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Acknowledging the plural Weberian rationalities in clinical embryology: When moral values, habits, and/or affection prevail beyond efficiency

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Abstract

This paper addresses the plural forms of reasoning used by clinical embryologists when deciding the fate of the human embryos they create and manipulate in the laboratory through assisted reproductive technologies (ART). Our analysis draws on empirical material from semi-directive interviews with 20 clinical embryologists working at public and private fertility units/clinics in Portugal. Within bureaucratic organizations based on a high level of functional specialization, embryologists display multiple perspectives about the criteria they use to evaluate and classify embryos' quality, potential, and viability. Taxonomies, international guidelines, and statistical data are primarily used by embryologists to qualify the embryos, basing their action on *instrumental rationality* (efficient means and calculated ends recognized inductively). However, beyond technical-scientific facts and theories employed as intellectual tools for action, some of them also mobilize alternative ethical rationalities, specifically, *value-rational action* based on moral valuations and legitimate rules/ends. *Affectual sub-rationality* governed by emotions, affects, and feeling states (such as empathy with the beneficiaries), and *traditional sub-rationality* based on habits and routines (embryologists' *feelings* gained by experience) intervene too. Therefore, Weber's distinctive ideal types, namely his foundational four *types of social action* and *rationality* – but also combinations of them – are relevant for rethinking professional practices within ART, especially clinical embryology.

Keywords: Weberian rationalities; clinical embryology; embryo assessment; decision-making processes; professional jurisdiction

1 Introduction

Human reproduction has been increasingly subject to biomedical and technological intervention (and innovation), as fertilization can now occur outside the female body, in a laboratory setting, through the manipulation and control of life and nature. These biomedicalization processes that have altered contemporary medicine's formal organization and

correlated practices (Clarke et al., 2003; 2010) have also transformed reproductive bodies and produced new technoscientific entities, such as the embryo *in vitro*. Within what has been called 'biopolitics' (Foucault, 2008) or the 'politics of life' (Rose, 2001; Fassin, 2009), disciplinary technologies of the governmentality of the population as a whole and also of the self and individual body are increasingly pervading more aspects of our daily lives, including reproductive rights and decisions, despite also being associated with new forms of resistance (agency, autonomy, and choice). Moreover, the application of biotechnology in reproduction, commonly known as assisted reproductive technology (ART), is associated with the 'technologization of life itself' and conceptualized as 'a new genomic governmentally' (Franklin, 2000, p. 188). ART comes with uncertainty (Machtinger & Racowsky, 2013) and is increasingly subject to specific regulations translated into good practice recommendations (Vermeulen et al., 2020).

The work of embryology has relied on material/visual representations of the embryo's development (drawings, photographs, videos, specimens, etc.) and the production of manipulable objects/models (Hopwood, 2000). Due to the rise of micromanipulation imagery in the staging of the mechanization of the human embryo, the latter has become both a tool and a lens, besides being a reproductive substance (Franklin, 2013). At the beginning of the twentieth century, the systematization of embryonic staging (Carnegie Stages) contributed to this mechanization of embryonic development stages in close articulation with temporal attention; the subsequent move to the genetic scale introduced a sense of perfectly planned biological life in terms of the presumed path of the embryo and its unfolding vital potentialities (Dicaglio, 2017). Biomedicine and new technologies induce decision-making based on this anticipation (ibid.). However, the creation of the embryo *in vitro* enhances and complexifies the issue of the fragility of the frontiers regarding the human condition since it constitutes a scientific object likely to generate dilemmas and controversies arising from its different categorical, moral and legal representations (Boltanski, 2013; ESHRE, 2001; Delaunay et al., 2021). Simultaneously, the existence of non-viable embryos created, selected, and discarded out of sight of would-be parents by the embryologists in the laboratory introduces a 'necropolitics of reproduction' (de Wiel, 2018; see also Mbembe, 2019).

Moreover, the processes of regulating scientific knowledge and practice within clinical embryology are related to the standardization of parameters, instruments, and protocols, which can be described as the government of life by standards (Thévenot, 2009). In Portugal, the forms of control, regulation, and certification of the professional practices of embryologists (e.g., scientific and laboratory-based procedures) refer to certain normative systems arising from higher regulatory instances such as the National Council for Medically Assisted Procreation (CNPMA) and the European Society of Human Reproduction and Embryology (ESHRE).

Information and conformity, as 'investments in forms' (i.e., the establishment of procedures, indicators, and benchmarks that define the standard by scientific committees), generate different 'forms of the probable' according to what is used as relevant evidence – for example, a statistical probability or proximity to a prototype (Thévenot, 1984; 2002; 2009). The way an embryo is classified – which refers to standardization as a necessary

precondition for assessment and comparability – constitutes a 'literary inscription' (Latour & Woolgar, 1986), i.e., a narrative constructed within a sociocultural environment or framework according to the laboratory's own mythology, including habits, beliefs, knowledge, and experience, among other aspects. Nevertheless, it is important to acknowledge that the embryologists' work is not limited to compliance with binding norms and standards as devices to support laboratory procedures; these professionals can also question internationally established rules, conventions, and guidelines (Delaunay & Gouveia, 2021) – intended to be neutral and objective – that were built through a work of 'investment in forms' by scientific committees (Thévenot, 1984; 2009).

Specifically, the objectivity and factual status of the standard norm confers it indisputability (not requiring any explanation or justification) in relation to the reality it seeks to account for, and dissociated from its creation process and previously existing scientific controversies (Latour & Woolgar; 1986). Standardization thus assigns measurable properties to independent objects and entities, which are mistaken for factual statements based on an objective state. Thus, standards threaten to overwhelm the dynamics of familiarisation (more localized and personalized judgments), imposing a fixed set of regulated routines – favouring, thus, a 'substantialist reduction' (Thévenot, 2010). However, besides this confident adherence to conventions, another facet or dynamic of engagement of the embryologists in their daily work is 'opening the eyes', associated with moments of inquietude, concern, and/or enduring doubt regarding standards (Thévenot, 2019). In fact, the consolidated criteria for assessing and qualifying the human embryo in its diverse stages can be differently interpreted, adapted, and incorporated into concrete practice by the professionals themselves (Delaunay & Gouveia, 2021). In sum, there seems to be either blind conforming to standards or, on the contrary, criticism and the recognition of the legitimacy of other forms of knowledge (such as that derived from experience) or complementary criteria (e.g., contextual factors and/or moral values) as a basis for decision-making (ibid.). Within the biomedical development of health, the standardizing conventions of the living have such short cycles that one could say that social actors 'blink', adhering to conventions while also expressing their doubt (Thévenot, 2009).

The social construction of scientific knowledge about embryonic development and the way laboratory work is carried out on embryos involves processes of inscription and translation, as well as the development of networks of relations between human and non-human actants (Latour & Woolgar, 1986; Latour, 2005), i.e., embryologists, ART users, gametes, embryos, bodies, taxonomies, laws, scientific articles, laboratory objects, and high-precision technologies, among others. These complex assemblages of heterogeneous elements (i.e., '*dispositifs*') produce and transform normativity in their interaction with and constraints on professionals (Dodier & Barbot, 2016).

It is against this backcloth at the crossroads of science and technology studies (STS), actor-network theory (ANT), and pragmatic sociology that we examine, through renewed Weberian lenses, the plural forms of reasoning used by clinical embryologists when deciding the fate of the human embryos they create and manipulate through laboratory procedures. These new technoscientific entities result from the application of second-line fertility treatments, such as conventional *in vitro* fertilization (IVF) or intracytoplasmic sperm

injection (ICSI).[1] Decisions include transferring the 'best' embryo to the woman's uterus, cryopreserving spare ones for later use, or discarding those of poor quality or that shall no longer be used. Embryologists display multiple perspectives concerning the criteria they use to assess and classify the quality, potential, and viability of the human embryo produced *in vitro* (i.e., its capacity to develop into a foetus and eventually become a take-home baby).[2] And these different positionings and standpoints are related to the diversity and fluidity of the embryos' meanings and statuses among those experts. In fact, within the decision-making processes of this professional group, there are differences in terms of cognitive schemes and target-based conduct, normative standards and personal values (cultural, moral-ethical, religious, etc.), experiential knowledge, and emotional labour when dealing with 'feelings' (theirs or others).

Weber's distinctive ideal types and theoretical contributions, namely his foundational four 'types of social action' (Weber, 1978) and his typology of rationality, seem epistemologically relevant for analyzing biomedical transformations and practices. As we will demonstrate, his sociological approach to social action is fruitful for rethinking professional practices within ART, and clinical embryology in particular, since it is oriented to the 'subjective meaning' attached to behaviour and 'interpretive understanding' in terms of causal explanations of a course of action and its consequences (Weber, 1978, p. 4). Weber does this by acknowledging the variety of motives or meaningful orientations for human action, whether as *instrumentally rational*, *value-rational*, *traditional*, or *affectual* (1978, pp. 24–25). This broad array of patterned action-orientations stems from a multi-causal and multi-dimensional analysis made by the author that takes into account 'the dynamic-conjunctural interaction of multiple patterns of action' (Kalberg, 2016).

By further developing Weber's four-fold typology of social action – as well as their tensions and articulations – researchers can gain insights into how the respective orientations and rationalities (practical, theoretical, formal, and substantive)[3] shape the choices and decisions made by healthcare professionals and institutions in the field of biomedicine. Therefore, the main aim of this paper goes beyond a simplistic application of Weber's four ideal types (1978, pp. 24–25) by discussing the relationship between the three alternative types other than *instrumental rationality* (where actions are determined by ex-

[1] After ovary stimulation through hormonal therapy, oocytes/eggs are aspirated from follicles using a needle suction device. Subsequent fertilization is carried out where male and female gametes fuse: in IVF, the retrieved eggs and the motile sperm are placed together in a Petri dish which contains a nutrient liquid, also known as culture media, which creates an environment that helps embryos grow; in ICSI, the procedure consists of extracting a spermatozoon from a semen sample or by testicular biopsy to select the most appropriate sperm, and involves the direct insertion of a sperm into the ovule to facilitate fertilization. Embryos will be cultured for two to five days and closely monitored by an embryologist. Viable ones will be transferred into the uterine cavity or will be frozen, as opposed to those that do not develop or are of poor quality, which are discarded.

[2] Embryologists are responsible for all the laboratory activities that involve the manipulation of gametes and embryos in their different stages. Their professional duties include performing the inaugural treatment procedures such as follicular puncture and sperm preparation for intrauterine insemination (IUI), fertilization techniques such as IVF or ICSI, monitoring embryonic development to select the more viable embryos that could generate a pregnancy, and transfer procedures.

[3] Given that Weber's analysis of the four types of rationality and respective multivalent embodiments are dispersed throughout his vast work, we rely on the inventory of their general features and interrelationships made by Kalberg (2016, pp. 13–42).

pectations regarding the choice of means or conditions to achieve certain ends) and also the relationship of the latter with them. We address these three alternatives, that is, *value-rational action* (where actions are driven by the belief in ultimate values and absolute convictions), *traditional-oriented action* (where actions are guided by deep-rooted habits such as customs and established practices), and *affectual behaviour* (where actions are motivated by strong emotions, affects, or feeling states), but also the in-between types resulting from possible combinations thereof. Instead of emphasizing their analytical distinctions based on means-ends considerations (Schluchter, 1981), we prefer a classification that refers to categories of value and conscious decisions (Etzrodt, 2005). In sum, based on our empirical data, we contest the opposition between rational and non-rational actions and discuss their dynamically changing nature.

Moreover, Weber's emphasis on the sociocultural context of human action is crucial when studying biomedical practices since different societies and cultures have varying attitudes, guiding beliefs, and norms regarding ART treatments, laboratory conduct, and ethical considerations about the use and manipulation of the embryo. Weber's framework allows us to assess and explore how these cultural and social factors interact with rationalities to shape the adoption – or partial circumvention – of certain legal and technical orientations for action.

Finally, Weber's work on rationalization and bureaucratization (1978, pp. 998–1002) is particularly relevant for understanding the current functioning of healthcare systems and the role of institutions since biomedicine is often subject to complex regulatory structures, organizational hierarchies, and administrative processes. The Weberian concept of 'rational-legal authority' (Weber, 1978, pp. 217–221) can help analyze how these late modern institutions – in the present case, ART units/clinics along with ethics committees and health authorities – are structured on and governed by a system of established legal norms and abstract rules, and how they influence the embryologist's decision-making on embryos and potential parents' health trajectories. Additionally, Weber's analysis of professions and their rational-legal authority can be applied to the field of biomedicine. The emergence and professionalization of reproductive doctors and clinical embryologists are influenced by factors such as functional specialization, scientific expertise, technical knowledge, and institutional recognition. Studying biomedical practices through the lenses of Weber's theoretical framework can shed light on the changing roles, jurisdictional negotiations, and power dynamics within health professions.

2 Methods

This paper stems from concluded research (2018–2022) on plural lay and expert meaning-making about human embryos created *in vitro*, that is, in the laboratory, within ART. This project was based on a mixed-methods approach, combining quantitative and qualitative methods, including semi-structured in-depth interviews with ART beneficiaries and health professionals and an online survey aimed solely at the former. The initial methodological protocol also integrated ethnography in ART centres, which unfortunately was not possible due to the restrictions imposed by the SARS-CoV-2 epidemic and some professionals' concerns. Ethnographic observation would be essential for witnessing and describing

the processes allowing the implementation of routines (Latour & Woolgar, 1986), such as the manipulation of embryos and the use of advanced technological equipment to record the classification of embryos at their various stages.[4]

For this article, we focus on the discourses of the clinical embryologists who were interviewed, as they are in charge of the technical-scientific manipulation of the embryo *in vitro*. The interviews with 20 embryologists – working at private and public fertility clinics/units in Portugal – were conducted by the same researcher between September 25, 2020, and January 28, 2022. The recruitment of interviewees was based on non-probabilistic convenience and snowball sampling: all public and private units/clinics integrating the ART medical care network in Portugal were contacted via their management bodies or appointed intermediaries (e.g., clinical director or laboratory coordinator). The e-mails of potential interviewees were obtained, and an invitation to participate in the study was sent. After each interview, the email addresses of other professionals suggested by the interviewee were also obtained.

The interview script covered a wide range of topics: description of the professional career (motivations for choosing the ART field, number and type of ART clinics/units, etc.); preconceptions, doubts and concerns about ART techniques expressed by the beneficiaries (and how they are addressed); work dynamics between professional groups within the respective ART clinic/unit (issues discussed, decision-making processes, disagreements, etc.); beneficiaries' doubts and concerns about the generated embryos (and how professionals deal with them); patients' conceptions and forms of attachment to the embryos thereby generated (meanings and statuses attributed, moments of emotional bonding, etc.); perspectives on bioethics (the moral status of the embryo, public controversies about embryo manipulation in clinical or research settings, personal ethical limits on the use of embryos, etc.).

Compared to a standardized data collection technique, such as a survey, semi-directive interviews allow interviewees to freely mobilize their own analytical categories, in this case, about the decision-making process concerning embryos created and manipulated in the laboratory, and thus capture the plurality of – and oscillation between – different ways of reasoning and acting according to each situation. In fact, during interviewing, what initially appeared to be patterned responses regarding embryo decision-making (i.e., references to technoscientific standards as guiding laboratory activities) gradually gave rise to several contextual nuances.

Ethical approval and informed consent were obtained prior to data collection. The confidentiality of the data and the anonymity of the participants through codification were guaranteed. The assurance of anonymity coupled with interviewing taking place via videoconference at the embryologist's home (due to Covid-19 pandemic constraints) may also have favoured an environment of greater informality and ease and consequently encouraged the open disclosure of individual perspectives and personal views, thus precluding social desirability bias. Moreover, pair interviews – especially those involving a hier-

[4] From a scientific point of view, the development of the embryo as a cell structure can be divided into three major stages: zygote (a cell that results from the fertilization of gametes), morula (an intermediate stage in which the embryo has between 16 and 32 cells) and blastocyst (a more complex level of cell organization).

archical relationship between interviewees (e.g., clinical embryologist and laboratory team coordinator) – were avoided so that any potential clash of perspectives would not inhibit certain viewpoints. When an issue seemed more uncomfortable due to its strong moral or political dimension (e.g., embryo moral status or beneficiaries' access to ART), the role of the interviewer was essential in ensuring an ethical stance consistent with scientific research aiming at mapping the plurality of perspectives without making normative judgments.

All interviews were recorded and transcribed verbatim. Thematic analysis followed inductive category formation (Bradley et al., 2007), where an open coding procedure was used to generate a preliminary list of themes, i.e., categories that emerged based on patterns derived from the raw data rather than on preconceived theories. The code structure, which aimed to reflect the key ideas expressed by the interviewees, was developed with the support of the MaxQDA software (version 2018) and was continually fine-tuned until theoretical saturation was reached, i.e., when no further codes could be derived from the interviews. Subsequently, the authors revisited the themes emerging from the professionals' discourses on their engagement in laboratory activity, namely the plural criteria for embryo decision-making, mobilizing Weber's theoretical approach. Our aim was to highlight both similarities and variations concerning how technical guidelines support embryologists' formal judgments and how they are combined with – or shift to – other Weberian rationalities (such as practical or ethical valuations). Moreover, the use of a non-probabilistic, convenience and snowball sample precluded performing a more systematic analysis (such as a quantitative/statistical one) with regard to comparing different ways of reasoning in relation, for example, to certain socio-demographic variables associated with the interviewees (age, gender, socioeconomic profile, etc.) or types of fertility units/clinics (public *versus* private, north *versus* south of Portugal, big metropolis *versus* small town, etc.).

3 Results

3.1 Fertility centres: A bureaucratic organization within the rationalization process

One of the main topics in Weber's sociological endeavours is the spirit of capitalism, that is, the distinctive character of highly urban and industrial Western societies and their singular pathway of economic development to modern capitalism (Weber, 2005). Capitalism is characterized by a focus on values such as technical efficiency, rational calculation, and profit maximisation, which are central to the rationalization process. According to this author, a fundamental feature of modern society is rationalization, conceived as a complex and multifaceted process with profound implications for the way people live their lives. Traditional modes of thinking and behaviour are succeeded by rational, calculated, and efficient ones; traditional, mystical, or religious explanations of the world are replaced with scientifically grounded ones. Therefore, a crucial driver of the rationalization process was the development of science and technology: science allowed people to understand the world in a systematic, rational way, while technology enabled them to control nature and achieve their goals efficiently.

According to the author, one key component of the rationalization process is the growth of formal, large-scale bureaucratic organizations, characterized by 'jurisdictional areas' ordered by general rules, with highly specialized and clearly defined 'duties' and 'spheres of competence', thus involving hierarchies of authority, 'technical expertise' acquired by training and qualifications, formal-rational procedures, as well as 'impersonal and functional' relationships (Weber, 1978, pp. 217–221 and 956–958).

Professional responsibilities and specialized tasks associated with expert knowledge are fixed by a firm hierarchy, with demarcated positions, formal statutes, and specified job descriptions. This scenario in terms of social organization, power, and authority occurs in certain fertility units/clinics, where there is a clear demarcation between physicians and embryologists in terms of professional dynamics and the type of relationships they establish with ART beneficiaries. In fact, within these organizations, the negotiation and establishment of borders and areas of jurisdiction between professional groups are noteworthy (Abbott, 1988).

As people began to rely more on science, technology, and bureaucracy to organize their lives, they became less reliant on traditional sources of authority and meaning, thus causing a decline in traditional values, such as those associated with religion or community. Decision-making occurs by reference to 'objective' criteria and prescribed procedures. In the subject under analysis, these processes of 'calculability of results' and the 'estimated quantifications of relative chances' (Weber, 1978, pp. 108, 975) underlie the development of standardized metrics used to evaluate and compare the quality and potential of each embryo, coupled with the use of statistical data (success rates) to measure and predict outcomes (a full-term pregnancy).

Moreover, the institutionalization of formal knowledge is articulated with professional powers (Freidson, 1986); within ART clinics/units, this knowledge circulates, and these powers have specific dynamics among professionals and within each professional group along with their interactions with the patients themselves. Technocracies, that is, the legitimation of applied knowledge and technical expertise as a source of authority, are used by these clinical specialties to define their borders, boundaries, and fields of action in a certain way, thus also stating their power in a very differentiated and specific context.

In the context of reproductive medicine, there is a division of roles and tasks between embryologists and physicians that is much more pronounced in some fertility centres:

> At [name of hospital], and it's not like that in many places, we are very much on the same level as the doctors in terms of decision-making and respect, too. Because unfortunately, you [often] hear [...], 'The doctor is the one in charge,' and there are many centres where that's the case. I'm in charge of the lab; I decide what I'm going to do, the technique. Normally, we talk amongst the four of us, but we decide what's best for that couple at that time. We don't go to the doctor to see if I should do this or that. Nor does he give us indications 'You should do a microinjection' or 'You should do fertilization.' (B7.1-M)

Issues relating to the medical records or therapeutic trajectory of beneficiaries fall within the competence of physicians, while embryologists focus their attention on the assessment of the embryo's cellular structure. This occurs in the context of new – and increasingly complex and specialized – technological and medical-scientific procedures commonly known as biomedicalization (Clarke et al., 2003; 2010). Other organizational en-

vironments incorporate much greater contact and involvement with patients on the part of embryologists. Such differentiation is reflected both in the type and frequency of communication between embryologists and patients regarding all the processes involving gametes and embryos. Embryologists can contact the couples on a daily basis or just occasionally, in person or by telephone. They can provide just quantitative and generic facts or, on the contrary, give qualitative and detailed information: 'As long as there is life [associated with] that couple in the laboratory, we contact the couple on a daily basis. And the lab does that' (B4-F).

This variability in the modalities of communication between embryologists and beneficiaries may help explain the differences in the way these professionals (re)appropriate guidelines and whether they are open to other criteria for decision-making. Both the co-shaping/negotiation of state regulatory instruments and the exercise of experience-based/embodied learning judgment are equally significant in establishing and justifying expert-professional authority (Blok, 2021). Some of these professionals perform 'normative work', i.e., evaluative and reflexive orientation directed both to the dispositif itself (e.g., embryonic taxonomies) and the behaviour of their colleagues within the context of these 'dispositifs' (Dodier & Barbot, 2016). Moreover, the divergences regarding the embryologists' adherence to the international recommendations and rules are also attributed by one interviewee to their use of standards as an instrument of affirmation of an occupational group in relation to medical knowledge, from a logic of safeguarding and legitimizing their area of professional jurisdiction (Abbot, 1988):

> I think most embryologist biologists cannot free themselves from their situation of competition or [inferiority] complex. Usually, in clinics, the owners are the medical doctors, right? Let's say, the ultimate decision belongs to the physician, and so maybe that's a way [the embryologists' way] of holding on to very strict criteria so as to make their position stronger. (B9-M)

As we will discuss hereinafter, standards appear as normative and evaluative devices (Thévenot, 2009; 2012) applied to laboratory procedures on embryos created *in vitro*, as in Weber's *instrumental rationality* (1978). Factuality, indisputability, neutrality, and objectivity characterize the embryologist's work. In fact, designedly universal standardization procedures and criteria constitute features of the forms of regulation of scientific knowledge and practice.

3.2 Instrumental rationality: the prevalence of scientific standards and guidelines

In the context of reproductive medicine, a standardization process has gradually taken place by means of the creation of several grading systems and the production of a set of normative guidelines and evaluative standards about the human embryo. Embryonic taxonomies and classifications, as indicators of a greater or lesser probability of implantation in the uterus (and subsequent successful pregnancy), are diverse. In Portugal, the two most used grading systems are those from a professional organization (the Alpha Scientists in Reproductive Medicine and the ESHRE Special Interest Group of Embryology, 2011) and a

specific country (the Spanish Society for Professionals working in the IVF laboratory-ASEBIR), with correspondence in terms of degrees: 1, 2, 3, 4…, or A, B, C, D… (Machtinger & Racowsky, 2013).

When questioned about the quality assessment and viability evaluation of the embryo, as well as the criteria for transferring to the uterine cavity, some interviewees emphasized a technical-scientific dimension, referring to taxonomies, international guidelines, and statistical data (e.g., success rates) that guide their professional practice, showing a relative standardization of procedures. Especially the youngest embryologists base their actions on *instrumental rationality* (Weber, 1978) – using technically efficient means in a calculated pursuit of ends recognized inductively – when qualifying and evaluating the embryos they manipulate.

Some professionals describe their decisions about the fate of embryos (to transfer, cryopreserve or discard) only based on a technical assessment according to morphological (degree of fragmentation, cell structure, quality of division, etc.) and kinetic (division timings) criteria with a strict link to standardized guidelines as a support device for laboratory procedures. The evaluation of the number and appearance of the cells (morphokinetic quality), as well as the development of the embryo in its various stages (developmental potential), is done through observation under a microscope or using more sophisticated equipment, such as an incubator with a time-lapse (TL) system. The latter allows for monitoring of the embryo's development on a daily basis and in real-time through images and videos and analyzing the cell division timings through an algorithm, thus facilitating the evaluation of the embryos.

Time-lapse imaging technologies in embryology – enabling observing and evaluating the development patterns of human embryos – involve datafication (Van de Wiel, 2019) and algorithmic knowledge production aimed at improving embryo grading and the selection of the 'best' one (Geampana & Perrota, 2021). These can even be shared with fertility patients as a way to involve them in their treatment (Hamper & Perrota, 2022). However, as we will show later, the lack of standardization of laboratory practices and epistemologies demonstrates the local embeddedness of TL technologies (Geampana & Perrota, 2021; Perrota & Geampana, 2021).

Concerning this relation with technical guidelines, we can also refer to one of the three types of authority identified by Weber, namely the one whose foundation of legitimacy rests upon 'rational grounds', i.e., that is anchored in 'a belief in the legality of enacted rules and the right of those elevated to authority under such rules to issue commands' (Weber, 1978, p. 215). For certain embryologists, the dominant cognitive and evaluative orientation is following international norms, established rules, and standardized protocols used in assessing the morphokinetic quality of the embryo and subsequent decision-making about its fate.

Strictly utilitarian orientations and pragmatic calculations characterize a 'practical rationalism' (Weber, 1946) in clinical embryology. In fact, some of these professionals consider that in order to be able to work in this area, they 'have to be very pragmatic' (B7.1-M), sticking to the technical-scientific evaluation criteria and standardized procedures for scoring, selecting, and/or discarding embryos – perceived as multi-cellular entities – without these decisions raising any kind of concern. In this case, the embryologist's technological means, instrumental calculation, effective control, and methodical planning of laboratory activities and objects may be categorized as intellectualization and *rationalization*

processes (Weber, 1978; 2005) instead of more traditional forms of thought and conduct, thus creating a knowledge and belief about being able to master everything in life technically (Weber, 1946).

The techno-scientific development of ART was followed by specific national regulatory frameworks that delimit the use of different procedures (e.g., the maximum number of embryos per transfer) and access criteria (e.g., the age limit for women, maximum number of publicly funded treatment cycles per couple/beneficiary[5]) (IFFS, 2019; Calhaz-Jorge et al., 2020). However, there are situations when greater flexibility in observing the standardized assessment norms and rules can occur when some information relating to the clinical condition or trajectory of the beneficiary couple can exceptionally be taken into account by the embryologist. For instance, when the beneficiary couple is in their last publicly funded IVF cycle according to Portuguese law, the embryologist can expand the interpretation of the guidelines and allow one last opportunity for that couple – provided that such embryo or embryos have a minimum quality that is still associated with some probability of treatment success: 'We may have a woman who is not able to do any further treatment, the embryos may not exactly meet our criteria, but they are not far below and in these cases, we can sometimes push it a bit, go a little beyond our basic criteria' (B8.2-F). Professionals, by (re)interpreting the dictates of government or other relevant stakeholders (such as ethics committees), introduce new rules and standards that grant – or deny – legitimacy to actors (Suddaby & Viale, 2011) within the ART field.

In Portugal, the National Council for Medically Assisted Procreation (CNPMA) recommends that only one embryo should be transferred, especially in women under 35 years old, in the first treatment cycle, to avoid multiple pregnancies and associated risks, such as prematurity and perinatal mortality: 'The clinical gold standard of transferring one embryo' (B9-M). However, in female patients with a poor prognosis (due to previous failed cycles) and older (around 40 years old), the option may be to transfer two embryos to increase the chances of pregnancy in terms of success rates. Therefore, although the maximum number of embryos to transfer is decided ex-ante at the beginning of treatments when beneficiaries sign their informed consent, it can be renegotiated with the clinician and the embryologist at a later stage, prior to the transfer, according to the embryo quality assessment.

Similarly, when a patient has no embryos that strictly meet the quality assessment standards, the embryologist may reconsider the grading of some of them. Scientific evidence that poorer-quality embryos can result in a pregnancy (even with a very low probability) supports this evaluative reasoning partially disconnected from the guidelines:

> We have ways of assessing embryos. The number of cells, fragmentation. And then we give letters, numbers, whatever is used, "A", "B", "C", "1", "2", "3"… There are also clinics and embryologists who are stricter than others. And then, as time goes by, we realize that sometimes a fragmented embryo that we think we shouldn't bet on ends up [Laughs] producing a child nine months later. Maybe we start our careers as embryologists very much respecting the

[5] According to the legal and regulatory framework for ART in Portugal, the age limit for women to obtain recourse to publicly funded fertility treatments is 40 years old for IVF and ICSI (being limited to three treatment cycles) and 42 years old in the case of intrauterine insemination (IUI) without treatment limit.

> guidelines we are given. And, as time goes by, we also end up sometimes… For example, the blastocysts, let's say the less good ones, I now freeze almost all of them because an article by a colleague from Italy came out […] obviously the probability is very low, but they had babies from those embryos. (B5-F)

Yet the cognitive and moral framework that ideally, according to these professionals, should guide the embryologist's perspective in the quality assessment of each embryo is embodied in the following crucial question: 'Do you think this embryo can or cannot result in a pregnancy? Yes or no?' (B11-M). Their actions are based on logical or scientific grounds (evidence, data, and best practices) and with reference to measured goals; that is, the selection of the best embryo to maximize the chances of successful implantation and full-term pregnancy.

Nevertheless, as we will explain hereinafter, beyond technical facts and scientific knowledge as intellectual tools for action, some embryologists also mobilize alternative ethical rationalities. More specifically, besides standard norms, rules, and procedures, certain professionals develop practical skills of embryo assessment in their different stages according to their own cognitive schemes, experiential knowledge, and normative viewpoints (such as cultural, ethical-moral, and religious values).

3.3 Value-rational action: vitality amidst uncertainty

Healthcare-related uncertainties and their management in a biomedical context – associated with the development of technoscientific entities – have been addressed in the literature (Sulik, 2009; Mackintosh & Armstrong, 2020), inclusive of what concerns embryology (Machtinger & Racowsky, 2013). In our study, regarding the assessment of embryo quality, potential, and viability, even when embryologists claim to stick to the grading systems used as references in the institutions where they work, an element of uncertainty may arise. This stems from the doubt or fears about the reliability of the results of the procedures (e.g., whether a given embryo will survive a freezing/thawing process) and the adequacy of their own decisions (e.g., if a particular embryo is considered non-viable and should be discarded). Biomedical technologies have 'extended choice to the very fabric of vital existence' (Rose, 2001, p. 22), not without some controversies concerning such decisions.

Notwithstanding the standardization of laboratory procedures and compliance with international guidelines, the unpredictability of the results of ART in terms of fertilization and embryonic development *in vitro* and *in utero* characterizes the working environment of these professionals, giving rise to concern, anxiety, and frustration. In fact, unless certain indisputable indicators defined in guidelines are present (anomalies, high level of fragmentation, and weak or no cell development), it is difficult to accurately predict the implantation potential of the embryo after transfer and whether it will result in pregnancy. Nevertheless, embryonic assessment is currently facilitated by the use of high-precision technological instruments, such as the time-lapse incubator.

In the absence of guarantees, embryologists resort to forms of measurement and management of uncertainty despite the critical tensions these generate (Thévenot, 1995). This is the case of trust in reference to (unlikely) successful cases and the relativization of assurances based on statistics (success rates). One way to overcome eventual doubts

and avoid the burden of individual decisions is peer consultation in an attempt to reach a consensus at the decision-making level regarding, for example, borderline embryos:

> We sometimes have doubts about whether or not to transfer that embryo, whether or not to freeze that embryo, and we debate, the team of embryologists. There are some that are obvious, 'this one is for throwing away,' 'this one is for freezing.' But then there is that grey area where we don't really know what we should do, and we debate. (B13-M)

Another option is the assumption of a precautionary principle, either cryopreserving all embryos considered viable or extending the culture to the blastocyst – up to the limit allowed by the norms – of those embryos situated in the 'grey area'.

In fact, especially if they conceive embryos as having a potential for life rather than as a cluster of cells, the moment of deciding which ones to select or discard is disturbing for some of our interviewees, in contrast to embryo transfer, which does not raise this kind of concern since success no longer depends on any human intervention and/or decision. This conception of the embryo dissociated from a more strictly functional perspective is reflected in the way these professionals perform their laboratory work. Several embryologists reported that, before making the decision to discard an embryo, they often prolong the *in vitro* culture for as long as it is scientifically sustainable (until the fifth, sixth or seventh day[6]) so that the observation of cell development leaves no room for doubt that the viability of that specific embryo is weak or null; 'I can't throw away boxes of embryos without seeing them on day seven. Hardly… They [colleagues] ask if I'm waiting for them to grow hair, but I can't. It's hard. It's hard for me… "What if?", "What if?" […] thinking about the embryo's potential, it's hard for us to throw it away, too. For me. I think it might be eliminating a possibility…' (B7.2-F).

Their moral actions and decisions are determined by a conscious belief in the worth of the embryo due to its potential to generate a new life. This behaviour is rooted in ethical, moral, and religious values, being independent of the prospects for success: the ends are determined by the judgment of the worth of the embryo as life potential; that is, not throwing out what could turn into a baby in the future. These professionals do not discard any embryos until all scientific doubts about the quality of development and implantation potential are removed, although the purpose is always to find the best one, capable of generating a full-term pregnancy and leading to the birth of a healthy child:

> There are embryos that, from the very beginning, are not going to get anywhere, but I don't rule it out until I'm sure. It's obvious that with experience, one can understand certain things, but I always consider the embryo as life potential from the very beginning. […] As I

[6] Despite the trend to standardization, there is a diversity among embryologists regarding the stage of embryonic development by which the transfer to the uterine cavity should take place, which results from the difference in schools of thought, as well as from technical constraints. There are ART units/clinics that perform embryo transfer on the third day, others on the fifth day (blastocyst stage) and also cases in which the *in vitro* culture is extended until the sixth or seventh day of embryonic development. The latter, according to some interviewees, are objects of controversy and discussion within the scientific community since these practices can result in the waste or loss of embryos that, if transferred earlier to the uterus, could have had a better chance of surviving and resulting in a successful pregnancy.

> often tell couples, what I want is a winner. There has to be a 'special one' that succeeds and generates a healthy child. That's what we always want in every treatment. But we have to assume that all of them can become that. The more there are, the better, right? (B12-M)

However, even when embryologists consider themselves confidently 'optimistic' in their assessment of each embryo, always trying to discard the smallest number possible, this optimism – translated into greater flexibility in interpreting norms – is counterbalanced by what is described as a kind of intellectual and moral integrity: 'As I am very optimistic, [I assume that] it may be an embryo that is not evolving very well, but I will always try, as far as possible, to see its evolution until the end. But I'm also not going to use embryos that I have doubts about, am I? I wouldn't be being honest with the couple' (B12-M). In such cases, embryos of doubtful quality are not used for future transfer, considering the efficiency criterion, but also the additional physical, emotional, and financial costs for beneficiaries associated with pregnancy failure. This type of action is guided by a belief in the intrinsic value of a particular goal: embryologists make decisions based on their deeply held values, such as the importance of creating life, maximizing chances of success, or prioritizing the well-being of the future child and prospective parents.

Notwithstanding, this cognitive and evaluative conception of the embryo as a set of cells (biological matter) with high potential to generate life (a human being) is likely to evolve and be reconfigured throughout the embryologist's professional career. Initially, embryo loss or disposal can have a greater emotional impact on the embryologist and be related to standards of good or bad conduct. In the case of embryologists who conceive the embryo as a 'set of cells with the potential to give rise to a human being' and 'almost as a working tool' (B13-M), no component of the laboratory work involving the embryo manipulation, even its destruction, is likely to raise any kind of moral or ethical concern, as this is considered an inevitability. However, in the course of the activity, some technical doubt (but not moral distress) arises about decisions related to the fate of each embryo in the event of potentially viable embryos being discarded that could have generated a full-term pregnancy: 'We have probably already thrown many babies away' (B13-M).

We acknowledge that moral valuations and legitimate rules/ends that are felt deductively play concomitantly an important role in what can be seen as *value-rational action* (Weber, 1978), especially when the embryo is perceived as a potential life instead of a cluster of cells. These values-anchored positions/choices and forms of individual accountability refer to an ethic of responsibility in opposition to an ethic of absolute ends (Weber, 1946).

3.4 Traditional sub-rationality: the embryologist's feeling

Bureaucracy's apparatus demands a rationally trained, 'personally detached and strictly objective expert' (Weber, 1978, p. 975) who eliminates all things that escape calculation (such as personal, irrational, traditional, and emotional elements). In bureaucratic organizations, 'individual performances are allocated to functionaries who have specialized training and who by constant practice increase their expertise' (Weber, 1978, p. 975).

In vitro fertilization can be described as a 'somatotechnique' that highlights the reproductive know-how at the intersection between the biological, the personal, and the

substance (Merleau-Ponty, 2017). In the absence of exhaustive technical guidance in the form of guidelines, the selection of embryos to transfer, cryopreserve, or discard also depends on a subjective dimension regarding the viability of the embryo: the personal judgment made by the embryologist. This sub-rational *traditional action* (Weber, 1978) is based on the embryologist's 'feeling', that is, the practicable knowledge, skills, and expertise gained through professional embodied experience in observing and evaluating embryonic development in the laboratory:

> If I want to see now how the embryos are developing in the clinic, I can see it, and I have a video of the embryo development in real-time [time-lapse technology]. But then, in case of doubt – because sometimes there are doubts – we decide. Our eye decides, and the embryologist's 'feeling' comes in. So, there are A, B, C, and D classifications, and then there is the 'feeling'. (B4-F)

The *traditional character* used in the quality assessment and scoring of embryos is rooted in a belief in habits and daily-life routines and their anchoring in the sanctity of forever valid traditions. In other words, action and decision-making are driven by ingrained habituation and long-standing customs, which then become deep-rooted skills. This occurs especially in the case of embryos that, in terms of quality, can be classified as borderline:

> Then there are those grey cases, so to speak, in which the embryo doesn't develop as expected but hasn't stopped developing either. There are no specific guidelines for these cases. It must therefore be analyzed on a case-by-case basis. And sometimes opinions do not always agree. […] Sometimes it is complicated, and the decision has to be made according to the person who had more time with and who is at that moment taking care of the embryos. (B10-M)

Among the surveyed embryologists, we identified those who establish a duality between what they call the human factor and the algorithm, that is, a parallel between the evaluation of the embryo supported by routine or by standards as distinct grounds for decision-making:

> We look at the embryonic development of another one that has a lower grading, and we wonder [that] 'this one looks prettier to me, but that one has a better grading.' Then it can also happen that we play a little bit with our 'feeling' and our experience of looking at embryonic development and assuming which ones will have a higher probability [of success]. (B10-M)

In this case, 'feelings' are integrated pragmatically into the daily routines and habits of the embryologists instead of referring to an instance of 'affective action'. In other words, this relates to a vague and sub-rational opinion or belief about the potentiality of each embryo that is incorporated in – but also derives from – the repetitive and embedded technical gestures of the professional: 'Sometimes I have to equip myself with a certain "feeling" that comes from the knowledge and experience I already have in order to select the embryos. Because, over these three years of experience, I've seen that often what is described in the literature, in this static classification, doesn't apply to morphokinetics' (B16-F). Biological scientists may also have a 'feeling for the organism', an 'intimate knowledge' about it (Keller, 1984, p. 198), and this emotional investment runs counter to the scientific method.

These critical understandings show a structural tension between the two sides of the convention – between adherence to and blind trust in conventional forms of qualification/assessment and, on the other hand, the doubt and uneasiness regarding conformity with the standard and the contestation of its validity (because of its disciplinary uniformity), making room for other normative perspectives (Thévenot, 2009).

In these cases, the decision-making of the embryologist is co-supported by a routine composed of know-how acquired by learning and accumulating professional experiences (Breviglieri, 2006) through a familiarity with the laboratory setting that goes beyond an action only mediated by institutionalized standards (Thévenot, 2006). Moreover, this mode of acting is reinforced by the existence of studies that show a non-linearity between, on the one hand, the scorings and approved criteria for grading the embryos and, on the other hand, real embryonic development in a laboratory setting. In other words, it refers to the existence of scientific evidence on the development possibilities (albeit weaker) of embryos with a lower grading. Thus, besides knowledge based on personal experience, the evaluative operation is also supported by the consultation of other scientific sources (such as published papers) with recommendations that go beyond what is already officially incorporated in the guidelines; that is to say, scientific knowledge that has not yet been the subject of 'investment in forms' (Thévenot, 1984).

In sum, scientific evidence and personal experience thus suggest greater caution in having absolute confidence and more flexibility in the interpretation of standard norms of embryonic development. However, depending on whether trust is placed in public conventions (guarantees), functional properties (planning), or familiar usages (habits or routines), so these three situations differ in the possibility of being generalizable, communicable, or communalized (Thévenot, 2009) among embryologists or between them and others (doctors, beneficiaries, etc.).

3.5 Affectual sub-rationality: an ethics of care

Just as Weber (2005 [1930]) highlights the ways in which emotions vary in intensity across a diversity of religious groups, likewise, the same can be said regarding embryologists in terms of actions and decision-making regarding embryos. Affect-based action is 'determined by the actor's specific affectual and feeling states', and it may involve 'an uncontrolled reaction to some exceptional stimulus', serving the purpose of working off emotional tensions (Weber, 1978, p. 25). Affectual action and emotion-based action thus overlap as in Weber's foundational definition (Kalberg, 2016): social action may be affectually determined, particularly by emotions; in other words, it is influenced by situations of affect and feeling (Weber, 1978).

In fact, some of our interviewees demonstrate an *affectual sub-rationality* when making decisions and choices about embryos, which is governed by emotions, affects, and subjective feeling states, such as personal conceptions about potential personhood (and childlikeness) or empathy with the beneficiaries' expectations and health trajectories: 'I suffer a bit with couples, I put myself in the other person's shoes, it's a bit empathetic' (B7.2-F).

Besides the international standards, guidelines, and norms for assessing the quality, potential and viability of each embryo, for some embryologists, the selection of those to

transfer, freeze and discard is not totally dissociated from the personalization of the clinical file (Merleau-Ponty, 2018), that is, the specificities of the patient's medical records, therapeutic paths and related emotional states. For example, a couple with a long and emotionally charged clinical history of failed treatments or a scenario of a couple in their final treatment cycle in the public sector and hence their last opportunity to achieve a pregnancy: 'The prognosis was terrible. I carried out the transfer. I spoke to the couple; it wasn't a fantastic embryo; it wasn't one of those that we classify as excellent. It was intermediate, not bad. But it was their last chance, we weren't going to do it any other way. And the couple got pregnant and had a baby girl' (B7.2-F).

Therefore, an embryo of average quality is likely to be evaluated differently in the case of a couple at the end of the legally prescribed age for publicly funded treatment than with a beneficiary couple with the possibility of further treatment cycles and/or where the woman is of more favourable age:

> It also depends on the story of the couple. For example, we have couples with some suffering, where sometimes the best you can get is a B-C embryo, which is a medium-low classification. In our area, this is the major difficulty, even when we look at embryos. Each case is unique and has this emotional part. For example, we write in our file – we have the process [documented] on paper – we have notes on whether the couple has children or not, how many years they've been trying... Notes written by us, embryologists. So, I look at the embryo [Laughs], but when the time comes to transfer, it's not only the embryo. It's the embryo and the whole story of the couple that's there, right? (B4-F)

Some interviewees even describe how their practice has evolved since the beginning of their professional activity in the sense of greater openness to the inclusion of other variables in decision-making. Even if, according to standards and taxonomies, an embryo is not high quality (a grade below B or C), is considered non-viable and therefore should be discarded, the professional may decide to cryopreserve it for later transfer. This decision is not only based on a probabilistic assessment of the development potential (according to the efficiency criteria) but also takes into account what that spare embryo means for that couple: either *hope* or a *last attempt*: 'I think we have to see the whole picture, namely, the context, what it represents for the couple. We have to realize if it's their last attempt. [...] In the balance is the probability of success of this embryo, which can be very low, and, on the other hand, the hope and view of the couple about the treatment and the embryo' (B3-F).

Embryologists manage the psycho-emotional impact on beneficiaries of a hypothetical failure (such as the suffering arising from the non-implantation of an embryo after transfer) and the anxiety associated with the uncertainty of achieving pregnancy that comes with the couple's engagement in the therapeutic plan (Delaunay, 2017): 'I also have to give them a chance to deal with failure in their own way. And that sometimes involves transferring embryos on day three, with low embryo quality, even after warning them about the low probability of pregnancy with those embryos' (B16-F). Nevertheless, as the interviewees highlight, such inflection in evaluative judgment regarding standardized norms demands a well-balanced capacity of dissociating emotional aspects from the technical-scientific ones on which their professional competence is grounded.

Moreover, biological scientists engage in emotional labour in which, in addition to having to manage their own subjective states and feelings, they consider as objects of care

both the reproductive material of which they view themselves to be custodians – 'We become attached, although it's a cell' (B7.2-F) – and the patients seeking a pregnancy for whom they have empathy and provide meticulous technical care (Fitzgerald, Legge & Frank, 2013): 'It's very rewarding to help couples. Even because… there are very few of them, but there are some couples whom I say are "my favourite couples". We're still connected to some of them, socially, outside the team' (B9-M).

This 'ethics of care' should not be viewed as an example of 'value-rational action', as a first analysis might suggest. Instead, the emphasis here is on empathy and care, as well as on 'affect' as a 'sub-rational' (and not simply 'irrational') character of affective action. It should also be noted that the different types of action often overlap and are in tension with one another, as we will further discuss in our concluding remarks.

Embryologists' work – namely, the observation, manipulation, and assessment of embryos and gametes according to personal expectations and scientific norms – also involves affective practices and emotional expressions, such as humour, joy, sadness, or aesthetic judgments (Kerr & Garforth, 2016; Merleau-Ponty, 2018b). For some of the former, embryos, as manipulable technoscientific entities, are both 'matters of concern' in ethical and political terms (Latour, 2003) and 'matters of care' (Bellacasa, 2010): 'The part that worries me most, undoubtedly, is the elimination of embryos. It is where I have a very big dilemma and troubles me and also sometimes […] its [morally] belittling' (B3-F).

Regarding concerns about professional activity, there are situations in which the emotional attachment to some couples can impact the laboratory work – for example, becoming translated into the greater uneasiness of the embryologist when performing the technical manoeuvres:

> We are human, and sometimes, without wanting to, we attach ourselves more to a story; we connect more with a couple. We have a day [involving] greater fragility or with greater tiredness in which it is more difficult for us to concentrate because it's our everyday life; we're people, aren't we? And sometimes, the execution of the technique, when it's technically very challenging, is very stressful. So, I don't particularly like to be shaking when I'm injecting or doing a biopsy or freezing and I'm feeling nervous for some reason. (B16-F)

Other studies have shown that for handling this 'performance anxiety', fertility specialists focus their attention not on the patient as a whole person but on their fragmented bodily parts ('embryo', 'follicle') as more controllable objects to which they can apply their expertise (Fedele et al., 2020).

According to Weber, besides the four types of action, social relationships also offer fertile ground for affectual action, namely, which concerns person-oriented and emotion-rooted relationships. This is the case of the relationships embryologists establish with beneficiaries, which differ according to the type of contact that is maintained between parties over time. In these cases, the social relationship between embryologists and beneficiaries throughout the IVF cycle goes beyond means-end rationality (Weber, 1978, p. 1002), that is, the achievement of pregnancy and the birth of a child. Similarly, this type of therapeutic relationship is not initially restricted solely to the technical achievements of each individual, such as a successful embryo transfer and implantation. Local contexts (i.e., how embryologists from different laboratories conceive and select embryos and interact with the beneficiaries) condition the meaning and evolution of sci-

entific naturalism in reproductive biology in what can be called an 'operative relationship', a chain of actions oriented towards an end, that is, the conception and birth of a baby (Merleau-Ponty, 2018a).

4 Discussion and conclusion

As we sought to explore, the Weberian typology of the four 'types of social action' is useful for analyzing how embryologists relate to their work, namely how they organize professional activity and decision-making around embryos created *in vitro* and their prospective parents. Moreover, means-end rational and value rational action are rooted or indirectly derived from different types of rationality employed to master reality (see Kalberg, 2016), which we found in embryologists' reasoning and conduct.

Practical rationality involves decision-making based on pragmatic considerations about personal/self-interest goals, weighing costs and benefits, and calculating the most adequate means. Embryologists, in their daily work, also assess the potential risks and benefits of certain procedures or interventions to determine the best course of action regarding embryos' successful implantation, thus adopting a means-end rational course of action.

Theoretical rationality – which influences action indirectly – revolves around purely cognitive processes and the systematic analysis of data and facts, with individuals often employing abstract logical reasoning and scientific methods. In fact, embryologists use empirical evidence and scientific research to make decisions that are grounded in a thorough knowledge and understanding of reproductive technologies and patterns of embryonic development.

Formal rationality emphasizes precision, calculability, and predictability in decision-making processes, which are driven by a consistent and standardized process. It involves selecting means that are most effective for achieving a specific goal (means-end rational calculations) by reference to universally applied rules and laws. In embryology, this involves following established guidelines, regulations, protocols, and fixed procedures to ensure efficient and reliable outcomes in laboratory work.

Substantive rationality refers to decisions made in alignment with a larger set of values ('value postulates'), principles, or ethical standards. Likewise, embryologists make choices that align with broader societal values, such as the principles of autonomy, beneficence, and social justice in biomedical ethics – without neglecting efficiency in the performance of tasks – thus engaging in value-rational action.

The following tree diagram schematizes the analysis so far (see Figure 1).

Decision-making about embryos takes place in a plural and contested domain linked to general norms issued by professional associations and ethics committees coupled with predictability through algorithms, the empirical knowledge of embryologists, their moral valuations, and personal affects in relation to patients and the respective biological matter. Tension and ambiguity arise from a plurality of non-coherent values and disputable sources of professional authority and expert jurisdictional engagement in clinical embryology; this leads to processes of critique, justification, and/or compromise in-between technocratic environments and democratic endeavours within different organizational scopes (Blok, 2021). Moreover, determining embryo viability involves complex and precarious decisions

and practical and situated achievements, that is, an enactment or combination of the scientific facts on embryo quality, expert knowledge, laboratory practices, and patients' engagement in the process of selection (Helosvuori, 2018).

From our data analysis, we can claim that, in certain situations for some embryologists, there is a connection between the ethic of conviction and the ethic of responsibility outlined by Weber in *Politics as a Vocation* (1946) and the corresponding ideal types of value and instrumental rationality defined by the author in *Economy and Society* (1978). This practical reconciliation of different ethics/action types entails the subordination of an ethic of conviction to an ethic of responsibility (see Gane, 1997, for another analytical context about the irrationality of political leadership). More specifically, instead of prioritizing their own personal and deeply held beliefs and values (conceptions/convictions about the moral status of the embryo), they emphasize the practical consequences and potential outcomes of their individual actions and decisions they are accountable/responsible for, particularly in relation to the common good.

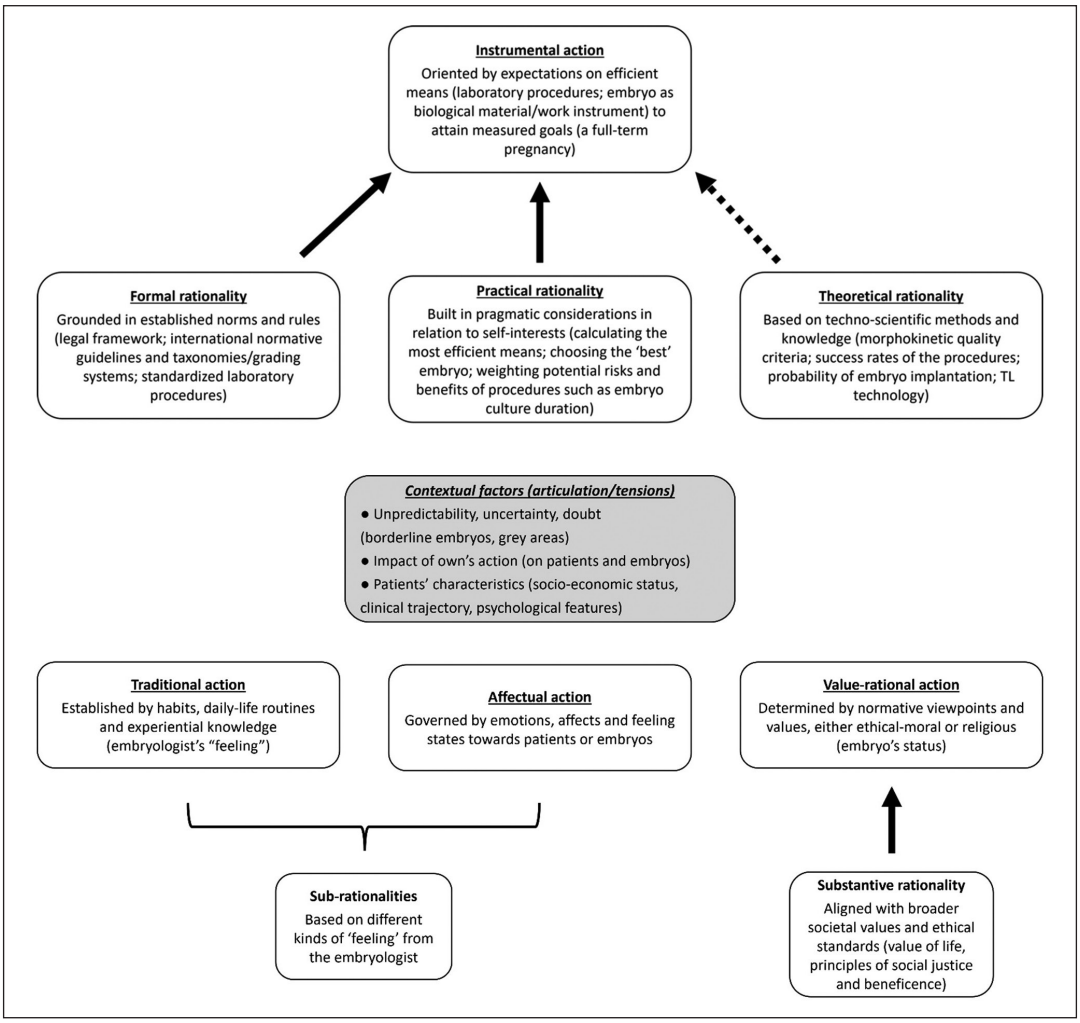

Figure 1 Tree diagram of embryologists' decision-making on embryos

The domain of clinical embryology reveals the disjunction of infinite scientific progress/rationalization and personal freedom already addressed by Weber. The individual is forced to opt between conflicting and even irreconcilable values while conditioned in their ability to choose according to the advance of instrumental rationality. This results in the perpetual struggle between personal conviction and rational calculation (Gane, 1997, 2002).

Critics of Weber's ideal types focus on 'pure' schematic models, in this case, modes of conduct, overlooking the connections between them and also ignoring the plurality of motivations for action. However, Weber also acknowledges the fluidity, overlapping, and mixed nature of his ideal types in historical reality: 'These ideally constructed pure types' always strive 'for the highest possible degree of logical integration by virtue of their complete adequacy on the level of meaning', although there is probably seldom an exact correspondence with real phenomena (Weber, 1978, p. 20). Therefore, it is important to note that these 'typical' cases, while not claimed to be exhaustive, are just theoretical concepts and analytical tools with heuristic value that help to understand and classify complex social phenomena; in real-world situations, human action is often influenced by multiple – and sometimes opposing and conflicting – types of orientation and the interactions or intersections between them, i.e., 'various complexes of motive' (Weber, 1978, p. 10). Likewise, the modes of conduct of embryologists involve tensions but also combinations of different rationalities and motivational situations.

This is the case of the articulation between *affectual sub-rationality* associated with emotion management and an ethics of care in the relationship with couples and embryos (e.g., assessing the emotional impact of a technical decision on couples), without losing sight of the rationalization derived from *instrumental rationality* based on standardized norms and clinical efficiency criteria. Also, that same *instrumental rationality* can be articulated with evaluations and decisions based on experience knowledge associated with *traditional sub-rationality*.

Moreover, *traditional* and *affectual* orientations to action are 'automatic' or 'uncontrolled' reactions to 'habitual' or 'exceptional' stimuli, respectively (Weber, 1978, p. 25). In addition, in our study, these two orientations to action also address different yet complementary dimensions of 'feeling' on and for things and/or people, either as a sense/intuition or an emotional reaction/response to others. Therefore, we believe both these non- or sub-rational dimensions – since they do not involve rationalization in terms of the calculated choice of means – are thus mutually interrelated and should be regarded conjointly. However, while traditional non-rationality is 'socially learned' through experience, affectual non-rationality is 'innate' and 'latent' until called out (Wallace, 1990, p. 217).

Embryologists' discourses demonstrate a 'double pluralism'. Namely, along with the coexistence of different types of Weberian action, we can identify combinations among these types of action – a fundamental element of acknowledging the plural rationalities in clinical embryology. Analyzing embryologists' decision-making using Weber's framework helps to understand the complex interplay of emotions, ethics, values, knowledge, efficiency, and scientific reasoning in the field of ART. It highlights the diverse factors that influence the choices made by embryologists regarding embryos and how different types of rationality and action come into play and interact.

This analysis is enriched when articulated with a pragmatic sociological approach to the different forms of engagement in action (Thévenot, 2002; 2006) of the embryologists, i.e., regarding how these actors seize a given situation and the other human beings (either

patients or health professionals), objects (biological matter, Petri dishes, time-lapse incubators, etc.) and conventions (laws, guidelines, taxonomies) that comprise it. According to both ANT and STS theoretical perspectives, in these networks of shifting relationships between different types of actants, the introduction of high-precision technology in healthcare settings contributes to and complexifies the shaping of social processes (such as embryo decision-making and disposal) and sociotechnical imageries (embryo meaning-making and the attribution of status). We are here in the field of moral and political actions and cultural interpretations, namely the meaning(s) and values attached to 'life as such' (Fassin, 2009) and the governmentality of 'life itself' at a molecular level (Franklin, 2000; Rose, 2001), i.e., the biomedical interventions affecting living matter (the embryo).

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