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Journey into the Local Market in Search of "Glitter" Microparticles: Mini Product Investigation and Relative Chemical-Physical Characterization

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Abstract: There is one type of primary microplastic, glitter, which has not received the same attention as microbeads. The general thought associates the use of glitter with extraordinary and rare events, in reality, its presence in everyday life is much more ubiquitous than one might think. The main objective of this preliminary study was to create a mini product survey with the aim of analyzing the distribution and composition of glitter in the local market of the city of Trieste (Italy), thus creating a starting point for larger future studies. The analysis of a real context served as a snapshot for the description of the phenomenon, from which useful information was obtained: glitter is everywhere, cheap, disperses easily in the environment, is made of different materials, often has sharp-edged shapes, and mainly affects sensitive audiences, such as children. It is time to put glitter in the spotlight.

Keywords: primary microplastic; plastic pollution; unconscious consumption; database; market analyses; hexagonal particles; μFT-IR

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1. Introduction

The problem of environmental pollution from plastics is a phenomenon that everyone is now aware of. Manufacturers, consumers, and legislators are pursuing strategies to improve environmental impact, reduce the consumption of single-use products, and ban the sale and marketing of certain types of primary plastics. For example, beads contained in various personal care products have been banned in several European and other countries, including the Netherlands, Italy, the United Kingdom, the United States, Canada, and Australia [1]. However, there is another type of primary microplastic, glitter, which has not received the same attention despite having potentially very harmful properties.

According to Tagg and Ivar do Sul [2], the omission of glitter in contexts where one should expect it to be discussed may be due to a lack of understanding of what glitter is in its composition. Glitter is more complex in composition than the commonly reported microplastic beads: they are composed of a variety of layers [3], usually of Mylar ™ (a film of polyethylene terephthalate, BoPET), poly-methyl methacrylate (PMMA), polyvinyl chloride (PVC), or other resin blends, covered by a metal layer of aluminum, titanium, iron, or bismuth to give them their typical "sparkly" aspect [4,5]. Glitters are fragments of any shape, with variable sizes and thicknesses. During the manufacturing process, holographic effects or colorants can be added [6].

The common thought associates the use of glitter with extraordinary and rare events, in reality, its presence in everyday life is much more ubiquitous than one might think. The fashion world has made it a real trend, favoring its spread in a wide variety of areas: from cosmetics to clothing and home decorations. Glitter in cosmetic products is applied to the body in the form of skin oil or is simply contained in the product, so it is very easy to wash it off. This explains the direct pathway of glitter into wastewater treatment plants (WWTPs), where glitter can account for up to 24% of microplastics [7]. Indeed, wastewater treatment plants appear to be a major sink and source of glitter: it is estimated that 2.7×10^7–3.0×10^7 particles are released daily from a wastewater treatment plant in Australia in activated sludge and 2.5×10^6–2.7×10^6 particles in effluent [7]. Consequently, both agricultural systems (receiving the sludge as fertilizer) and aquatic systems (receiving the effluent) can potentially be contaminated [8]. Some glitters are applied to clothing or objects with a type of adhesive so that a light rub is sufficient to detach them and disperse them in the environment. Over the years, the ease of transferability has contributed to the identification of glitter at crime scenes as genuine evidence [9,10] and several studies have reported the presence of hexagonal colored microplastics in the form of glitter in the urban dust of Iranian cities [11,12].

Glitters thus appear to be elements of particular interest for many reasons. From an ecotoxicological perspective, the microscopic and multi-material nature suggests similar or worse effects than ordinary microplastics. From a management perspective, Tagg and colleagues [2] suggest the use of glitter as "flag elements" to attribute litter pollution to a likely source [13]. Glitter particles, because of their complex and unique morphology, have the potential to be directly associated with a specific manufactured product or the associated wastewater treatment plant through which they may have passed. In addition, there is no regulatory framework governing the labeling and marketing of glitter particles. Finally, the glitter phenomenon has social implications: glitter is the symbol of a throwaway culture. Sensitivity to the issue of environmental protection has grown strongly among the population. However, as several authors have shown [5,14], there is no real awareness of the disposable nature of glitter, its composition, its easy dispersion in the environment, and the resulting impact on the ecosystem.

The literature provides us with information about the theoretical composition of glitter, but little or nothing is known about its actual distribution in the market. The main objective of this preliminary study was to create a mini-product survey with the aim of analyzing (in a qualitative and semi-quantitative way) the distribution of glitter in the local market of the city where the university was located (Trieste, Italy). The study, which initially covered a limited area, may be expanded in the future to better characterize the phenomenon on a larger scale. The analysis of a real context will serve as a snapshot for the description of the phenomenon, from which useful information can be obtained. The type of glitter available and the way it is used (powder or immersed in a liquid or solid) will allow conclusions to be drawn about the ease and mode of dispersal in the environment; morphological characterization (in terms of shape, color, and size) and an initial chemical study of its composition will also be of interest to the scientific community, which will then be able to carry out much more targeted ecological and ecotoxicological tests. In addition, the information collected in this way will be used to identify the client type for the market (i.e., adults or children) and thus plan targeted awareness programs to raise awareness. Finally, the data we collect will be used to create a first database that will allow us to look at the glitter as "flag items" and thus hypothesize about the possible sources.

2. The Survey

The study described here began in June 2021, when various types of stores were visited: hardware stores, bookstores, clothing stores, furniture stores, DIY stores, stationery stores, department stores, and perfumeries. The first inspection made it possible to understand how widespread the distribution of products with glitter was (found in each of the above categories of stores), which suggested the identification of six main affected retail sectors chosen in a discretionary way. These sectors are Cosmetics and Personal Care, Arts and Crafts, Clothing, Party and Events, Home furnishings, and Toys and Pets. Later, it was decided to select the most representative products for each sector, purchase them and bring them to the laboratory to isolate the glitter contained in them. A total of 37 items were purchased (Table 1): 6 from the Cosmetics and Personal Care category, 15 from Arts and

Crafts, 5 from Clothing, 6 from Party and Events, and 2 from Home furnishings and Toys and Pets.

Table 1. List of products considered representative of each retail sector (CPC = Cosmetic and personal care; Art and Crafts; Clothing; Party and Events; Home furnishings; Toys and Pets) purchased and from which glitter particles were isolated. Stereomicroscopic images are shown, followed by the morphological description in terms of shape, maximum length and maximum area (mean ± standard deviation), color, vehicle, and chemical composition of the outer layer. Magnification is between × 5 and × 40 depending on the size of the particles.

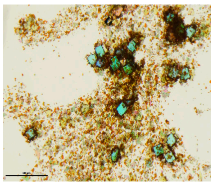
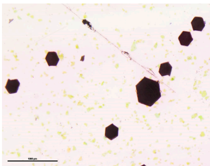
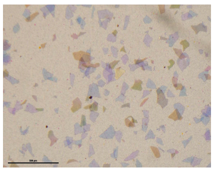
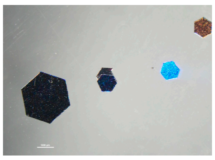
Retail Sector	Product Name	Photo	Shape	Max Length (μm)	Area (μm^2)	Color	Vehicle (Liquid, Glued, Powder)	Composition of the Outer Layer
CPC	Liquid eyeshadow		Square Irregular polygons	84.8 ± 4.7 28.5 ± 21.2	3898.9 ± 810.3 395.9 ± 558.6	Green Multicolor	Liquid Liquid	PE PE
CPC	Nail laquer 1		Hexagons	409.6 ± 265.5	151,927.2 ± 243,381	Silver	Liquid	PMMA
CPC	Lipgloss		Irregular polygons	102.1 ± 45.7	4426.1 ± 3601.2	Multicolor	Liquid	PMMA
CPC	Hair gel 1		Hexagons	954.1 ± 315.2	626,216.6 ± 328,944	Silver	Powder	PMMA
			Hexagons	1052.6 ± 1183	173,081.8 ± 2,566,028	Multicolour	Powder	PE

Table 1. *Cont.*

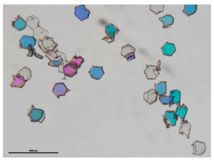
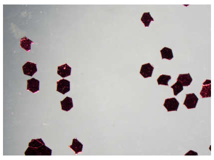
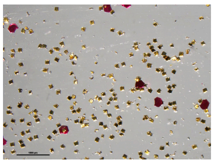
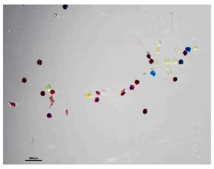
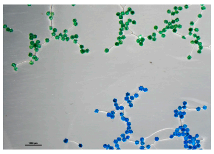
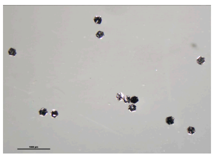
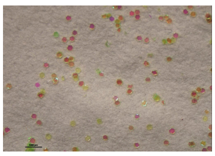
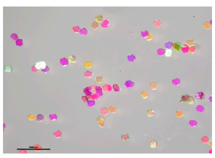
Retail Sector	Product Name	Photo	Shape	Max Length (μm)	Area (μm^2)	Color	Vehicle (Liquid, Glued, Powder)	Composition of the Outer Layer
			Hexagons	296.3 ± 18.8	56,856.3 ± 6622.3	Multicolour	Powder	PET
CPC	Hair gel 2		Star	3047.8 ± 63.1	3,907,645.9 ± 144,158.3	Silver	Powder	PA
			Hexagons	913.6 ± 34.1	499,020.2 ± 65,171.5	Pink	Powder	PET
CPC	Nail laquer 2		Square Hexagons	145.5 ± 14.4 289.2 ± 16.4	12,935.1 ± 3339.6 70,442.3 ± 45,311.2	Gold Pink	Liquid Liquid	PE PE
Art and Crafts	Stickers 1		Hexagons	325.7 ± 37.2	68,061.3 ± 5362.1	Multicolor	Glued	PE
Art and Crafts	Glue 1		Hexagons	269.4 ± 18.7	50,425.0 ± 6062.1	Multicolor	Glued	PE
Art and Crafts	Stickers 2		Hexagons	275.3 ± 8.4	4894.2 ± 4193.9	Silver	Glued	PE
Art and Crafts	Glued 2		Hexagons	333.0 ± 20.5	71,830.0 ± 9341.8	Multicolor	Glued	PE
Art and Crafts	Purpurin 1		Hexagons	221.6 ± 13.5	39,351.8 ± 3437.7	Green, yellow, purple, orange, pink	Powder	PMMA

Table 1. *Cont.*

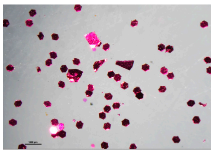
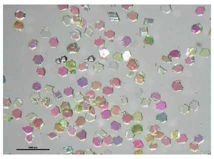
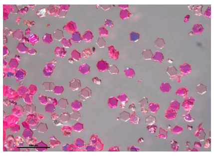
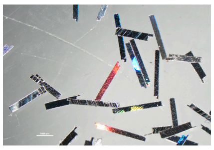
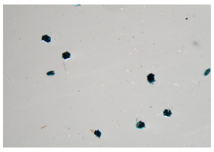
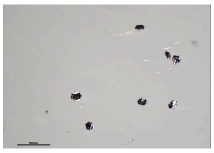
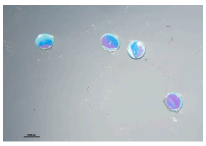
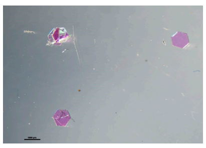
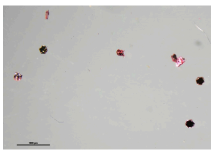
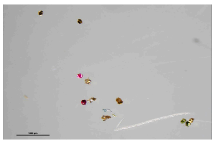
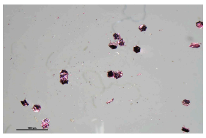
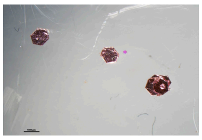
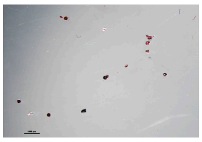
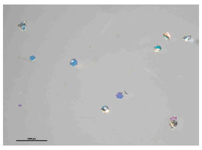
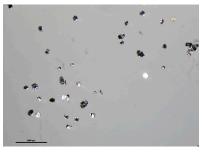
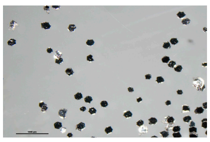
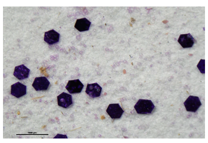
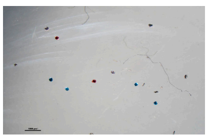
Retail Sector	Product Name	Photo	Shape	Max Length (µm)	Area (µm^2)	Color	Vehicle (Liquid, Glued, Powder)	Composition of the Outer Layer
Art and Crafts	Purpurin 2		Hexagons	654.5 ± 232.5	277,547.0 ± 153,956	Pink	Powder	PA
			Rectangles	1698.8 ± 455.1	481,346.0 ± 155,098	Pink	Powder	PET
			Hexagons	318.8 ± 44.8	59,461.2 ± 15,709.6	Multicolor	Powder	PE
			Hexagons	221.6 ± 13.5	39,351.8 ± 3437.7	Pink	Powder	PET
			Rectangles	2504.2 ± 616.5	813,307.0 ± 222,881	Silver	Powder	PE
Clothing	Water bottle cover		Hexagons	275.9 ± 22.7	49,922.7 ± 12,124.7	Blue	Glued	PE
Clothing	Shoes		Hexagons	294.9 ± 32.7	55,225.0 ± 12,086.6	Silver	Glued	PE
Clothing	T-shirt		Circle	569.0 ± 34.7	1,016,752 ± 3778.7	Blue	Glued	PMMA
Clothing	Hair-clip 1		Hexagons	953.3 ± 354.4	679,882 ± 333,039	Pink	Glued	PE
Clothing	Hair-clip 2		Hexagons	284.8. ± 27.7	50,145.7 ± 5210.8	Multicolor	Glued	PE

Table 1. *Cont.*

Retail Sector	Product Name	Photo	Shape	Max Length (µm)	Area (µm^2)	Color	Vehicle (Liquid, Glued, Powder)	Composition of the Outer Layer
Party and Events	Face art tattoo		Hexagons	209.3 ± 52.3	23,721.5 ± 5853.4	Multicolor	Glued	PE
Party and Events	Hairband 1		Hexagons	268.5 ± 12.8	46,689.3 ± 1974	Pink	Glued	PE
Party and Events	Sceptre		Hexagons	1128.2 ± 67.6	907,878 ± 77,113.1	Pink	Glued	PE
Party and Events	Hairband 2		Hexagons	277.8 ± 20.9	50,202.4 ± 6470.5	Purple	Glued	PE
Party and Events	Greeting cards		Hexagons	246.8 ± 31.2	36,224.7 ± 10,843.7	Multicolor	Glued	PE
Party and Events	Candles		Hexagons	167.5 ± 23.3	18,280.8 ± 3920.9	Silver	Glued	PE
Home furnishings	Paint additive		Hexagons	244.4 ± 13.5	39,351.8 ± 3437.7	Silver	Powder	PE
Home furnishings	Christmas decoration		Hexagons	365.7 ± 59.2	88,826.3 ± 29,833.8	Gold	Glued	PE
Toys and Pets	Play-Doh		Hexagons	538.6 ± 12.9	193,186 ± 7751.5	Pink, purple, blue, green, yellow, orange	Liquid	PU
Toys and Pets	Cat collar		Hexagons	259.8 ± 17.5	42,747.4 ± 5480.2	Multicolor	Glued	PE

Morphological characterization was performed under a stereomicroscope to determine the shape, color, and size of the glitter isolated from the purchased items (Table 1). Seven different shapes were identified: in decreasing order of relative abundance, hexagons (77.8%), rectangles, irregular polygons, and squares (5.6%) appear; circles and stars are less common (2.8%, Table 2). The isolated glitters are characterized by a large chromatic variability: nine colors were identified, of which multicolor (i.e., a mixture of several hues, 26.7%) was the most common, followed by pink (22.2%) and silver (17.8%). Less frequently occurring were blue, followed by purple, green (6.7%), orange, gold and yellow (4.4%). In terms of dimensions, glitter particles have an average length between 65.3 and 3047.8 microns. The Craft and Arts sector has particles with larger dimensions (682.3 ± 146.1 microns, mean ± standard deviation), while the smaller particles were isolated from products related to Home furnishings (305 ± 85.8 microns). As for the shape of the glitter, the most common shape (hexagons) has an average size of 430.4 ± 289.2 µm, the stars and rectangles are the largest (>2101.5 µm), while the square ones are the smallest (65.3 ± 52 µm).

Table 2. Relative abundance (%) by shape, color, size (mean ± standard deviation) and polymer composition.

Shape	**Relative Abundance %**
hexagons	77.8
rectagles	5.6
irregular polygons	5.6
square	5.6
circle	2.8
star	2.8
Colors	**Relative Abundance %**
multicolor	26.7
pink	22.2
silver	17.8
blue	6.7
green	6.7
purple	6.7
yellow	4.4
gold	4.4
orange	4.4
Size by Commercial Sector	**Max Length (µm)**
Home furnishings	305.0 ± 85.8
Party and Events	383 ± 367.3
Toys and Pets	399.2 ± 197.2
Clothing	475.6 ± 294.1
Cosmetic and Personal Care	665.8 ± 180.2
Arts and Crafts	682.3 ± 146.1
Size by Shape	**Max Length (µm)**
irregular polygons	65.3 ± 52.0
square	115.2 ± 42.9
hexagons	430.4 ± 289.2
circle	569.0 ± 34.7
rectangles	2101.5 ± 569.6
star	3047.8 ± 63.1
Polymers	**Relative Abundance %**
PE	66.7
PMMA	13.9
PET	11.1
PA	5.6
PU	2.8

As the last step of the investigation, the chemical nature of the outermost layer was then investigated by means of microscopy associated to Fourier transformed infrared spectrophotometry (μFT-IR Nicolet iN 10MX, Thermo Fischer Scientific, Waltham, MA, USA) using a liquid nitrogen-cooled MCT-A detector operating in the spectral range of 650–7800 cm^{-1} way transmission technique (particle-size detection limit of 10 μm). The acquired FT-IR spectra were compared with the reference library (OMNIC ™ Picta ™ software libraries integrate with libraries collected by the Bioscience Research Center on reference materials); only spectral matches higher than 80% were considered; while matches between 70% and 80% were evaluated by qualified researchers before being excluded. The detection limit of the chemical analysis was defined as particle size of 10 μm. This analysis revealed five different polymers: the most frequent was polyethylene (PE, 66.7%), followed by poly methyl methacrylate (PMMA, 13.9%), polyethylene terephthalate (PET, 11.1%), polyamide (PA, 5.6%) and polyurethane (PU, 2.8%).

3. Take Home Message

The mini survey we conducted allowed us to obtain extremely useful information, such as noting the high prevalence of glitter in products from a wide range of daily life. For rationality, six main commercial sectors were identified, some of which showed more obvious participation: this is the case in the cosmetics sector, where virtually every type of product can be found in a version with or without glitter. Figure 1 shows a series of images that confirm what has been said: eye pencils, liquid and powder eyeshadows, highlighters, bronzers, lip glosses, lipsticks, and lacquers—the list is endless. The products we bought are only a small part of the total offer, which was chosen for their representativeness and ease of obtaining glitter. The glitters in this range have an average size of about 665 microns and wide variability in shape (square, polygonal, hexagonal and star-shaped), which indicates their decorative function. The predominant colors are multicolor (36.4%), silver (27.3%), then pink, green and gold. They are sold as a component of a viscous liquid (this is the case of lip gloss, liquid eye shadow and nail polish) or as a free powder (see hair glitter, which is later added to a gel). In all cases, their use is one-time and they are removed by rinsing with water or detergents. Here, glitter can be collected both from polymers with high density (PMMA, PET) and low density (PA, PE). Considering the large number of products containing glitter, relatively frequent use is conceivable, and not exclusively tied to extraordinary events, such as parties.

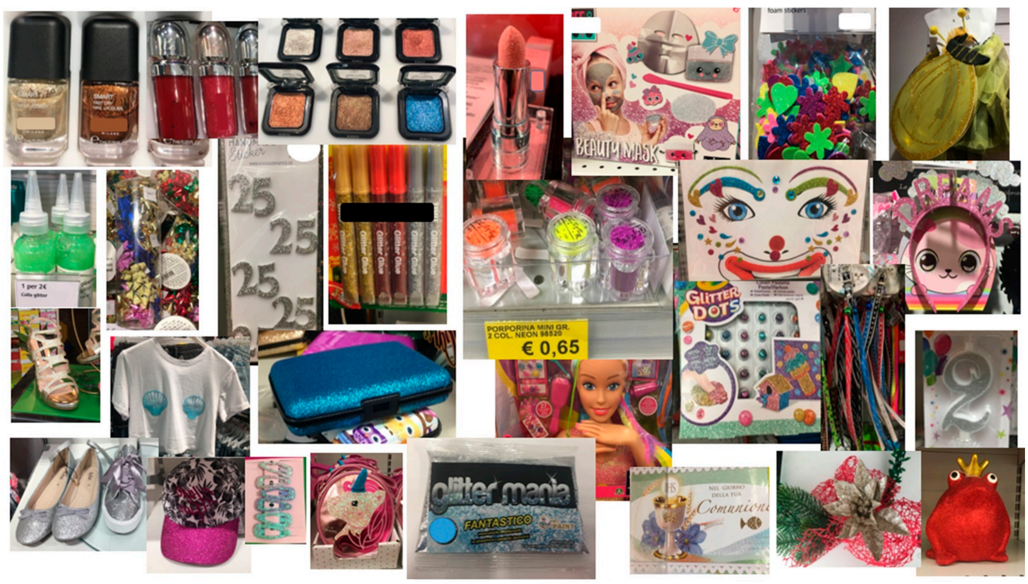


Figure 1. Photos of some products decorated with glitter, available on the local market.

Another area where glitter is undoubtedly the real protagonist is Arts and Crafts and Party and Events. Glues, stickers, face tattoos, costumes, headbands, candles, greeting cards: in these cases, you can make a statement in the absence of an alternative without glitter. As commented by Yurtsever [14], glitter is used to obtain a more attractive look, it allows one to stand out in the crowd of ordinary people. Glitter is associated with a spiritual force, they symbolize vitality, joy and hope. This justifies their wide use in the above areas.

Then there are cases that may seem unusual to many but are not really an exception: those of accessories for pets and toys for children. Besides women (who wear makeup), children seem to be the primary target group: dolls, puppets, modeling pastes, hairpins, and clothing of all kinds (hats, t-shirts, sandals, shoes, water bottles, cases and school backpacks; Figure 1). Here, the glitter is often only weakly glued to the fabrics and can, therefore, be easily removed during the first wash in the washing machine. Everything has to shine to look more cheerful and less boring (young people do not like boredom). Most likely, the children who wear such products are not even aware that glitter is also microplastic and, as such, poses a potential threat to the ecosystem. Awareness programs on plastic pollution have been carried out for years in schools of different types and levels; however, it is advisable to deepen the knowledge about these small, colorful and cheerful particles that permeate the lives of little ones.

Glitter is not only invading the lives of the little ones: there is plenty of it in our homes and private environments, too. Paint additives are available on the market and commercial activities, such as hairdressers, beauticians and offices, but also private rooms can have shiny walls. Then, a season in which the whole house shines is that of the Christmas holidays, whose glitter decorations are a must.

Finally, we would like to point out the easy access to almost infinite amounts of glitter in the form of purpurin. This is available in stationery stores at ridiculously low prices (a few cents per ten mL of the product) and is sold as a highly dispersing powder. In short, glitter is everywhere, cheap, disperses easily in the environment, is so small that it is hardly held back by sewage treatment plants or hardly detected in environmental samples, and is made of multiple materials (which poses a chemical risk because of the plastic polymers but also the metals they contain), and often has sharp-edged shapes (which can damage tissue if ingested). Compared to microspheres, there has been little or no awareness campaign for glitter, and it primarily involves sensitive target groups, such as children. A recent study of ours [15] has shown that the methods traditionally used for the extraction of microplastics from environmental matrices (i.e., the use of hypersaline solutions in NaCl) are completely unsuitable in the case of glitter. The recovery rates of hexagonal and rectangular glitter from PE and PMMA ranged from 4% to 11%. This suggests that the limited data available on the ambient values of glitter are likely to be underestimated. It is also difficult to calculate the associated ecotoxicological risk. Given this, it seems only right to shine a spotlight on glitter, and the study presented here should serve as a starting point for larger future studies.

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