



# Potenziali marker linguistici dell'Anoressia Nervosa: uno studio pilota

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The background features a complex abstract design. It includes a large red shape with white wavy lines, a bright yellow-green shape with white wavy lines, and a dark brown shape with white dots. There are also smaller yellow-green shapes with white dots and a dark brown shape with white dots. The overall composition is layered and textured.

# Linguistic Biomarkers

- **Clinical Linguistics:** «the branch of linguistics that applies linguistic concepts and theories to the study of language disorders»

[Cummings, 2017]

- **Natural Language Processing methods and tools** for the analysis of written and spoken texts, to reveal latent patterns and regularities in pathological speech.
- **Subtle language disruptions** can be employed as **Digital Linguistic Biomarker:** «objective, quantifiable behavioral data that can be collected and measured by means of digital devices, allowing for a low-cost pathology detection, classification and monitoring»

[Gagliardi, Kokkinakis & Duñabeitia, 2021]

## Linguistic Profile of Anorexia Nervosa

- Many works have been published on the “**linguistic profile**” of various clinical populations (e.g., Autism Spectrum Disorder, Mild Cognitive Impairment and Dementia, Parkinson's Disease, Depression)
- However, **very few papers** have been devoted to linguistic changes in **patients with eating disorders**

# Feeding and Eating Disorders

- **Feeding and Eating Disorders (FED)** are characterized by “a persistent disturbance of eating or eating-related behavior that results in the altered consumption or absorption of food and that significantly impairs physical health or psychosocial functioning”

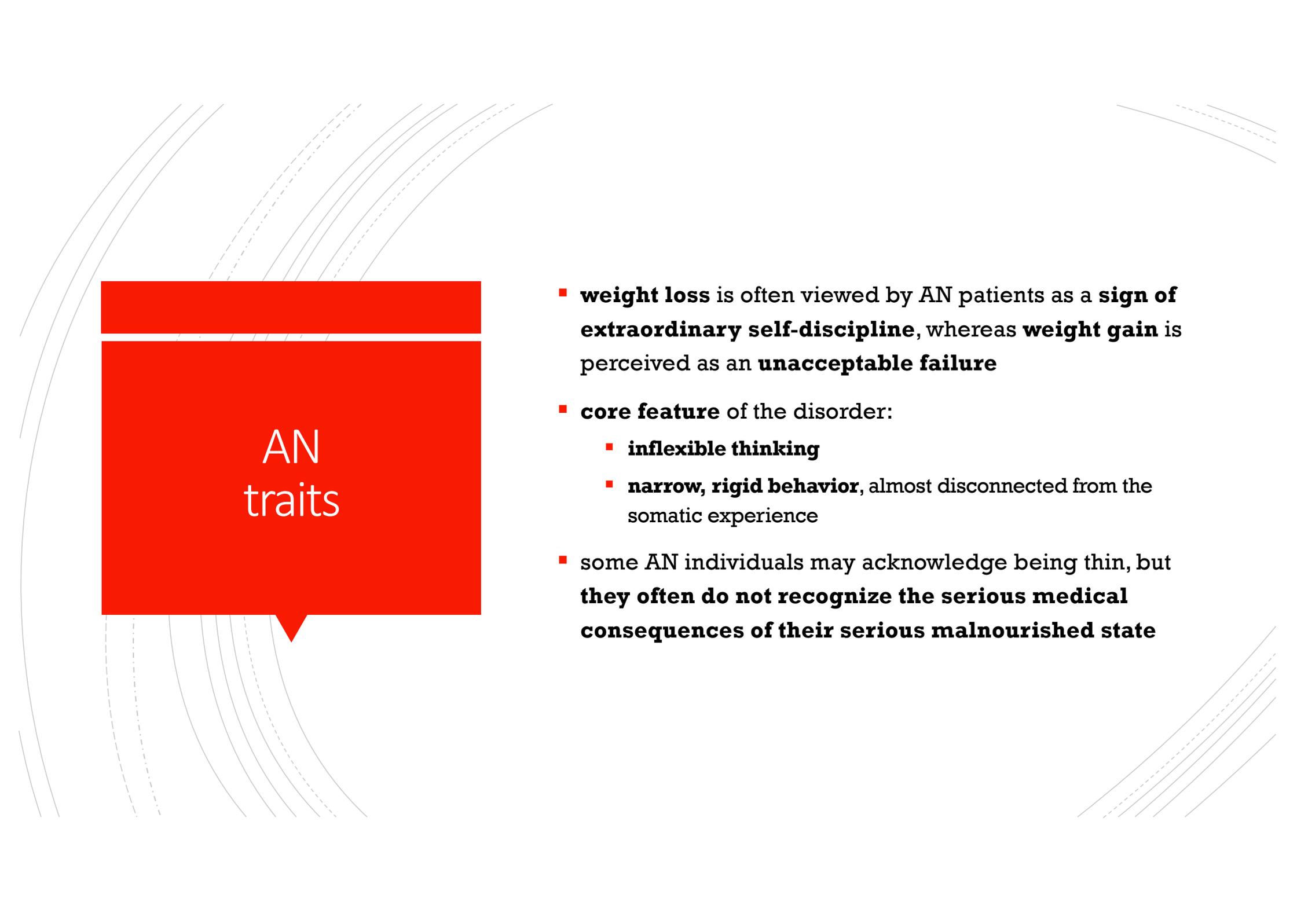
DSM-5 [American Psychiatric Association, 2013]

# Anorexia Nervosa [1]

- **Anorexia Nervosa** (ICD10-CM codes: F50.01-F50.02)
  1. persistent **energy intake restriction**, leading to a significantly **low body weight** (i.e., less than minimally normal or, for children and adolescents, less than that minimally expected) in the context of age, sex, developmental trajectory, and physical health;
  2. intense **fear of gaining weight or of becoming fat** (also known as “fat phobia”), or persistent behavior that interferes with weight gain, usually not alleviated by slimming
  3. **disturbance in self-perceived weight or shape**

# Anorexia Nervosa [2]

- **AN** takes on a **special relevance**, due to both epidemiological reasons and medical outcomes
  - relatively **common among young women**: one-year **prevalence rate** 370 per 100000 young females [Hoek, 1993; Smink *et al.*, 2012]
  - **elevated mortality risk**: AN shows the highest mortality rates among psychiatric pathologies, 5.1 deaths per 1000 person-years, of which 1.3 deaths resulted from suicide [Harris & Barraclough, 1998; Arcelus *et al.*, 2011]

The background features several sets of curved lines in shades of gray, some solid and some dashed, creating a sense of movement and depth. A prominent red speech bubble shape is positioned on the left side of the slide.

## AN traits

- **weight loss** is often viewed by AN patients as a **sign of extraordinary self-discipline**, whereas **weight gain** is perceived as an **unacceptable failure**
- **core feature** of the disorder:
  - **inflexible thinking**
  - **narrow, rigid behavior**, almost disconnected from the somatic experience
- some AN individuals may acknowledge being thin, but **they often do not recognize the serious medical consequences of their serious malnourished state**

## AN diagnosis

- A **prompt identification (and treatment)** of symptoms is linked to **better outcomes** [Herzog *et al.*, 1996]
- Unfortunately, the **diagnosis of AN is often elusive**, and more than one half of all cases go undetected in the primary care setting [Becker *et al.*, 1999]
- Current research continues to emphasize the **need for novel reliable strategies** to identify even early warning signs

# Linguistic Profile of AN [1]

- **little research has addressed the linguistic profiles of AN**

- **«pro-ana» blogs**
- **body's symbolic role and «concretized metaphors»**  
i.e., «instances where the metaphors are not experienced as indirect expressions showing something thus mediated, but they are experienced as direct and bodily revelations of a concrete reality»

[Enckell, 2002; Skårderud, 2007]

e.g., heaviness/lightness:

“I feel sad. And when I am sad, I feel burdened and heavy... and then comes the urge to lose weight”

## Linguistic Profile of AN [2]

- All these insights are not clear-cut and conclusive. Thus, the **Linguistic profile of AN** (and FED in general) **remains**, to date, mostly **unexplored**.
- Moreover, all the retrieved studies tackled verbal productions written in a language that belongs the **Germanic language group**: English, German or Norwegian. Given the peculiar typological features of Italian language (e.g., at the morphosyntactic level), **these results cannot be readily generalized**.

# Rationale

- **We hypothesize that:**
  1. **disturbances in self-perceived body image, black and white thinking and mood changes** strongly associated with AN disorder **can results in altered linguistic patterns**
  2. these subtle modifications **can be detected by means of NLP tools**, acting as early proxy measures for the disorder
- To test our hypothesis, **the study will compare some short, written productions of AN patients with those of a control group**, in order to identify possible distinctive linguistic features
- To the best of our knowledge, **this is the first work on linguistic profile of AN in Italian**

## Data collection

- The study was approved by the **Ethics Committee of Azienda Ospedaliero-Universitaria di Bologna, Policlinico Sant'Orsola-Malpighi**

(prot. 683/2019/Oss/AOUBo)

- We enrolled **51 participants**, ranging in age from **14 to 18**
- The sample is composed of an **Anorexia Nervosa group (AN)** and a **Control Group (CG)**, with a ratio of 1:2

GROUP	N	AGE (mean ± sd)	YEARS OF EDUCATION (mean ± sd)
AN	17	16 ± 1.37	11.06 ± 1.34
CG	34	16 ± 1.35	11.15 ± 1.28

## Language Proficiency in Italian

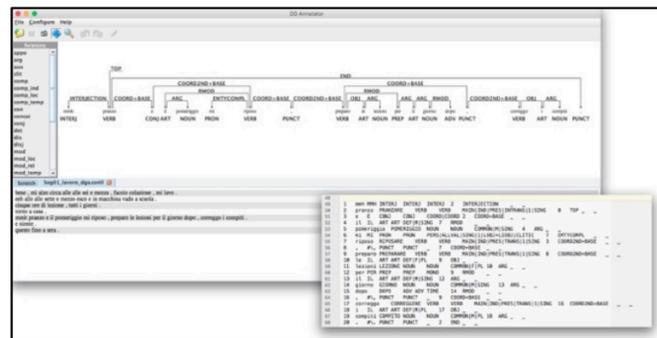
- Bilingualism and multilingualism are the norm rather than the exception in today's Italy
- **Language proficiency in Italian has been assessed,** by means of a **short self-reported questionnaire**
- This additional test aims at assessing both **quality and quantity of bilingual experience**, in order to remove from the sample poor productions due to scarce language exposure

- Subjects were asked to produce **three short written texts** (around 10-15 lines long)
  1. **personal task (-PER-)**: “How would you describe yourself? (Please, talk about your physical and personality traits, your hobbies etc.)”
  2. **neutral task (-NEU-)**: “How do you usually spend time with your friends?”
  3. **description of a complex picture (-FIG-)**  
stimulus: “Cookie theft”, from the BDAE - Boston Diagnostic Aphasia Examination Battery [Goodglass et al., 2001]



# Data analysis [1]

- **The handwritten texts have been converted into digital texts manually by the linguists**
- After the automatic tokenization of the transcripts, all the sentences have been **automatically PoStagged, lemmatized and syntactically parsed** with the dependency model used by the Turin University Linguistic Environment – TULE [Lesmo, 2007]
- **All the annotations have been manually checked** by one linguist, in order to remove the errors introduced by the automatic tagging
  - The revision has been made by using the Dependency Grammar Annotator - **DGA opensource**



## Data analysis [2]

- **A multidimensional parameter analysis has been performed on the corpus**
  1. Examining the relevant literature, we calculated a wide range of **linguistic/stylometric indexes** [Calzà *et al.*, 2021; Gagliardi & Tamburini, 2021]
  2. We used the **software LIWC (Linguistic Inquiry and Word Count)** [Chung & Pennebaker, 2007; Tausczik and Pennebaker, 2010; Agosti & Rellini, 2007]
- The **statistical significance** of differences between AN and controls on all the indexes has been evaluated with the **Kolmogorov–Smirnov non-parametric test**, because of the small size of our corpus
- **R statistical software** has been used for the analysis

# Results [1]

- **Text length** (in token) produced by the groups for each task

task	AN (mean ± sd)	CG (mean ± sd)
task1 -PER-	98.63 ± 42.94	105.5 ± 35.05
task2 -NEU-	61.53 ± 40.98	68.56 ± 31.55
task 3 -FIG-	81.50 ± 40.02	77.15 ± 24.13
overall	80.22 ± 43.16	83.74 ± 34.18

- As corroborated by the statistical analysis, the three stimuli show different “elicitation power”: the **“personal task” prompted richer responses** in both samples
  - Kruskal-Wallis non-parametric test with Dunn's multiple comparison, p-value < 0.001
- However, **the most effective task is the description of a complex picture -FIG -**

## Results [2]

FEATURES	task 1 -PER-	task 2 -NEU-	task 3 -FIG-	overall
LEX_ContDens			*	
LEX_PoS_ADV	*			
LEX_PoS_CONJ				*
LEX_PDEIXIS		*		
LEX_HonoreR			*	*
SYN_NPLENSD		*		
SYN_GRAPHDISTM				**
SYN_SLENM	*			**
SYN_SLENSD	*			*
LIWC_WPS		*		*
LIWC_SIXLTR			*	***
LIWC_DIC		*	***	
LIWC_PERCP		*		
LIWC_PRES			*	

- linguistic tasks not directly pertaining to psychological and bodily states provide a non-reactive way to explore social and personality processes [Chung, 2007]
- aggregated tasks represent the best testing ground for the evaluation of subtle linguistic alteration

## Conclusions

- From the qualitative point of view, **syntactic reduction** appears as the most relevant trait of AN productions
- In particular, the following features emerge as **statistically significant** in distinguishing AN girls and their normal-weighted peers:
  1. **the length of the sentences**
  2. **the complexity of the noun phrase**
  3. **global syntactic complexity**
- **This peculiar pattern** of linguistic erosion **may be due to** the severe **metabolic impairment** also affecting the central nervous system in AN

## Future works

- Additional evidences are needed to assess the actual reliability of linguistic parameters as biomarker of AN
- Future works should also consider possible correlation between linguistic and clinical variables:
  - diagnostic subtypes (“restricting” or “binge-eating/purging”),
  - severity
  - physical signs and symptoms (e.g., amenorrhea)
  - comorbidity (e.g., bipolar, depressive, anxiety, or obsessive-compulsive disorders)
  - age of the onset
  - pharmacological treatment with Selective Serotonin Reuptake Inhibitors (e.g., fluoxetine, sertraline, fluvoxamine), anxiolytics (e.g., benzodiazepines) or antipsychotics (e.g., olanzapine, quetiapine)



Grazie per  
l'attenzione!

Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity  
<https://doi.org/10.1007/s40519-021-01273-7>

ORIGINAL ARTICLE



## Linguistic feature of anorexia nervosa: a prospective case–control pilot study

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