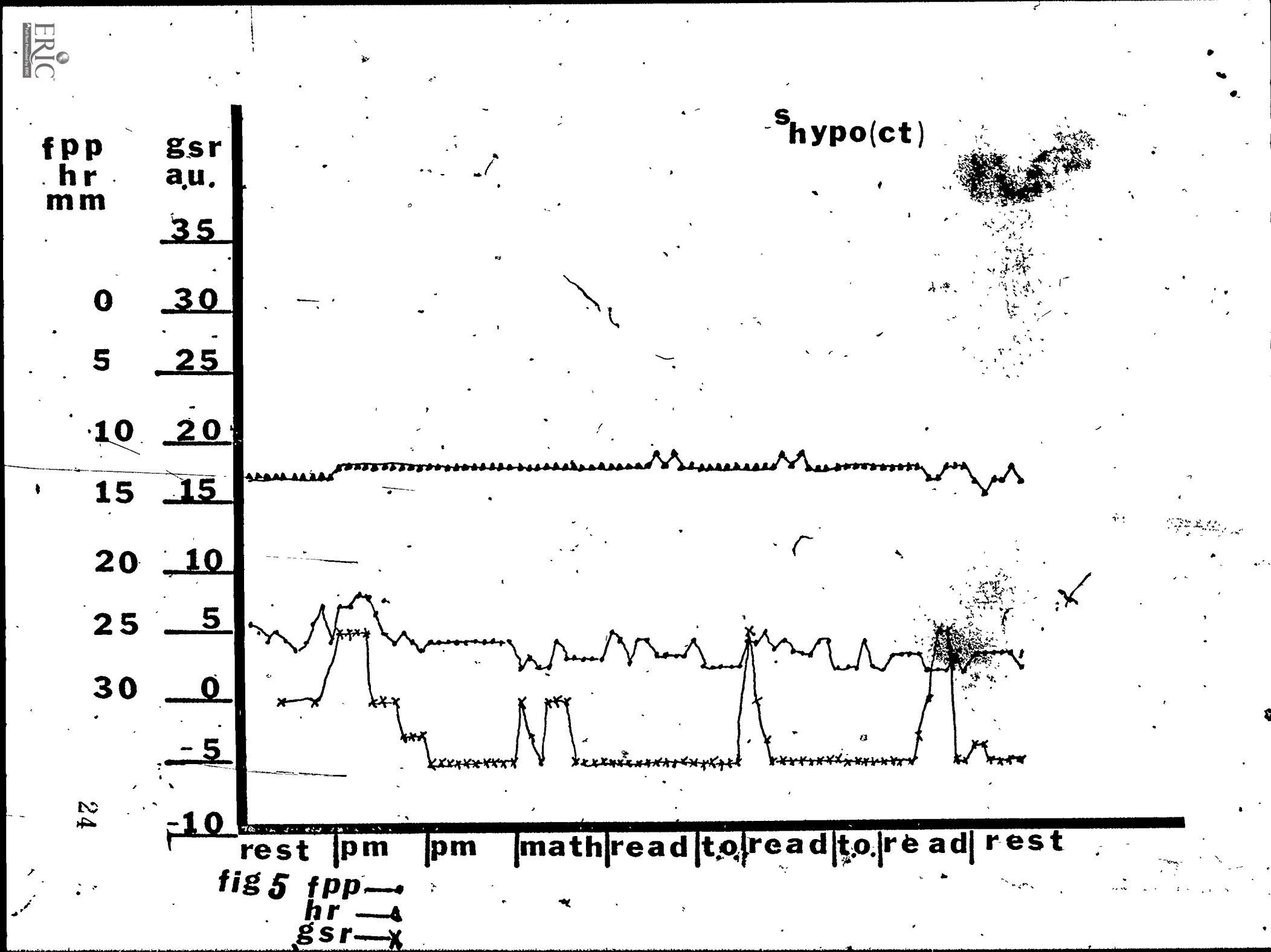

fig 5 fpp
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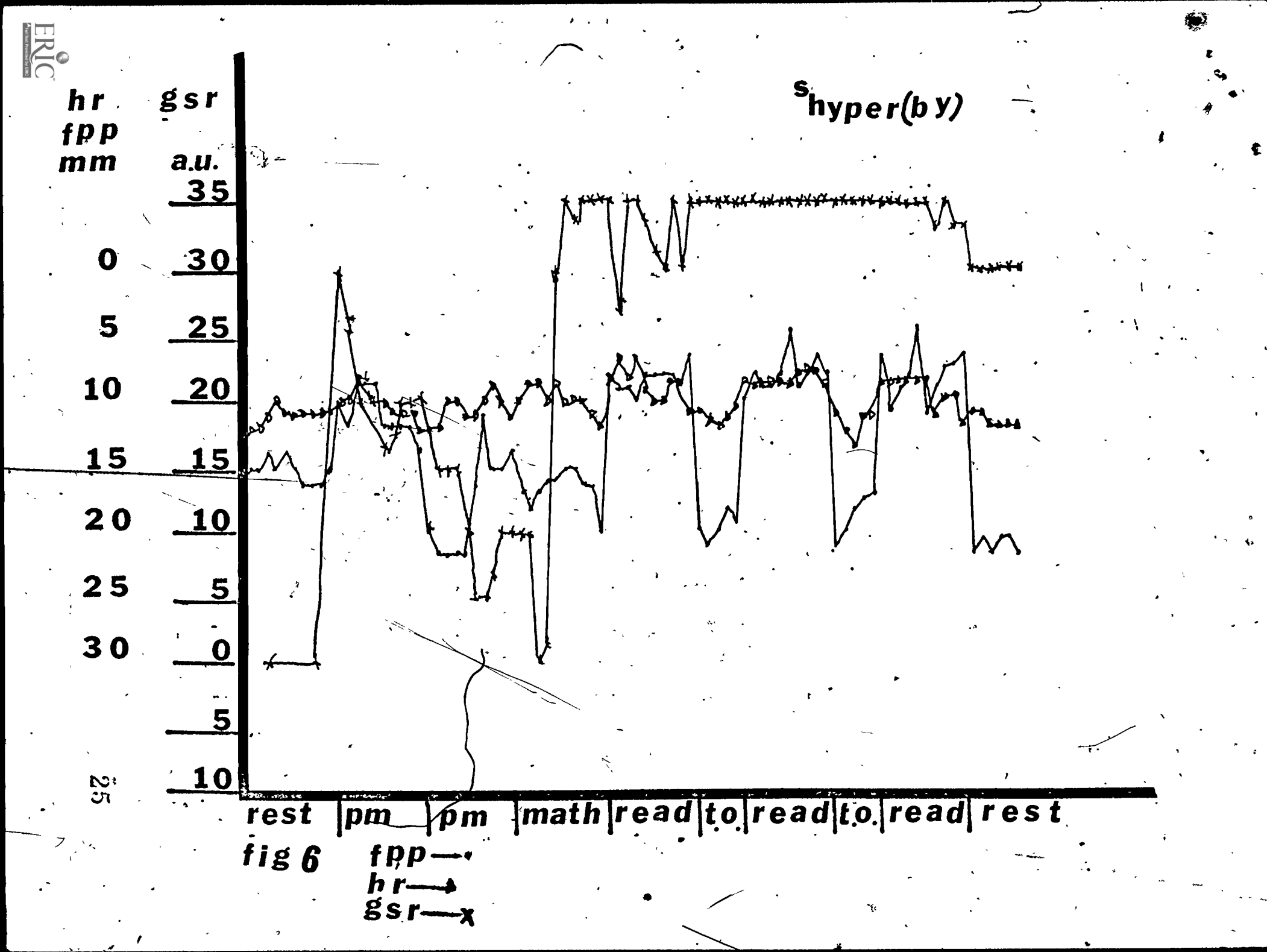
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fig 6