Impression formation: A time-based panel study with students at a Brazilian public university

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Published in 1946, Asch's study was a heuristically important paradigm in the field of impression formation research, in particular for suggesting that an initial impression, even if strong enough to anchor subsequent social judgments (primacy effect), could be modified if the perceiver were offered decisive information capable of leading to a transformation of the initial impression (centrality effect). The present study reports the testing of a modified version of Asch's paradigm, conducted over 9 years, with 667 university students from the northeast region, aiming to identify, the joint effect of a photo and the attribution of psychological traits on impression management of a fictional teacher. We can conclude that both categorization and centrality influence the formation of impressions.
Keywords: Impression formation; perception; psychological traits; Bayesian statistics; machine learning.

Formación de impresiones: Un estudio de panel basado en el tiempo con estudiantes de una universidad pública brasileña
Publicado en 1946, el estudio de Asch fue un paradigma heurísticamente importante en el campo de la investigación sobre la formación de impresiones, en particular por sugerir que una impresión inicial, incluso si era lo suficientemente fuerte como para anclar juicios sociales posteriores (efecto de primacía), podría ser modificada si al observador se le ofreciera información decisiva capaz de llevar a una transformación de la impresión inicial (efecto de centralidad). El presente estudio reporta la prueba de una versión modificada del paradigma de Asch, realizada a lo largo de 9 años, con 667 estudiantes universitarios de la región noreste, con el objetivo de identificar el efecto conjunto de una foto y la atribución de rasgos psicológicos en la gestión de impresiones de un profesor ficticio. Concluimos que tanto la categorización como la centralidad influyen en la formación de impresiones.
Palabras clave: Formación de impresiones; percepción; rasgos psicológicos; estadísticas bayesianas; machine learning.

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Formação de impressões: Um estudo de painel baseado em tempo com estudantes de uma universidade pública brasileira

Publicado em 1946, o estudo de Asch foi um paradigma heuristicamente importante no campo da pesquisa de formação de impressões, em particular por sugerir que uma impressão inicial, mesmo que forte o suficiente para ancorar julgamentos sociais subsequentes (efeito de primazia), poderia ser modificada se ao observador fossem oferecidas informações decisivas capazes de levar a uma transformação da impressão inicial (efeito de centralidade). O presente estudo relata o teste de uma versão modificada do paradigma de Asch, conduzido ao longo de 9 anos, com 667 universitários da região nordeste, visando identificar o efeito conjunto de uma foto e a atribuição de traços psicológicos no gerenciamento de impressões de um professor fictício. Concluímos que tanto a categorização quanto a centralidade influenciam a formação de impressões.

Palavras-chave: Formação de impressão; percepção, traços psicológicos; estatísticas bayesianas; machine learning.

The literature on impression formation has a long history (Uleman & Kressel, 2013), although it became the subject of systematic scientific scrutiny only from the mid 20th century (Cronbach, 1955; Heider & Simmel, 1944; Thorndike & Stein, 1937). The legacy of the Polish psychologist Salomon Asch has been considered a decisive turning point in the development of studies in the area, mainly for highlighting the importance of *first impressions*, especially when anchored in the sociability dimension, and for emphasizing the decisive role of the *centrality* of certain psychological characteristics in the initial formation of impressions. The literature establishes the understanding that the initial impression of a central trait is a crucial element in the subsequent management of the impression about a person (Asch, 1946), although this initial impression can be modified in the face of new information endowed with a high degree of centrality or importance to the perceiver. The configuration of the psychological traits attributed to the target of the judgment, especially the dimensions of primacy, recency and centrality, as well as the characteristics of the perceiver and the context in which the impression is formed, have become fundamental elements in the underlying research on the formation of impressions.

Due to theoretical, conceptual and methodological problems concerning the absence of a hegemonic model capable of enumerating and organizing psychological traits and offering a formulation on how these traits are integrated to configure people's perception (Rosenberg et al., 1968), a new tradition of studies develops. In this approach, psychological traits, that is, contents, no longer occupy a central position and are replaced by the investigation of psychological processes. Initially, this new conception for the study of impression formation is organized around the notion of information processing, a tradition that is strengthened by studies guided by the notion of *schema*, defined as a cognitive organization capable of offering the interpretative framework from which later

social judgments could be implemented (Cantor & Mischel, 1977; Higgins, 1996). Subsequently, the role played by stereotypes is accentuated (Andersen & Klatzky, 1987), although, under the influence of European social psychology from the 1960s, studies became strongly influenced by the concept of social categorization (Tajfel, 1969).

In the educational context, the formation of impressions is a determining factor in interactions between teachers and students, directly impacting academic performance and institutional commitment. This process is linked to the activation of stereotypes constructed in the classroom, which contribute to confirming the prior expectations of students and teachers and, consequently, to maintaining academic inequalities. By influencing mutual perceptions and guiding behavior, impression formation acts as a subtle yet effective mechanism in maintaining unequal educational trajectories.

In the specific case of forming impressions about teachers, the central theme of the present study, categorical reasoning and the subsequent stereotyping process represent decisive elements in the literature, especially when the judgment takes place *online*, under conditions of uncertainty or under time pressure. The experimental paradigm adopted in the present study, as observed in the diagram found in figure 01, embraces the assumption that when performing tasks in a web environment, in which photographs are presented and a subsequent textual description of a characterological profile, the photograph is the starting point for the formation of impressions, as this has the ability to initially attract the attention of the perceiver (Scott & Hand, 2016; van der Zanden et al., 2022).

Given that the three basic modalities of *social categorization* (sex, age and racial-ethnic profile) are processed quickly and almost automatically, and that the teachers' sex, both portrayed as men, and the racial-ethnic profile, both characterized as white, were maintained constant in the experimental task, it is possible to assume that the social category age has a decisive role in the formation of impressions, depending on the experimental group, due to the age differences evident in the photographs.
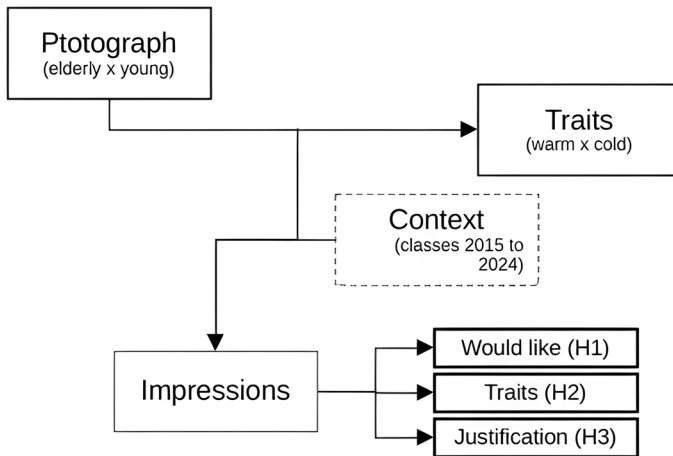
Figure 1. Diagram of the experimental model and respective hypotheses

Once this initial stage has been completed, impressions are formed and managed, with the attribution of adjectives, *psychological traits*, being particularly decisive in this process, whose predicates indicate the presence of stable psychological structures, capable of imposing themselves on differences that may be present in different situations. The establishment of a theoretical model on the formation of impressions based on this psychological attribute involves the enumeration of the traits, which are numerous, as well as the identification of how they are organized. This theoretical choice sparked heated debates between defenders of a linear model (Asch, 1946) and those who postulated more holistic models (Anderson, 1981).

The attribution of certain psychological traits to the target of the trial, such as affection, it is of decisive importance, depending on the characteristics of who is being judged, who conducts the trial and the context in which the trial takes place. In the specific case of Asch's study, it is suspected that cold or warm psychological traits are central in the formation of impressions about the person, and are expected to have significant effects on the subsequent management of impressions.

In light of what was exposed in the previous paragraphs and, in line with the previously presented diagram, we hypothesize that both the initial formation of the impression, represented by the photograph of a teacher and a small text in which a descriptive profile of the teacher is presented, and the central features, represented by the inclusion of the psychological traits warm or cold, will impose differences in judgment regarding:

H1) the participant's decision as to whether or not they would like to have X as a teacher.

H2) to the differential attribution of psychological traits; and.

H3) to formulate descriptions that justify the choice exposed in H1.

Method

The data collection procedure was entirely *online*, using the EF Survey platform. The research can be characterized as an experimental study with a 2 x 2 design, in which participants received the same information, except regarding the photograph of the professor (presented as elderly or young) and the differential attribution of a central psychological trait (warm or cold). Since the data were collected successively over fifteen academic semesters, the study can also be considered as a temporal panel study.

Participants

667 students participated in the study, all regularly enrolled in a Brazilian public university, located in the northeast region. Participants were distributed over 15 academic semesters, between April 2015 and April 2024, totaling a period of 9 years. Data collection was carried out collectively, in the same laboratory and under the supervision of a single experimenter. The valid response rate was 82.7%, with an average response time of 17.1 minutes.

Table 1

Numbers and participants, distributed by academic semester

Semester	Frequency	&	% valid	% cumulative
2015_1	28	4.198	4.198	4.198
2016_1	52	7.796	7.796	11.994
2016_2	39	5.847	5.847	17.841
2018_1	33	4.948	4.948	22.789
2018_2ª	35	5.247	5.247	28.036
2018_2b	46	6.897	6.897	34.933
2019_1	61	9.145	9.145	44.078
2019_2	27	4.048	4.048	48.126
2021_1	32	4.798	4.798	52.924
2021_2	62	9.295	9.295	62.219
2022_1	31	4.648	4.648	66.867
2022_2	37	5.547	5.547	72.414
2023_1	87	13.043	13.043	85.457
2023_2	54	8.096	8.096	93.553
2024_1	43	6.447	6.447	100.000
Total	667	100.000		

As seen in table 01, external circumstances, particularly associated with strike movements carried out by teachers in 2017 and the suspension of academic activities at the institution due to the COVID-19 epidemic (2020), prevented data collection in some semesters. Furthermore, the rearrangement of the university's academic calendar led to the offering of subjects for two different classes in the same academic semester (2018.1)

Procedures

The experimental task of forming impressions about the professor was implemented using a photograph positioned in the upper left corner of the computer screen, accompanied by a text containing the following terms:

This is professor José Paulo da Fonseca. He graduated from the University of São Paulo and completed his postgraduate studies abroad.

Below we indicate some characteristics of professor José Paulo.
Intelligent
Skillful
Worker
Warm or cold (depending on the experimental condition)
Decided
Practical
Prudent

Instrument

For the purposes of testing the proposed hypotheses, the following dependent variables were measured, drawn from the following questions:

H1) The scalar variable relating to the answer to the question "Would I like to have a professor like X" (1 = no; 2 = more or less; and 3 = yes).

Would you like to have a professor like him in your classroom?
No
More or less
Yes

H2) The scalar variable related to the attribution of agreement with the application of adjectives to professor X, measured on a 4-point Likert format scale, presented in random order to each participant. (See supplementary material 1)

H3) The variable in *string* format, relating to the justifications presented for the answer to question 1. (See supplementary material 2)

Data analysis

The design adopted in the study was an experimental design of independent samples 2 (photo: young x elderly) x 2 (traits: warm x cold). Participants' responses to questions related to hypotheses 1 and 2 were treated in accordance with Bayesian statistical analysis procedures in the JASP *software*, version 0.18.3. The use of Bayesian statistics is justified due to the reduced sample size and in order to offer a more direct interpretation of the results than frequentist statistics, since the Bf value represents an alternative to the presentation of confidence intervals. The analysis of the justifications provided by the participants was conducted with the help of Orange Data Mining *software*, version 3.36.2. The Orange Data Mining is a front-end applied to the Python programming language, developed from libraries specialized in data analysis, such as Pandas and Scikit-learn.

Discussion

To test hypothesis 1, we conducted a Bayesian factorial ANOVA, using the variables photo (elderly x young) and traits (cold x warm) as the independent variable and the answer to the question whether you would like to attend classes with the professor configured as the dependent variable. The interaction model between the two variables resulted in a robust statistical model (BF_{10} = 443,2), suggesting the need to consider both the two individual variables and the interaction between them. The averages for each of the experimental conditions are plotted in the graph found in figure 02, showing that being presented as cold considerably reduced the professor's acceptance, regardless of being presented as an elderly or young person. (2,19 ± 0,64 x 2,17 ± 0,75).

On the other hand, in the condition in which the professor was characterized as a warm person, a tendency of preference for the professor represented as an elderly person compared to a young one can be identified (2,51 ± 0,61 x 2,34 ± 0,70). Main effects analyses, however,

point to the need to separately consider the effect of primacy and centrality of psychological traits.
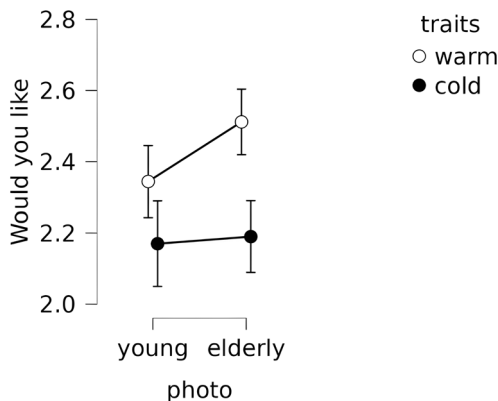

Figure 2. Interaction between photo and psychological trait and its effects on the assessment of whether one would like to have a professor as X

To evaluate the differential effect of each of the variables, we conducted separate analyzes using the Bayesian student t test for independent samples. With the help of the sequential analysis algorithm included in JASP, we sought to identify the effect of the hypothesis test for the variables photo and psychological trait over the different semesters in which the data were collected.

The graphs plotted in figure 03 summarize the results of testing the substantive hypothesis H1 for the variables photo and psychological traits. In the upper panel, where the results for testing the hypothesis of the effect of photography on professor evaluation are aligned, it is necessary to maintain the null hypothesis, even though the BF_{01} value (2.748) characterizes only anecdotal evidence, which suggests a condition of undecidability regarding the acceptance or rejection of the hypothesis. This effect becomes clearer when we consider the evolution of Bayesian factor values throughout data collection, as considered

by the registration number in the database (N) and the year in which they were collected, making it clear that the data were contrary to the substantive hypothesis, in an anecdotal or at times moderate way, until the year 2023, when the hypothesis initially received moderate support, then declined until favoring an interpretation favorable to the null hypothesis.
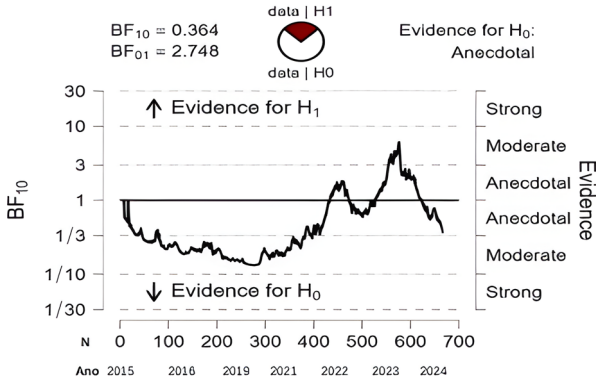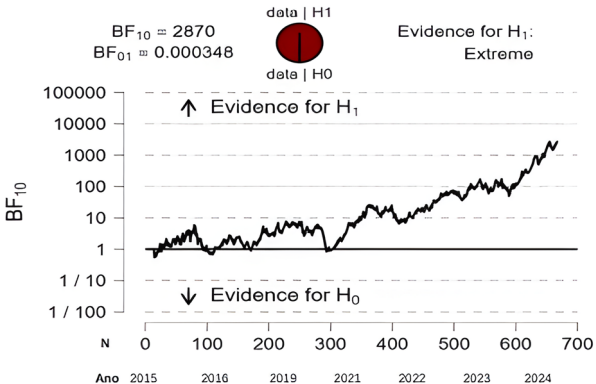
Figure 3. Sequential analysis of the hypothesis test for the variable's psychological trait and professor's photo

On the other hand, the test of the effect of the psychological trait on impression formation presented evidence that can be characterized, in terms of the Bayesian interpretation, as robust (BF_{10} = 2870,0). The sequential analysis revealed that, at no stage of data collection, evidence was identified that favored the null hypothesis. In contrast, evidence favorable to the substantive hypothesis began to appear moderately from record 200, with a constant and significant increase from data collected in 2021.

What explains the lower power of influence of pictorial content, considering that the literature indicates that the importance of photography is more accentuated in the formation of impressions in a web environment (D'Angelo et al., 2014; van der Zanden et al., 2022)? One possible explanation for the less incisive effect of photography consists in the assumption that pictorial information, because it has a lower informative density compared to textual information (Rayner et al., 2001), may be superseded by the recency effect resulting from reading the descriptive profile subsequently presented, particularly if it is centered on a particularly important trait in the assessment of the professional category in question.

In summary, while the evidence indicates partial corroboration of hypothesis 1, particularly with regard to the effect of centrality, the results regarding the effects of photography proved to be dubious in relation to the understanding initially postulated. The decision about whether or not I would like to have been a student of professor X involved a deliberate, direct and objective decision, based on analysis of the photograph and the descriptive profile offered. Would a more indirect measure also allow us to identify the joint effect of the photograph and the psychological traits of coldness/warmness? To answer this question, seventeen psychological traits were segmented into two groupings, following the theoretical perspective of the contents of stereotypes (Fiske et al., 2002; Wojciszke, 2005). After conducting a Bayesian reliability analysis of the items, compatible McDonald ω values were obtained both for the composite variable competence (ω = 0,676; 0,640 - 0,713), which grouped the attributes prudent,

persevering, trustworthy, important, serious, restrained, strong, imaginative, and for the variable sociability (ω = 0,794; 0,770 - 0,817), which included the attributes happy, generous, affable, sociable, trustworthy, humane, altruistic, jokester, honest.

The subsequent conduct of a Bayesian factorial ANOVA of repeated measures, adopting the variables competence and sociability as VDs, and the variables trait and photo as VIs, allowed generating a robust model, with the inclusion of the two dependent variables constructed, the independent ones and the respective interactions (BF_{01} = 1,81* 10^{96}). The results can be summarized in the graph found in figure 04, in which the quadratic regression lines of the association measures between sociability and competence in the four experimental groups are plotted.
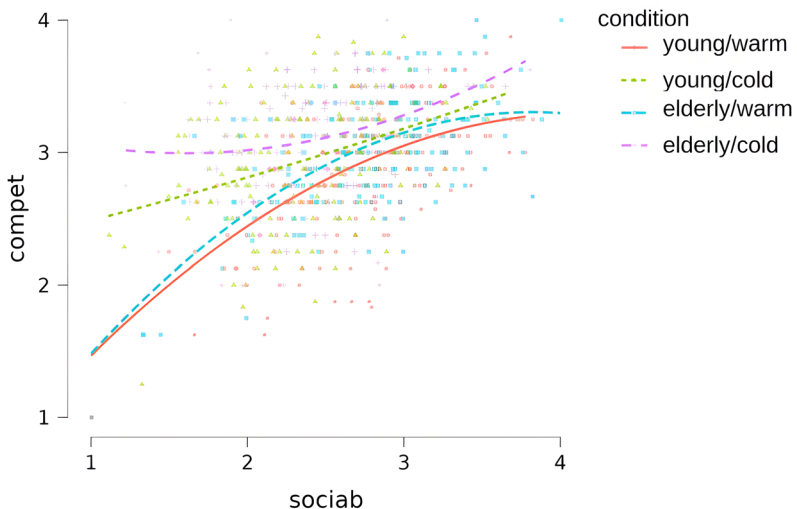

Figure 4. Relationships between sociability and competence, depending on the experimental group

Analysis of regression lines indicates three distinct patterns of relationships between sociability and competence. For participants allocated to the experimental group who viewed a photograph of

a young professor, characterized as cold, an absolutely linear relationship was identified between competence and sociability, indicating that the more the professor is perceived as sociable, the more competent he is perceived. Participants allocated to the affectionate young and cold elderly experimental groups showed a common pattern of responses, indicating a strong relationship between competence and sociability in the lowest scores and the subsequent reduction of this tendency in the highest scores. This can be interpreted as an indicator that the relationship can only be observed if the target of the assessment is judged as not very competent and of low sociability. In the experimental group in which a photograph of an elderly professor characterized as affectionate was presented, a distinct pattern was identified: the relationship between sociability and competence is not noticeable in the lowest scores, but increases significantly as the scores become higher.

The subsequent analysis of the main effects of the Bayesian ANOVA suggested the acceptance of an even more parsimonious model, in which the relationship between sociability and competence interacts exclusively with the psychological trait variable ($BF_{01} = 2,47 * 10^{14}$), whose graphic representation can be found in figure 05.
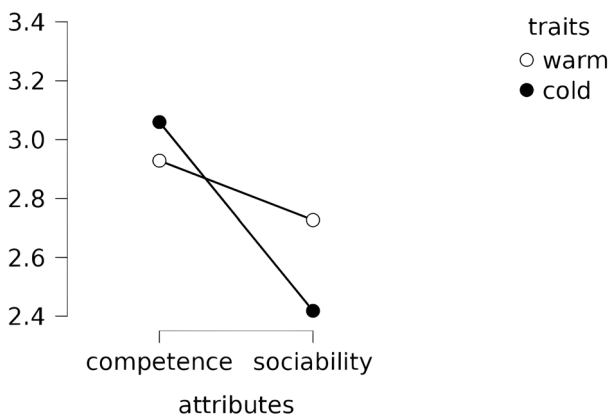
Figure 5. Averages in competence and sociability scores, by psychological trait

The result indicates that, regardless of the experimental condition, the professor was seen more as competent than sociable. However, when perceived as cold, he was considered even more competent and much less sociable. To evaluate the consistency of this relationship, we conducted two t tests (Bayesian student t tests), one for each attribute, both using the trait variable as VI. After the sequential analysis, it was possible to identify that the value of the Bayesian factor in the test of the sociability variable grew steadily and uninterruptedly, which highlights an extremely robust model (BF_{01} = 4,17* 10^{12}). In the case of the competence variable, the effect, although considered very strong (BF_{01} = 84,5), was only shown unequivocally from the second half of 2021 onwards, as seen in the graphs presented in figure 06.
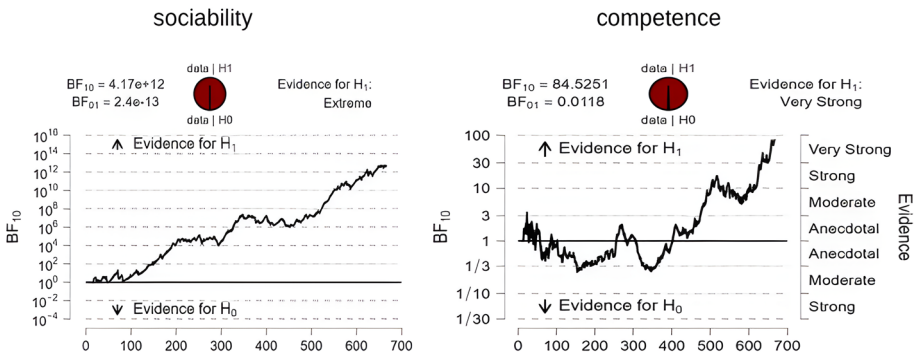
Figure 6. Sequential analysis of the test of the hypothesis of difference between psychological traits in sociability and competence

The results together offer good support for hypothesis 2, indicating that both the social categorization of the professor as elderly or young, and the cold/warm psychological traits influenced the perception of the characteristics attributed to the professor when measured on a scale in the format Likert. This effect also extends to the open textual responses presented in the justifications?

To analyze the effect of experimental conditions on the distribution of justifications, the network analysis algorithm embedded in the

Orange Data Mining software was adopted. The content of the participants' responses generated a textual *corpus*, which was subjected to pre-processing with transformation algorithms, tokenization, filtering of *stopwords* common in the Portuguese language and normalization through the application of the Porter stemming algorithm. After pre-processing, the IA *Document embedding* algorithm was applied, with the *fast text* parameter, in Portuguese.

The degree of semantic diversity of the content and the importance of each term in relation to the *corpus* can be identified in table 02, which presents the values TF-IDF (*Term frequency - Inverse document frequency*) of the key words identified in the justifications presented by the participants allocated to each experimental condition.

**Table 2**

Values of TF-IDF, by experimental condition

Position	Warm young	Warm elderly	Cold elderly	Cold young
1	student (0.032)	student (0.035)	student (0.033)	serious (0.035)
2	classroom (0.026)	content (0.028)	serious (0.030)	student (0.029)
3	content (0.025)	classroom (0.027)	content (0.027)	classroom (0.026)
4	person (0.025)	class (0.024)	demanding (0.026)	content (0.025)
5	serious (0.023)	serious (0.023)	classroom (0.025)	class (0.025)

An element highlighted in the table refers to the item positioned first in the cold-young column, which differs from that extracted from the justifications of the other participants. Being serious is the attribute that clearly differentiates the justifications presented for a cold and young professor, while in the other experimental conditions the emphasis fell on the term student. The impact of the cold feature on the justifications is also notable in the case of the elderly professor, as, in this case, the key words listed do not include the term student, common to the other experimental conditions, nor the word class, although they do provide the adjective demanding. The noun person was only listed in the justifications presented by participants allocated to the evaluation condition of a young and warm professor.

How these terms identified by the keyword extraction algorithm relate to other items found in the documentary *corpus*? To answer this question, we ran the routines *Corpus to network* and *Network explorer*. The representation networks of the words used in the justifications of the respondents allocated to each experimental condition will be presented and discussed below, starting with the semantic network of the participants allocated to the young and warm professor condition.

As we pointed out, the term that appeared most frequently in the semantic network related to the justifications of the participants allocated to the experimental condition young and warm professor was the word student (Figure 7). This type of professor was characterized as a serious person, who provides good content in the classroom, as he has good knowledge of the subject he teaches, which makes him a person well valued by students. Additionally, he is seen as a professor with good teaching skills, intelligent, organized and competent, making classes more enjoyable by interspersing them with some jokes.
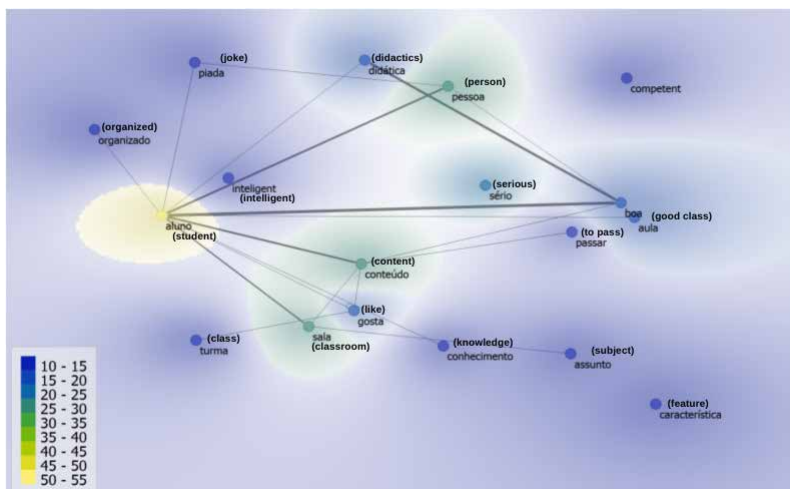
Figure 7. Semantic network of justifications of participants allocated to the condition of young and warm professor

The elderly and affectionate professor, the one that participants most indicated they would like to have, was characterized as someone who masters the content exposed in the classroom, a space in which he appears intelligent and serious, which leads him to be perceived as a rigid, rigorous, demanding and committed person (Figure 8). Additionally, he was characterized as a professor with good teaching skills, able to transmit the knowledge he has mastered, while showing himself capable of maintaining a good personal relationship with the class.
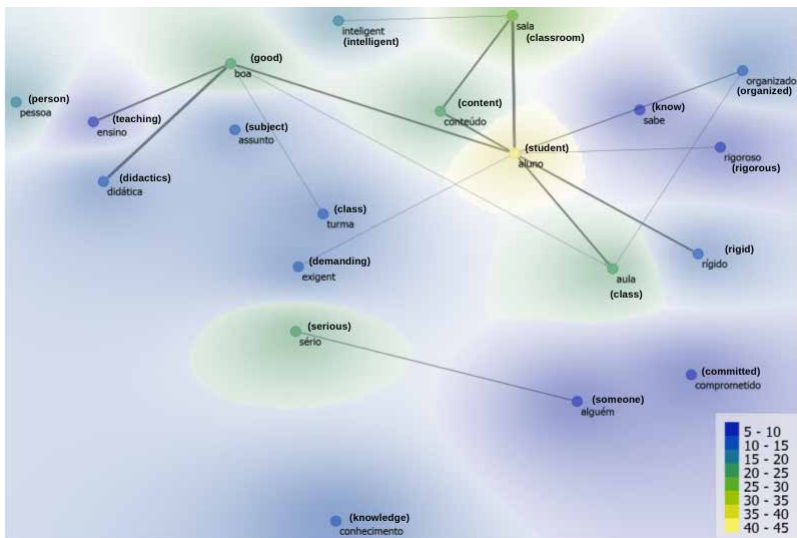
Figure 8. Semantic network of justifications of participants allocated to the condition of the elderly and warm professor

Professors characterized as cold were overlooked when compared with warm ones, regardless of whether they were portrayed as elderly or young. In both cases, a marker strongly associated with coldness was seriousness. In the case of the elderly and cold professor, seriousness was strongly associated with competence, forming a profile in which the professor was portrayed as a well-organized, professionally competent,

demanding and rigid person (Figure 09). Due to these characteristics, he tends to be seen as someone who is punctual and who presents good teaching skills in the classroom environment.
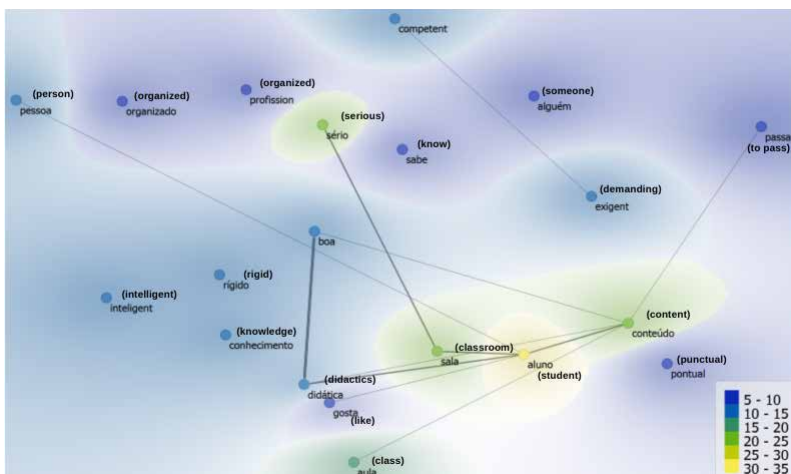
Figure 9. Semantic network of justifications of participants allocated to the condition of the elderly and cold professor

The professor, when characterized as young and cold, comes to be perceived as a serious person, with an extremely rigid and rigorous attitude in the classroom environment. In this context, priority is given to transmitting content in an objective, organized and consistent way with the course schedule (Figure 10).

The results presented corroborate hypothesis 3, by suggesting that differences in the professor's presentation, both with regard to the photograph and with regard to the psychological traits emphasized, produced different effects on the frequency of the terms evoked, as well as on the distribution network of the components semantics.
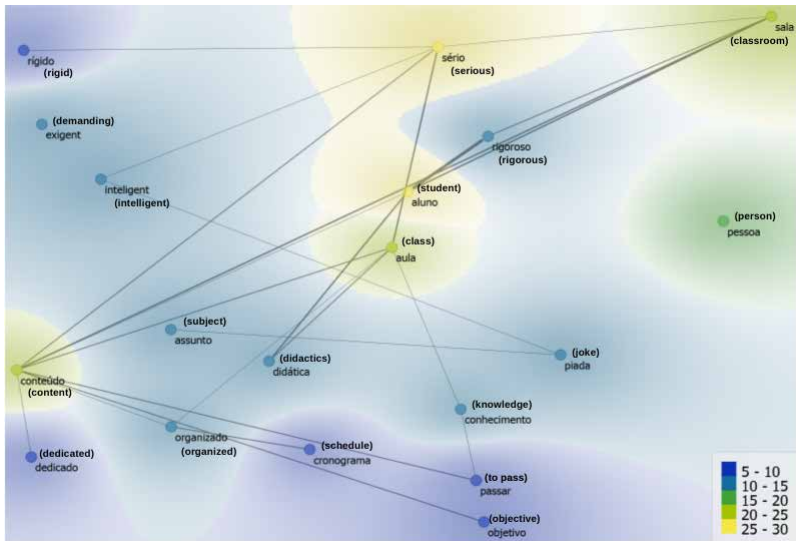
Figure 10. Semantic network of justifications of participants allocated to the condition of the young and cold professor

Conclusions

The evidence obtained by the experimental method applied during the different temporal segments indicate that both categorization and centrality influence the formation of impressions about other people. Differences were identified both with regard to an objective and deliberate judgment, as the participants' responses to the question about whether or not they like having a professor with characteristics X or Y underwent significant changes depending on the experimental condition, as well as when a less direct assessment was carried out. These differences reinforced the previous interpretation, showing that the distribution and frequency of a constellation of psychological traits were also influenced by the social age category and psychological traits.

However, the intensity of these effects varied throughout data collection, demonstrating the complexities of impression formation, especially in the relationships between primacy and centrality.

Furthermore, the temporal context in which the data were collected also played an important role.

In addition to these effects identified in the analyzes of the variables implemented at the interval measurement level, differences were also detected in the responses obtained through open data collection procedures, especially when considering the analysis of the justifications presented by the participants allocated to the different experimental conditions. The study confirms the robustness of the paradigm developed by Asch in the 1940s, making it an excellent resource or tool for classroom demonstrations of a psychosocial theory recognized in specialized literature.

The studies presented here, however, have methodological limits that should be considered in future research. One of them refers to the absence of participants' sociodemographic data, as they were not collected, due the nature of the space in which the study was conducted. It is possible to assume, additionally, that the data obtained from university students cannot be directly generalized to populations with other profiles, despite the university in question having implemented the quota system a few years ago, which made it more plural and accessible to students from various spheres of society.

A second limit of the study refers to the lack of equivalence in the teachers' photographs. The study was designed a decade ago, when there was no specialized *software* available, such as Facegen, capable of modifying a parameter of a photograph (age, for example) while keeping the other criteria constant (gender, skin color, racial ethnic profile, physical characteristics, degree of attractiveness, etc.). Although the photographs were evaluated by a panel of judges and equalized in terms of attractiveness and pleasantness, this evaluation cannot be considered equivalent to current image editing and manipulation resources, especially with the introduction of artificial intelligence resources.

A third limit of the study refers to the use of written vignettes to define the psychological profile of the teacher being evaluated. With current computational resources, in particular the spaces for conducting experiments in multimedia web environments, it is possible to implement more sophisticated experiments in which the descriptive profiles of the targets of the judgments can be presented through video resources or even through immersion in virtual environments.

Finally, another limit of the study refers to the lack of data regarding participants' response times to the various experimental tasks. Although it cannot be considered a critical variable in the analyzes conducted in the present study, it is an important resource in the analysis of psychosocial processes.

A future development resulting from the research presented in this article refers to the proposal for the creation of an *online* experimental environment, in the web environment, accessible to other teachers, with the purpose of replicating or modifying some parameters of Asch's classic experiment on the formation of impressions, opening paths for new research and learning.

It is concluded that this study contributes to the understanding of impression formation, a classic and central theme in social psychology, highlighting the importance of social categorization, the centrality of traits and temporal context. The limitations of the study point to promising directions in the area, and the proposal of an *online* experimental environment, using sophisticated image production tools, opens up new possibilities for investigations in social psychology. The results of this study corroborate the relevance of Solomon Asch's paradigm on impression formation and highlight its explanatory potential for understanding interpersonal judgments occurring in educational contexts. The observed effects of social categorization and trait centrality in participants' assessments of teachers indicate that first impressions are influenced by structural and temporal variables. Such mechanisms define students' attitudes towards teachers, affecting the way they are perceived and how interpersonal relationships are established in the school environment. The continued empirical validity of Asch's model, even decades after its formulation, reinforces its analytical relevance in the field of Social Psychology. However, the limitations observed in this study indicate the need for more sophisticated experimental methodological designs that incorporate contemporary technological resources, such as image manipulation by artificial intelligence and immersive multimedia platforms. In this sense, the proposal to develop online experimental environments appears to be a promising path for advancing this line of research.

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