The Early Signs of Autism in First Year of Life: Identification of Key Factors Using Artificial Neural Networks

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BACKGROUND AND OBJECTIVES

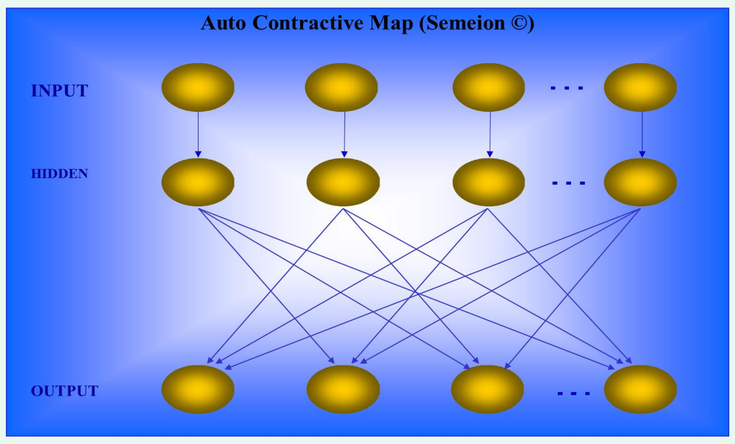
In a previous study we have presented an innovative methodology to detect early manifestations of autism, using retrospective analysis of parents' video-recordings of their children's first year of life, filmed before any suspicion concerning defective development arose. Traditional statistics did not allow to handle all the information available due to the high intrinsic non linearity and skewed distribution of symptom frequencies. Similar problems hampered the understanding of natural relationships among factors on study, taking into account simultaneously occurrence, their severity and their precocity in onset. The aim of the study is to assess the natural relationships among variables associated with autism onset.

MATERIALS AND METHODS

This continued data set is composed of 16 variables displayed in 110 infants (76. % boys and 24% girls between the ages of 3-15 months) who were diagnosed with autism at the age of 2-3 years, using retrospective analysis of video-recordings of the infants' first year of life. In addition, interview questionnaires were distributed to the parents. Variables investigated were: Excessive Passivity; Excessive activity; Lack of reaction to voice or presence; Lack of eye contact; Aversion to touch; Delayed motor development; Accelerated growth of head circumference; Resistance to eating; Refusal to eat vegetables/fruit; Refusal to eat solid food; Nutrition fixation; Crying; Aggression; Excessive eating; Obsession with doors; Breath holding. All variables were measured blindly according to a validated evaluation form. All variables were objectively measured according to a validated evaluation form scoring.

Traditional statistics (Principal component analysis [PCA]) and Artificial Neural Networks (Auto-CM system) were applied to highlight the associations among variables under study. Auto-CM (see figure 1) is a special kind of Artificial Neural Network developed at Semeion Research Institute (Rome) and successfully applied in many complex chronic degenerative diseases, able to find out consistent trends and associations among variables creating a semantic connectivity map. The matrix of connections, visualized through minimum spanning tree filter, takes into account nonlinear associations among variables and captures connection schemes among clusters.

Fig.1. Scheme of Auto-CM, fist generation of Artificial Neural Network (ANN), used for data mining



References : Buscema M, Grossi E. The semantic connectivity map: an adapting self-organising knowledge discovery method in data bases. Experience in gastro-oesophageal reflux disease. Int J Data Min Bioinform. 2008;2(4):362-404.

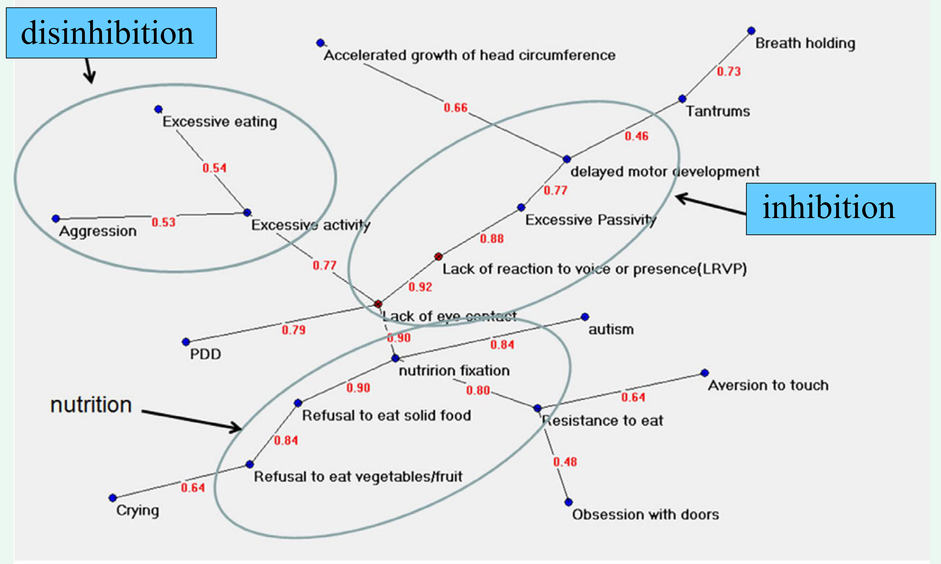
Methodology highlights

- Accurate review of published epidemiological studies
- Selection of features in videotapes by expert therapists in consensus
- Strong cooperation by the parents
- Use of Artificial Neural Networks to handle the data

RESULTS

Auto-Contractive Map (Auto-CM) is a new data mining tool based on an Artificial Neural Networks developed at Semeion Research Center, that is especially effective at highlighting consistent patterns and/or systematic relationships and hidden trends and associations among variables. Associations, linear or non linear, are visualized as links by transforming the weights determined by Auto_CM into physical distances and applying a simple mathematical (minimum spanning tree) to the matrix of distances. The graph obtained allows a very intuitive visual mapping of the complex web of connection schemes among variables, and greatly eases the detection of the variables that play a key role in the schemes, i.e. that appear to be "hubs" of the graph, generally located in the central part.
As **figures 2** shows, the variables connection scheme of early symptoms is remarkably complex with many branches, hubs and interconnections.

Fig.2 Semantic connectivity map of variables in autistic group



Nota bene: The figures express the strenght of the link

Principal Component analysis was unable to show meaningful trends of variables associations with inconsistent results between first-second component and third-fourth component. On the other hand the semantic connectivity map developed by Auto-Cm system showed a meaningful scheme of connections. Lack of eye contact and lack of reaction to voice or presence resulted the central nodes in the graph. Variables describing inhibition (Lack of eye contact; Lack of reaction to voice or presence; Excessive Passivity; Delayed motor development); disinhibition (Excessive activity; Aggression; Excessive eating) and nutrition habits, (Resistance to eating; Refusal to eat vegetables/fruit; Refusal to eat solid food; Nutrition fixation)were naturally clustered together, in parallel diverging along the graph. Autism diagnosis resulted directly linked to nutrition fixation. Five variables composed an internal loop in the graph(Excessive Passivity; Lack of reaction to voice or presence; Lack of eye contact; Nutrition fixation and refusal to eat solid food) pointing out hypothetical core signature of the disease.

CONCLUSIONS

✓ **Findings from this study indicate the presence of three major macro-classes as a three-leaf clover that aggregates in its "leaves" the more mutually connected variables. In this regard derangement in nutrition behavior play an important role in early diagnosis of autism possibly higher than well recognized manifestations like lack of eye contact and lack of reaction to voice or presence.**

✓**The use of ANNs may be an important advance in autism research.**