Exploring the dynamics of Emotions in the space of colours through the Viable Systems Approach (vSa) perspective

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***Abstract*— We explore the positioning of emotions in the colour space and the relationship linking a particular emotion to a colour hue rather than another.**

By shifting the focus on Computer Science Perspective (CSP), through the lens of the Viable Systems Approach (vSa) we want to draw attention on the dynamism of the algorithm used to calculate the Emotional Distance (ED) which, once the emotions have been positioned in space, allows to measure the distance between two different hues in the space of colours quickly and intuitively. We propose a literature review to better understand both trends and gaps.

Keywords—Colours, Emotions, AI, CSP, VSA

I. Introduction

Colours are often used to signify information in our environment as they have strong impact on our emotions and feelings; in fact, research studies confirm that individuals often associate colours with various emotional terms: it seems that colour-emotion associations are ubiquitous (e.g., [1]; [2]; [3]; [4]; [5]; [6]). So, starting from the well-known correlation between colours and emotions, we propose a shift in focus on Computer Science Perspective (CSP), by imagining a metric that could lead to the devising of an algorithm capable of measuring in real-time the "resonance", intended as the degree of 'emotional closeness', between two or more people during any face-to-face or telematic comparison (a dialogue, a video-chat, a meeting, a lesson), given a certain degree of pre-detected "consonance" between the individuals. Consonance and resonance are intended, through the lens of the Viable Systems Approach (vSa [7], [8]; [9], [10]), respectively as the potential and the consequent effects of harmonic interactions between two or more systemic entities. Consonance identifies a condition of compatibility and/or complementarity between interacting entities. Resonance is related to pre-existent conditions of consonance and is what could emerge from the interaction between consonant entities ([11], [12]). The vSa underlines the importance of relation (identified by the structural compatibility defined by consonance) and interaction (identified by the systems dynamic defined by resonance), rather than homogeneity of skills and curriculum. To this end, our aim is to read and interpret emotions to better understand their dynamics in order to measure the level of consonance trough the colour-emotion associations optimizing human interactions. By these means, we intend to work on the ontology level describing emotions. Then, according to the correlation between emotions and colours we will place emotions in an abstract Cartesian space and through the algorithm that we propose we will improve the ability to manage also the different shades of emotions.

As we will explain in section III, from an integrated CSP&vSa perspective, our aim is to provide two different metrics, the first exclusively a function of the position of the emotion itself placed in a point, the second, what we call "emotional distance" (ED), from the distance between two different hues in the space of colours dependent on the position of the point in relation to the surrounding space.

The application area, among the many possible, has been identified in (ED), considered as an ideal moment of comparison between emotions of individuals, where the proposed algorithm will work and express its potential.

The contribution of our study to the existing literature is threefold: 1) understanding and learning (in Education), 2) promptness and good predisposition (in Recruiting and Team-Building), 3) convergence and harmony (in corporate Decision Making).

This work frames in the context of team building solutions in the educational field; future research could involve the process of acquisition of information by a team leader operating for the setup of a "RandomM" (randomly selected students) team [13] in order to create the conditions for which the team is successful in relation to a specific project.

The paper is structured as follows: first we illustrate the different takes about the correlation between colours and emotions through a bibliometric review of the scientific literature on the topic. Then, we underline the need to shift the focus on (CSP) and through the lens of the (vSa) we illustrate our methodological approach. Finally, we discuss results and future implications.

II. Literature Review

Humans have a keen tendency to associate colours with emotions and feelings [1]. Across languages and cultural traditions, we use colour to express and convey emotional states. Common wisdom would suggest that we *feel blue*, *see red*, or we are *green with envy*; we wear white to weddings and black to funerals; and we give red hearts to our loved ones on Valentine's Day. Are such colour-emotion associations fundamental to our shared cognitive architecture, or are they cultural creations learned through our languages and traditions? In an effort to answer this question, we have conducted a literature review through a bibliometric approach in order to identify not only the roots of the scientific discussion around the theme but also the current lines of research and those which could see the most development in the future. Represented in Fig. 1 is the visual output of the bibliographic coupling analysis conducted on the sample obtained through Scopus, displayed in Overlay Visualization, which clearly shows the different age of the contributions implementing a linear colour scale (from blue to yellow). As shown from the visual representation of the analysis, research on the connection between colour and emotion has been active since the 1950s; starting from the seminal studies on dynamism and sensibility related to the brightness and saturation of colours, whereas different Scholars studied how artists caught viewers' attention by varying the brightness and saturation of their objects to add emphasis in their artwork [14; 15]. Colour can be specified by its hue (e.g., green, red, blue, or yellow) and by two additional perceptual colour dimensions: saturation (difference from an achromatic stimulus; that is, a neutral gray or white) and brightness (perceived intensity of the light) [16]. Studies have indicated that the saturation of a colour stimulus has a stronger effect on the emotional response than the hue [17]. Colour is pervasive in our everyday lives, and it plays an integral role in many aspects of human behaviour, including object recognition [18] [19], buying decisions [20], and communication (e.g., Bonce in a blue moon). For example, the effect of colours on emotions and preferences is critical in marketing; the colours of products positively or negatively influence viewers' attitudes toward them [21], and colours contribute to the differentiation of products and brand and corporate images [22]. Throughout the literature can be find many examples of correlations between colours and emotions in general: red evokes excitement in people; orange is perceived as vibrant, energetic, and outgoing; yellow resonates with hope, wisdom, and vastness; green feels refreshing and natural; and blue evokes passivity, cleanliness, and quiet [23]. Ou et al. [24] [25] proposed an account based on "colour-emotions" which they defined as "feelings evoked by either colours or colour combinations". Hurlbert and Ling [26] analysed their preference data in terms of the two cardinal dimensions of opponent cone-contrasts: theLM-axis (L-M) that runs roughly from red to blue-green and the S-axis [S-(L+M)], that runs roughly from violet to yellow-green [27] [28], where "S", "M", and "L"refer to the outputs of short, medium, and long-wavelength cone types, respectively. According to the crossmodal-correspondence framework [29], two unrelated entities (here, colours and emotions) can become cross-modally associated when they regularly appear together in one's perceptual or linguistic environment, whether on a global (shared by all) or local (shared by some) scale. Colours may become associated with emotions because they appear in particular emotional situations of evolutionary significance (e.g., red face in anger [30]. If so, colour-emotion associations should be largely universal (in support, see [31]; [32]; [33]; [34]).

The metaphorical expression seeing red associates red with feelings of anger, which would indicate a linguistic influence. Nonetheless, when one gets angry, blood rushes to the face

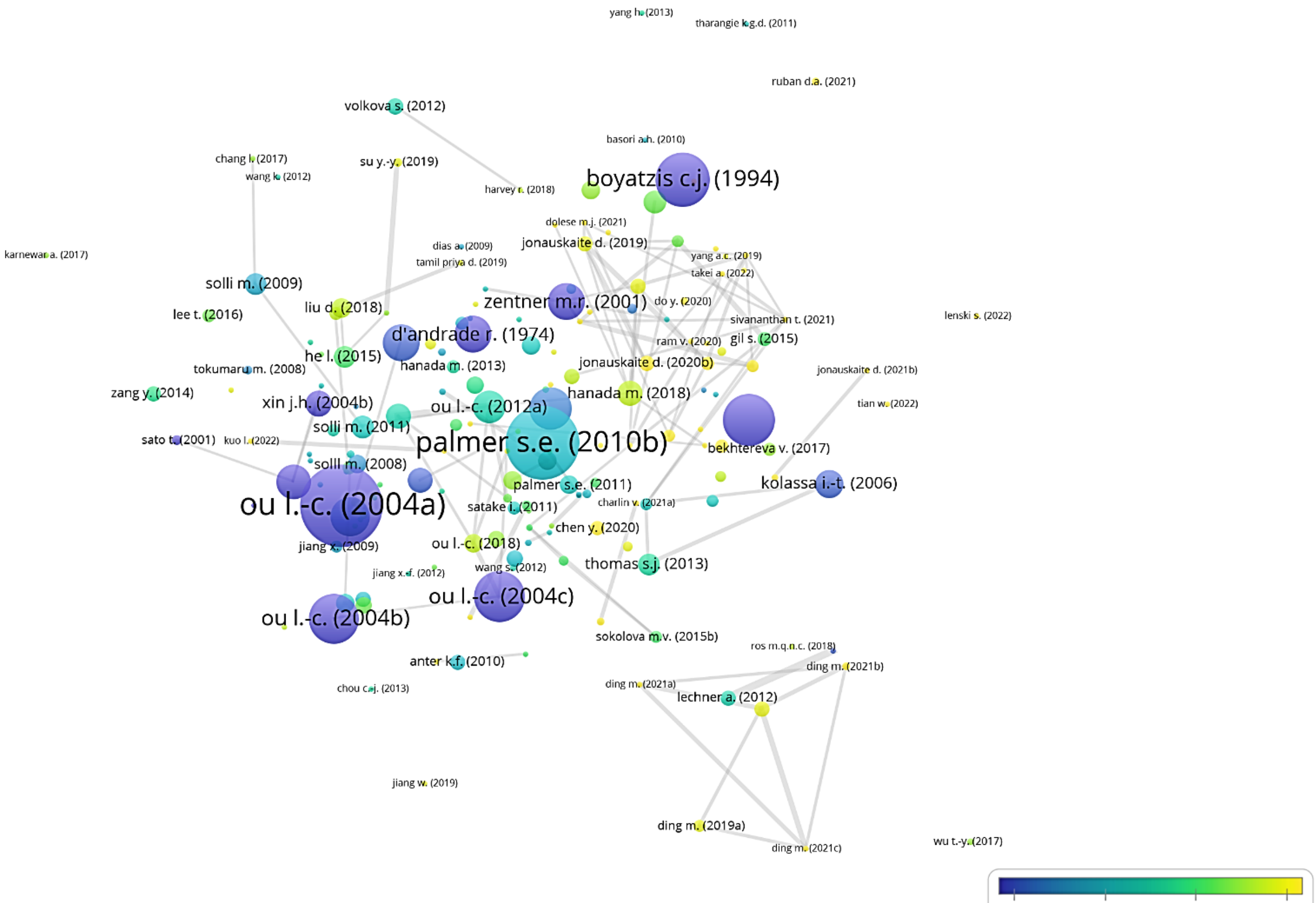

Figure 1. Bibliographic coupling of the references (Overlay Visualization).

[30], and so the perception of red faces in an angry situation might further strengthen the association between red and anger.)

Colour-emotion associations were observed across these previous studies using different methods and populations; red is associated with anger and excitement [35], green with peacefulness and calmness [35] [36] [37], yellow with happiness and cheerfulness [38], blue with calmness and comfort [35] [36] [37], and black and gray with sadness, despondence, and depression. Previous research has examined colours' effects on emotion using psychological scales either with [39] [40] [41] or without physiological measurement. Warm colours (e.g., red, yellow) promote anxiety more than cool colours (blue, green).

III. Model architecture and Results

From the literature analysis, as can be seen in the previous section, the correlation between colours and emotions is a hot topic, able to involve various research fields; however, most of the studies on the subject are limited to the psychological and/or socio-economic sphere [42] [43]. The aim of our research is to shift the focus to an integrated CSP&vSa perspective, by imagining a metric that could lead to the devising of an algorithm to measure "emotional distance" in a recursive manner from the distance between two different hues in the space of colours.

A. RGB colour model

According to the RGB colour model [44], all the possible colour combinations can be represented through the composition of the three primary colours (red, green, blue). R, G and B represent three mutually independent entities that can be treated, in a three-dimensional space, as three orthogonal axes: none of the three primary colours can be obtained, in any of its possible shades, through the linear combination of the others.

From a CSP view point, all major programming languages embrace the RGB colour model using an 8-bit representation per channel. In this way, each of the three primary colours can be depicted through a scale of shades of increasing intensity, each indicated by an integer number from 0 to 255; since R, G, B can each take on 256 different intensity values, there exist 256^3 different hues that can be expressed as a function of the values of R, G and B of which they are composed.

B. Spatial representation of colours and emotions

The RGB colour model is well suited to the most varied spatial representations of the colour scale. A more complex issue concerns the positioning of emotions in the colour space and the relationship linking a particular emotion to a colour shade rather than another. In addition to the numerous psychology related studies (mentioned in the previous section), examples related to artificial intelligence are limited to the application of neural networks for word embedding in the search for a correlation, from a semantic point of view, between colours and emotions [45] [46]. Our work assumes that the spectrum of emotions can have a structure analogous to that of colours: just as it is possible to derive all other colours from the linear combination of red, green and blue, it is likewise possible to identify three primary emotions of which all the other emotions are composed. Although this is a rather strong assertion, the intent of the paper is not to demonstrate an unequivocal correspondence between a certain emotion and a particular shade of colour; on the contrary, the final purpose is to identify a metric that, once the emotions have been positioned in space, allows the distance between them to be assessed quickly and intuitively. The very choice of the three primary emotions, namely anger, hope and fear, and their association with R, G and B respectively, is based on personal considerations derived from the literature analysis and in no way seeks to be posited as scientific evidence of that correlation.

Ultimately, one of the possible configurations of the problem is shown in Fig. 2, using the Colour Wheel [47]. In the chosen representation, the three primary colours are positioned along three different directions to form a 120° angle between them; the space is subdivided into concentric circles to establish a hierarchical scale that allows the different colour intensities to be positioned from the highest to the lower, moving from the edges towards the centre. To complete the picture, the three "primary emotions" have each been assigned to one of the three directions represented by the shade scale of R, G and B.

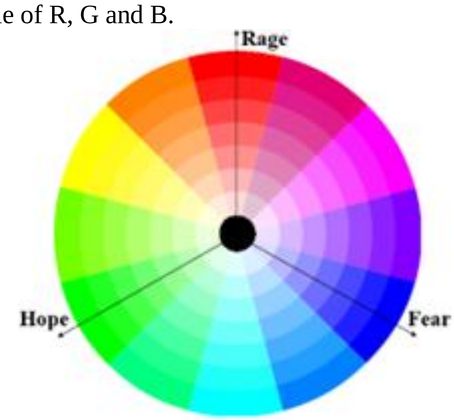

Figure 2 Spatial representation of the three primary emotions on the Colour Wheel.

C. "Emotional distance" measurement

For "emotional distance" (ED) measurement model implementation, we used Wolfram Mathematica, so as to be able to take advantage of dynamic functions that allow easier data manipulation and visualisation of the results. The system previously described is characterised by the presence of three axes that can indicate both the three primary colours and the three primary emotions in all their possible shades. Moving to a three-dimensional representation, it is reasonable to assume an orthogonality relationship between them, given the independence of each of the three axes from the remaining two.

According to these considerations, we decided to reorganise the space of colours by constructing three orthogonal axes, whose possible values cover the entire range of integers between 0 and 255. The result is that the entire universe of colours, composed of the 256^3 different existing combinations of R, G and B, can be enclosed within the area

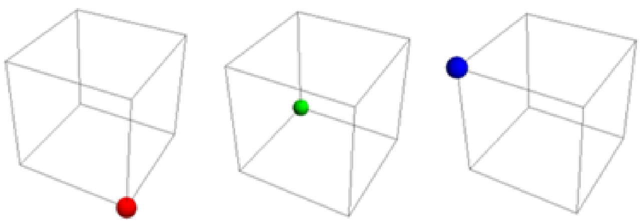

Figure 3 Representation of three different points in the cubic space of colours.

of the cube shown in Fig. 3. By means of the "Manipulate" function, it is possible to appreciate how each point within the space identified by the cube, uniquely represented by three coordinates (r, g, b), corresponds to a specific shade of colour.

Similarly, reasoning in terms of emotions, it is possible to define each point in the cubic space as a function of three coordinates on the axes of anger, hope and fear. This first definition of points in space has a "static" nature and depends solely on the use of univocally determinable coordinates in an arbitrary space, created on the basis of the analogy between the colour spectrum and the emotional spectrum. The next step is to define emotions in a "dynamic" manner, as a function of the Euclidean distance between a point and its three first neighbours.

The aim is to be able to describe each point in space according to two different metrics, the first exclusively a function of the position of the point itself, the second, what we call ED, dependent on the position of the point in relation to the surrounding space.

The graphic output of the algorithm used to calculate ED is shown in Fig. 4. Having a new point y in the cubic space, arbitrarily chosen, the algorithm is able to identify the three closest points (x_1, x_2, x_3) in terms of Euclidean distance and describe y as:

$$y = f(x_1, x_2, x_3) \quad (1)$$

The function f (x_1, x_2, x_3) is then rewritten in terms of composition, whereby the point Y (representing a new emotion) is described by a certain percentage of x_1, x_2, x_3.

D. Results

The three-dimensional representation of the colour space, the association of the three axes with the three primary emotions and the function for measuring ED, allow our algorithm to identify an intuitive metric for describing emotions.

Further advantages arise from the possibility of using the algorithm recursively, as new points in space are identified. Assume to initially have only three points in the space of colours, identified by the coordinates (255,0,0), (0,255,0), (0,0,255), corresponding to the maximum intensity of the three primary colours. Suppose, then, to randomly choose a new point with the arbitrarily associate name of "happiness"; the happiness point can be described according to the coordinates of the axes R, G, B that define its position, but also as a function of its distance from the other three points in space (Fig. 5a). In Fig. 5b instead, the same system is represented enriched with many points, each one corresponding to a different emotion; in this case happiness is again described by its spatial coordinates, unchanged from the previous case, but this time its ED will be a composition of its three first neighbours (i.e. satisfaction, enthusiasm, giddiness). The dynamism of our algorithm makes it possible to obtain a description of emotions that is the more accurate the greater

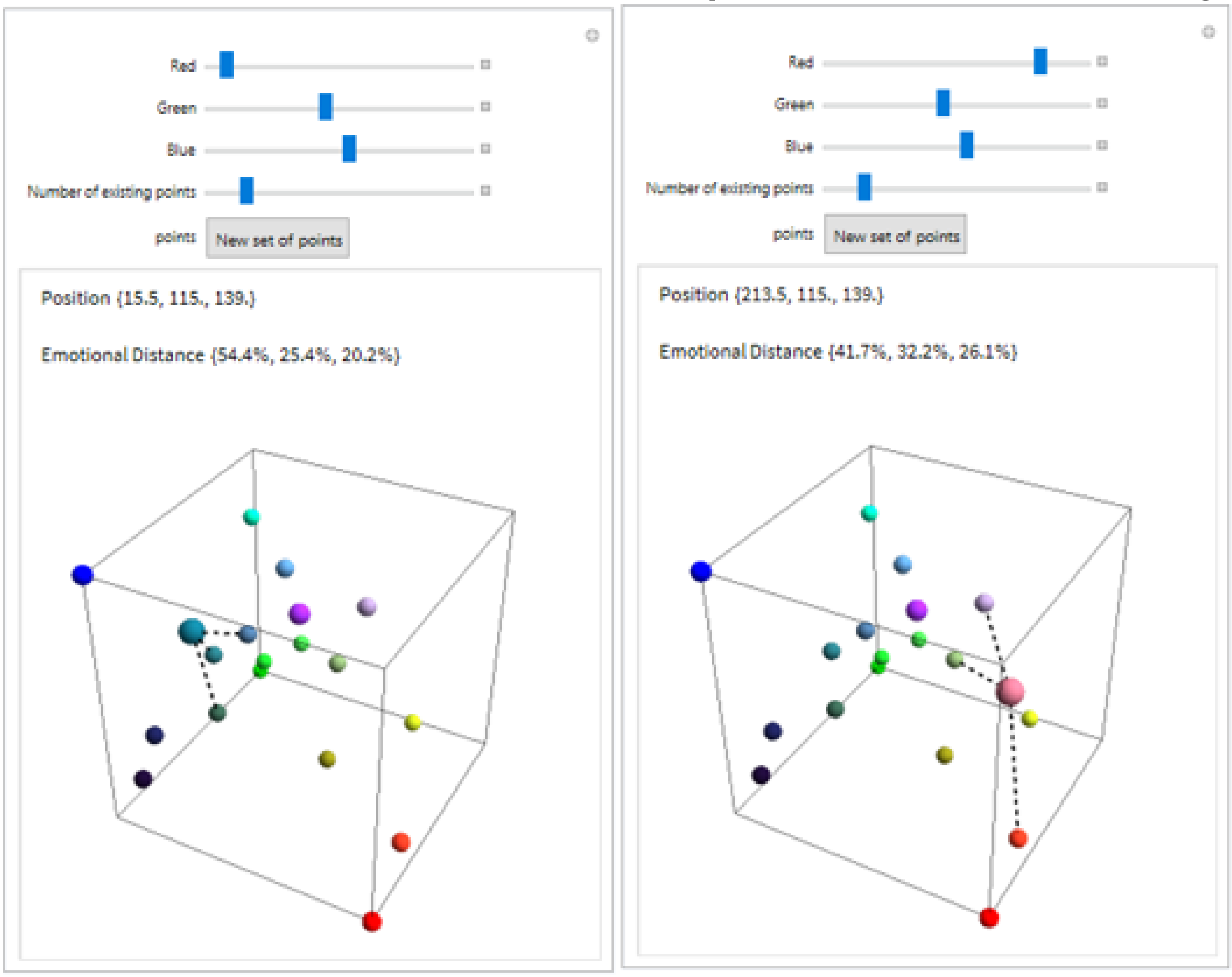

Figure 4 Graphic output of the model for two different points: as the position of the point changes, the algorithm finds the first neighbours and calculates the new ED.

the number of points in space, although the static definition allows any point to be identified as a function of the three generating axes at any time.

From the vSa, this double key can be reinterpreted, in the economic sphere, by referring to the concepts of 'critical supra-system' and 'influential supra-system' [7] [48].

The concept is that the critical supra-system is linked to the static definition of emotion, so whatever the emotional condition we want to describe it is always linked, in some way, to anger, fear and hope. The influential supra-system, on the other hand, derives from the dynamism of emotional distance, since it depends on the context: in other words, there will be a context such that an emotion can be described in a certain way, another context in which its definition will be different; in any case, whatever the context, emotion cannot free itself from its critical supra-system (anger, fear, hope).

IV. Conclusions

The algorithm used to calculate ED allows to identify an intuitive metric for describing emotions in order to improve the ability to manage the nuances of emotions. The important point is that there are emotions that generate new emotions, and the innovation is precisely in understanding on how much the new emotion is linked to a certain emotion rather than another.

As we have highlighted in section III, our focus is on how emotions move according to the proximity of one and the other, so we want to underline a dynamic of evolution in the interactions between systems through a key to interpreting “emerging emotions”. One of the concepts that emerges from the observation of the dynamic system that we have illustrated is that emotions pass from one to another through a continuous path, not in jerks. This means that the space of emotions is full of "intermediate emotional states" and following one another they themselves transfer their general state from one emotion to another. From our perspective, it could be said that in any relationship if one intervenes in time there is always an "emotional reversibility" or rather it can return to a previous state since the progression is not "jerky", as previously clarified.

The conclusion to be reached is to refine the criterion of composition of emotions which is not necessarily the Distance! The more I go inside the colour wheel, the more nuanced it is. The proposed algorithm intends to dynamically define the minimum K or the families of emotions resulting from the “closeness” of K elements.

Future research will try to focus on how to create the conditions for which the “RandomM” (randomly selected students) team is successful in relation to a specific project improving the overall quality provided, as there are many nuances to be analysed to measure the “consonance” in this context [49].

References

[1] Hemphill, M. (1996). A note on adults' colour–emotion associations. *The Journal of genetic psychology*, *157*(3), 275-280.

[2] Adams, F. M., & Osgood, C. E. (1973). A cross-cultural study of the affective meanings of colour. *Journal of cross-cultural psychology*, *4*(2), 135-156.

[3] Allen, E. C., & Guilford, J. P. (1936). Factors determining the affective values of colour combinations. *The American Journal of Psychology*, *48*(4), 643-648.

[4] Hupka, R. B., Zaleski, Z., Otto, J., Reidl, L., & Tarabrina, N. V. (1997). The colours of anger, envy, fear, and jealousy: A cross-cultural study. *Journal of cross-cultural psychology*, *28*(2), 156-171.

[5] Ou, L. C., Yuan, Y., Sato, T., Lee, W. Y., Szabó, F., Sueeprasan, S., & Huertas, R. (2018). Universal models of colour emotion and colour harmony. *Colour Research & Application*, *43*(5), 736-748.

[6] Valdez, P., & Mehrabian, A. (1994). Effects of colour on emotions. *Journal of experimental psychology: General*, *123*(4), 394.

[7] Golinelli, G. M. (2010). Viable systems approach (VSA). *Governing business dynamics*.

[8] Barile, S. (2011). Towards qualification of the concept of systemic complexity. *Sinergie rivista di studi e ricerche*, (79).

[9] Barile, S. (2006). Introduzione alla dinamica di varietà di un sistema vitale. Barile S.(a cura di), *L’impresa come sistema. Contributi sull’Approccio Sistemico Vitale (ASV)*. Giappichelli, Torino.

[10] Barile, S. (2009). *Management sistemico vitale* (Vol. 1). Giappichelli.

[11] Barile, S., & Saviano, M. (2008). Le basi del pensiero sistemico: la dicotomia struttura-sistema. *L’impresa come sistema. Giappichelli, Torino*, 63-81.

[12] Barile, S., & Saviano, M. (2011). Foundations of systems thinking: the structure-system paradigm. Various Authors, Contributions to Theoretical and Practical Advances in Management. A Viable Systems Approach (VSA). ASVSA, Associazione per la Ricerca sui Sistemi Vitali. International Printing, 1-24.

[13] Sahin, A., Zehir, C., & Kitapçı, H. (2011). The effects of brand experiences, trust and satisfaction on building brand loyalty; an empirical research on global brands. *Procedia-Social and Behavioral Sciences*, *24*, 1288-1301.

[14] Wright, B., & Rainwater, L. (1962). The meanings of colour. *The Journal of general psychology*, *67*(1), 89-99.

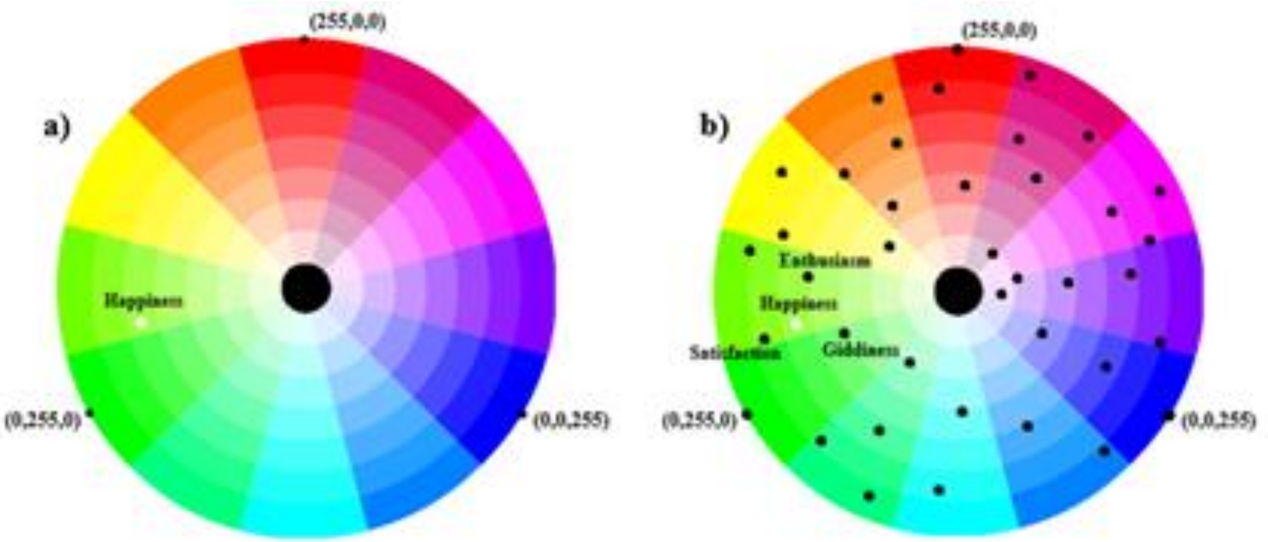

Figure 5 Variation of the emotional distance of "happiness" as a function of the density of points in the colour space.

[15] Hogg, J. (1969). A principal components analysis of semantic differential judgements of single colours and colour pairs. *The Journal of general psychology*, *80*(1), 129-140.

[16] Wyszecki, G., & Stiles, W. S. (2000). *Wiley Series in Pure and Applied Optics*.

[17] Valdez, P., & Mehrabian, A. (1994). Effects of colour on emotions. *Journal of experimental psychology: General*, *123*(4), 394.

[18] Ostergaard, A. L., & Davidoff, J. B. (1985). Some effects of colour on naming and recognition of objects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*(3), 579.

[19] Wurm, L. H., Legge, G. E., Isenberg, L. M., & Luebker, A. (1993). Colour improves object recognition in normal and low vision. Journal of Experimental Psychology: Human perception and performance, 19(4), 899.

[20] Bellizzi, J. A., & Hite, R. E. (1992). Environmental colour, consumer feelings, and purchase likelihood. *Psychology & marketing*, *9*(5), 347-363.

[21] Singh, S. (2006). Impact of colour on marketing. *Management decision, 44(6):783–89*.

[22] Fehle, F., Fournier, S. M., Madden, T. J., & Shrider, D. G. (2008). Brand value and asset pricing. *Quarterly Journal of Finance and Accounting*, 3-26.

[23] Mahnke, F. H. (1996). Colour, environment, and human response. *Detroit: Van Nostrand Reinhold*.

[24] Ou, L. C., Luo, M. R., Woodcock, A., & Wright, A. (2004). A study of colour emotion and colour preference. Part I: Colour emotions for single colours. *Colour Research & Application*, *29*(3), 232-240.

[25] Ou, L. C., Luo, M. R., Woodcock, A., & Wright, A. (2004). A study of colour emotion and colour preference. Part III: Colour preference modeling. *Colour Research & Application*, *29*(5), 381-389.

[26] Hurlbert, A. C., & Ling, Y. (2007). Biological components of sex differences in colour preference. *Current biology*, *17*(16), R623-R625.

[27] Webster, M. A., Miyahara, E., Malkoc, G., & Raker, V. E. (2000). Variations in normal colour vision. II. Unique hues. *JOSA A*, *17*(9), 1545-1555.

[28] Wuerger, S. M., Atkinson, P., & Cropper, S. (2005). The cone inputs to the unique-hue mechanisms. *Vision research*, *45*(25-26), 3210-3223.

[29] Spence, C. (2011). Crossmodal correspondences: A tutorial review. *Attention, Perception, & Psychophysics*, *73*(4), 971-995.

[30] Benitez-Quiroz, C. F., Srinivasan, R., & Martinez, A. M. (2018). Facial colour is an efficient mechanism to visually transmit emotion. *Proc. Natl. Acad. Sci. U. S. A.*, *115*(14), 3581–3586.

[31] Adams, F. M., & Osgood, C. E. (1973). A cross-cultural study of the affective meanings of colour. *Journal of cross-cultural psychology*, *4*(2), 135-156.

[32] D'Andrade, R., & Egan, M. (1974). The colours of emotion 1. *American ethnologist*, 1(1), 49-63.

[33] Gao, X. P., Xin, J. H., Sato, T., Hansuebsai, A., Scalzo, M., Kajiwara, K., ... & Billger, M. (2007). Analysis of cross-cultural colour emotion. *Colour Research & Application: Endorsed by Inter-Society Colour Council, The Colour Group (Great Britain), Canadian Society for Colour, Colour Science Association of Japan, Dutch Society for the Study of Colour, The Swedish Colour Centre Foundation, Colour Society of Australia, Centre Français de la Couleur*, *32*(3), 223-229.

[34] Huang, H. P., Wei, M., & Ou, L. C. (2018). White appearance of a tablet display under different ambient lighting conditions. *Optics* express, 26(4), 5018-5030.

[35] Wexner, L. B. (1954). The degree to which colours (hues) are associated with mood-tones. Journal of applied psychology, 38(6), 432.

[36] Murray, D. C. (1957). An investigation of the Rorschach white space response in an extratensive experience balance as a measure of outwardly directed opposition. Journal of Projective Techniques, 21(1), 40-46.

[37] Kaya, N., & Epps, H. H. (2004). Relationship between colour and emotion: A study of college students. College student journal, 38(3), 396-405.

[38] Clarke, T., & Costall, A. (2008). The emotional connotations of colour: A qualitative investigation. Colour Research & Application: Endorsed by Inter-Society Colour Council, The Colour Group (Great Britain), Canadian Society for Colour, Colour Science Association of Japan, Dutch Society for the Study of Colour, The Swedish Colour Centre Foundation, Colour Society of Australia, Centre Français de la Couleur, 33(5), 406-410.

[39] AL-Ayash, A., Kane, R. T., Smith, D., & Green-Armytage, P. (2016). The influence of colour on student emotion, heart rate, and performance in learning environments. Colour Research & Application, 41(2), 196-205.

[40] Küller, R., Mikellides, B., & Janssens, J. (2009). Colour, arousal, and performance—A comparison of three experiments. Colour Research & Application: Endorsed by Inter-Society Colour Council, The Colour Group (Great Britain), Canadian Society for Colour, Colour Science Association of Japan, Dutch Society for the Study of Colour, The Swedish Colour Centre Foundation, Colour Society of Australia, Centre Français de la Couleur, 34(2), 141-152.

[41] Caldwell, J. A., & Jones, G. E. (1985). The effects of exposure to red and blue light on physiological indices and time estimation. Perception, 14(1), 19-29.

[42] Elliot, A. J., & Maier, M. A. (2014). Colour psychology: Effects of perceiving colour on psychological functioning in humans. Annual review of psychology, 65, 95-120.

[43] Sroykham, W., Wongsathikun, J., & Wongsawat, Y. (2014, August). The effects of perceiving colour in living environment on QEEG, oxygen saturation, pulse rate, and emotion regulation in humans. In 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (pp. 6226-6229). IEEE.

[44] Hunt, R. W. G. (2005). The reproduction of colour. John Wiley & Sons.

[45] Peng, Y. F., & Chou, T. R. (2019, April). Automatic colour palette design using colour image and sentiment analysis. In 2019 IEEE 4th International Conference on Cloud Computing and Big Data Analysis (ICCCBDA) (pp. 389-392). IEEE.

[46] Ruan, S., Zhang, K., Wu, L., Xu, T., Liu, Q., & Chen, E. (2021). Colour enhanced cross correlation net for image sentiment analysis. IEEE Transactions on Multimedia.

[47] Shevell, S. K. (Ed.). (2003). The science of colour. Elsevier.

[48] Barile, S., Bassano, C., Lettieri, M., Piciocchi P., Saviano, M. (2020), "Intelligence Augmentation (IA) in Complex Decision Making: a New View of the VSA concept of Relevance. In Spohrer, J.C, Leitner, C. (Ed.s), *AHFE 2020, Advances in Intelligent Systems and Computing* (AISC), Vol. 1208, Springer Nature AG, part of Springer Nature, Switzerland, pp.1-8 https://doi.org/10.1007/978-3-030-51057-2_36.

[49] Golinelli, G.M., & Bassano, C. (2012), Human resources for governing business dynamics. The Viable Systems Approach. pp.359-368. In Advances in the Human Side of Service Engineering – Taylor&Francis Group, CRC Press, ISBN:9781439870266 - eBook ISBN 9780429065156.